Feedback in a method of architectural education

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ABSTRACT: Architecture offices often complain about insufficiently qualified graduates entering the profession. This is attributed to imperfect methods of education in schools of architecture. The poor knowledge of technical aspects of the profession demonstrated largely by young designers is usually emphasised. Engineering modules are mostly taught in a traditional way based on model technical solutions for buildings presented in academic manuals. Rarely are the faults, which appear in many buildings as a result of the application of apparently inadequate construction methods mentioned. It seems that many problems with the inappropriate performance of buildings could be prevented by the use of feedback procedures introduced into the educational systems. The results of such *in-situ* research could contribute to better understanding of the processes that had led to premature deterioration of constructions. The proposed method would contribute to an increase in the durability of buildings, which is a basic paradigm of contemporary sustainable architecture.

INTRODUCTION

Many complaints are lodged against architects and builders about the faulty performance of buildings they have designed and constructed. These situations entail high costs for renovations and refurbishments. In some cases, serious dangers are associated with faulty designs or poor workmanship. The problem has two different aspects: one is related to faults in the built structures appearing a short time after starting their operation; the other is a result of the premature ageing of buildings or their components due to an inadequate choice of technologies, materials or technical solutions.

In both cases, the technical or even functional performance of buildings is compromised and this justifies legal actions against the architects and contractors. In view of the increasing number of complaints filed by investors in this regard, it seems essential for architects to anticipate better the potential damage that can come about in the buildings, which they design.

This situation turns attention to architectural schools, which apparently are to be blamed for defective and ineffective educational methods offered to prospective architects. As a result of that, they do not receive a properly modelled scope of technical knowledge that would prevent them from committing design errors in their future work. This serious gap in professional education, characteristic of most architectural schools, calls for discussion about new methods of teaching in this discipline.

CONVENTIONAL METHODS OF EDUCATION

Education in architectural schools is divided into three main disciplinary groups concentrating on artistic, humanistic and technical modules. Depending on the type of school, the proportions of teaching load between these modules can differ. There are schools which, for instance, favour artistic subjects at the expense of the two other modules. This is basically the case of architectural schools or faculties integrated with academies of fine arts. However, there are also schools in which technical modules get their share.

A good example of this can be seen with German architectural schools in which the technical approach to architecture and relevant educational methods assign a relatively high significance to building technologies. This can be attributed to high technology standards maintained in that country.

The ideal educational system, however, due to the traditional approach to the profession, should be as close as possible to maintaining an undisturbed balance between the three. This accomplishes the classic rule considering (in Latin) *venustas* (beauty), *utilitas* (function) and *firmitas* (structure) as basic qualities of architecture [1].

Technical aspects of buildings relate to the term *firmitas*. An overview of the curricula adopted in schools of architecture indicates that technical modules usually account for 11-17% of their teaching programme in the four leading schools in Poland. Based on the idea of keeping a balance between the three modules, one-third of the curriculum should cover technical subjects. However, the real percentage given above is much less than half the suggested teaching load.

A similar proportion of the curriculum is also envisaged for these three modules in the majority of architectural schools in other European countries; but at German universities this percentage is higher. For example, at the Technische Universität München, it amounts to 22%. This proportion is closer to the ideal. The differences indicated have to do with diverse models of education, and the relative high or low ranking position and relevant prestige of schools.

A typical school of architecture teaches technical modules comprising a few subjects, which should provide students with the complete knowledge of technical problems in designed buildings.

Building Construction, Building Structures, Building Physics, Building Materials and Building Services are basic subjects in technical modules (Figure 1). A sort of synthesis of them all comprises the subject *Building Construction*, which considers reasonable and effective methods of using building materials in a way to form stable, durable building components performing satisfactorily in local geographic and climatic conditions. Therefore, it is important for the educational process to use the best possible method of teaching this course.

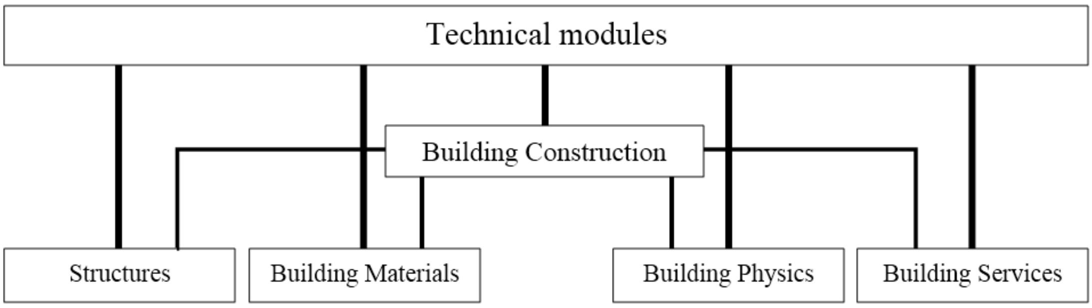


Figure 1: Technical modules in architectural education and their interrelations.

At present, the widely-applied method for achieving this goal is theory-driven instruction in technical design based on the use of manuals containing standard solutions for building components. These are explained by instructors who frequently do not have a sufficient professional experience gained on building sites. In such situations, the subject is compromised by a purely theoretical approach.

As a result, the graduated architects, both while designing and later accomplishing their responsibility as supervisors on building sites, cannot provide the necessary expertise. If they happen to attend practical exercises consisting of construction of some small building components in student teams, as part of the teaching process, which is included in the curricula of some schools, they still are insufficiently prepared for practising their future profession.

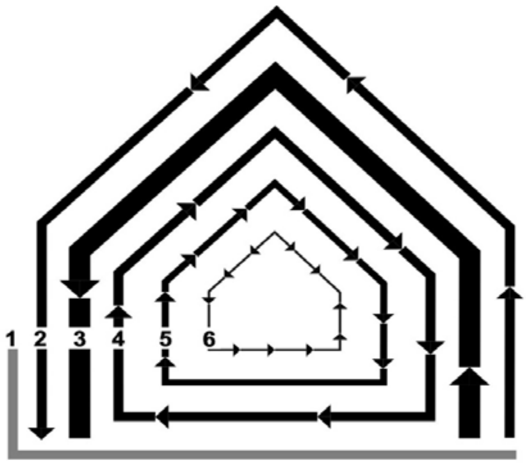
NEW GUIDELINES FOR ARCHITECTURAL DESIGN

The gradually appearing need for essential modifications in curricula, aimed at a substantial increase in the content of technical knowledge passed on to students has been commented on for some time. This comes about not only due to the imputations voiced by investors, as stated initially, but also to new challenges that have appeared since the 1970s, and which have had a great impact on contemporary architecture and methods of designing.

The new guidelines for architectural design take into account the requirements for sustainability of the built environment. Integrated design method, modified layouts determined by the orientation of buildings, compactness of building forms, better insulation and a multitude of energy-related technical systems - this is a set of requirements that should be considered in contemporary architectural practice. This challenge is hardly accomplished by traditional curricula, and particularly in the case of technical modules. Therefore, one can see in the leading architectural schools a gradual restructuring of curricula aimed at better adaptation to the new situation, which is a pervasive tendency towards more sustainability in architecture.

The paradigm of sustainable architecture calls for low energy input in buildings and for their long durability. Both aspects are within the scope of technical subjects, especially, *Building Construction*. Technical solutions in buildings have to do with the choice of materials and structure of building components. It can also be defined as *organisation of materials in buildings* - the term used instead of building construction in some curricula. The materials and stratification of building elements are responsible for energy demand of buildings, whereas embodied energy characterises materials only. Durability of buildings and their components is conditioned by the quality and type of materials, as well as by their stratification within components.

Every part of the building is subjected to modifying and destructive action of various agents. However, the exterior walls, often defined as the envelope, is the system most endangered by premature deterioration. Therefore, from the technical point of view, this building element is crucial and requires special attention from designers and contractors as it conditions the effective operation of buildings. Energy and durability aspects are of primary importance in view of good performance of building skins. The structure of the building is usually protected by exterior walls and its life span is much longer when compared with its other constituent elements. This is comprehensibly depicted in the repeatedly cited diagram of the layers of buildings by Brand (Figure 2).



1. Site; 2. Skin; 3. Structure; 4. Services; 5. Space plan; 6. Stuff

Figure 2: Shearing layers of buildings (based on S. Brand`s diagram [2]).

It is true to say that the durability of buildings depends primarily on the long-time satisfactory performance of their components and structure, and first the performance of their envelopes, the building component most exposed to detrimental climatic factors. Needless to say, all endeavours of architects towards achieving better quality of designed architectural objects should be concentrated on the appropriate technical solutions to the components of exterior walls. This should also be the case for the technical modules within the educational system in schools of architecture. It would provide the graduates in architecture with appropriate skills permitting them to design sustainable buildings responsibly and, thus, to meet the paradigm of high durability.

Table 1: Shearing layers of buildings and their longevity (based on S. Brand`s diagram [2]).

Layer	Components	Useful life (years)
Site	Graphical setting, urban location	*Eternal*
Structure	Foundation, load-bearing elements	30-300 years, average 50-60 years
Skin	Exterior surfaces	Average 20 years
Services	Technical installations	7-15 years
Space plan	Interior walls, ceilings, floors, doors	Commercial spaces 3 years, homes 30 years
Stuff	Furniture, appliances	Weeks (10-20 years)

FIELD STUDIES AND EDUCATION

The traditional method of teaching building construction, consisting of the analysis of appropriate solutions for building details turns out not to be very reliable, as many examples of faulty envelopes have shown. It seems that a much better approach to the problem of effective teaching in this regard would be a method of *reverse analysis* consisting in carrying out research works *in situ*, on building sites. It is actually tantamount to the feedback method used effectively in many other disciplines and fields of professional and economic activity. The proposed method of using feedback procedures is basically not new in architectural design. Evidence-based design (EBD) and performance-based building design (PBBD) are the terms which are used to define new methods of designing buildings based on information from research [4].

They usually relate to Vitruvian *utilitas*, sometimes including *venustas*, and as a rule involve the participation of end users. The technical solutions to buildings, corresponding to *firmitas*, do not result from the use of this method; however, they can also be formulated in a similar way using feedback. However, the method seems to be more complex in this case, as it is based on many variable components.

The participation of the users of buildings is only sporadically constructive. For technical systems in buildings, due to their multiple interrelations and crucial impact on durability, the most appropriate method seems to be performance-based building design (PBBD). Its transplantation to the educational systems of architects within the technical modules would permit an improvement in the effects of teaching. Because this method is based on case studies, the students would inspect the conspicuously deformed or destructed fragments of envelopes, in order to identify them and to carry out their documentation in the form of hand sketches, photographs and diagrams.

A valuable inspection of analysed details would also require discussions as to the potential and registered causes of specified damage. An indispensable team participant at this stage should be a competent, committed and inspiring instructor who would help the students to track the causes of damage done to a building envelope, as well as to analyse the whole destructive process leading to the appearance of imperfections.

The second stage of this operation would take place back in the school and consist in a further in-depth study and extensive debate on the problem of mechanisms of degradation of technical systems and materials, the *cause and effect* mechanism or synergic action of all identified and presumable destructive factors. Extensive use of accessible professional manuals and books, as well as advice offered by other tutors would be of much help. The result of this procedure should be a conclusion as to the degree of conformity between the assumed performances of originally accepted technical solutions with its final performance in the lapse of time. Finally, the students should formulate indications concerning recommended modifications of conventional detailing contained in manuals and other instructive materials.

A positive element of the proposed educational method would be encouragement to co-work with students of other related engineering disciplines. It would certainly be a valuable experience for all members involved in interdisciplinary student research teams. This would also help the students to get used to the good practice of using feedback from the buildings they design in their professional practice as this habit is normally missing in practising architects.

Research conducted on the interest of architects in the performance of buildings they have designed indicated that very few of them ever take the effort to visit and inspect them [3]. If this happens, however, it is the owners who call them in emergency situations. In their normal practice, it does not come about. They devoid themselves of an excellent opportunity to gain a valuable feedback to redefine the design problems permitting them to acquire precious professional knowledge and to avoid committing errors, while producing details for buildings that they will design in the future.

The feedback method (PBBD) in building construction design makes it possible to reveal and identify a causal loop [5] represented by a relevant diagram showing a reciprocal flow of influence between the architect’s technical concept for a building detail or component and the effect of its installation later (Figure 3).

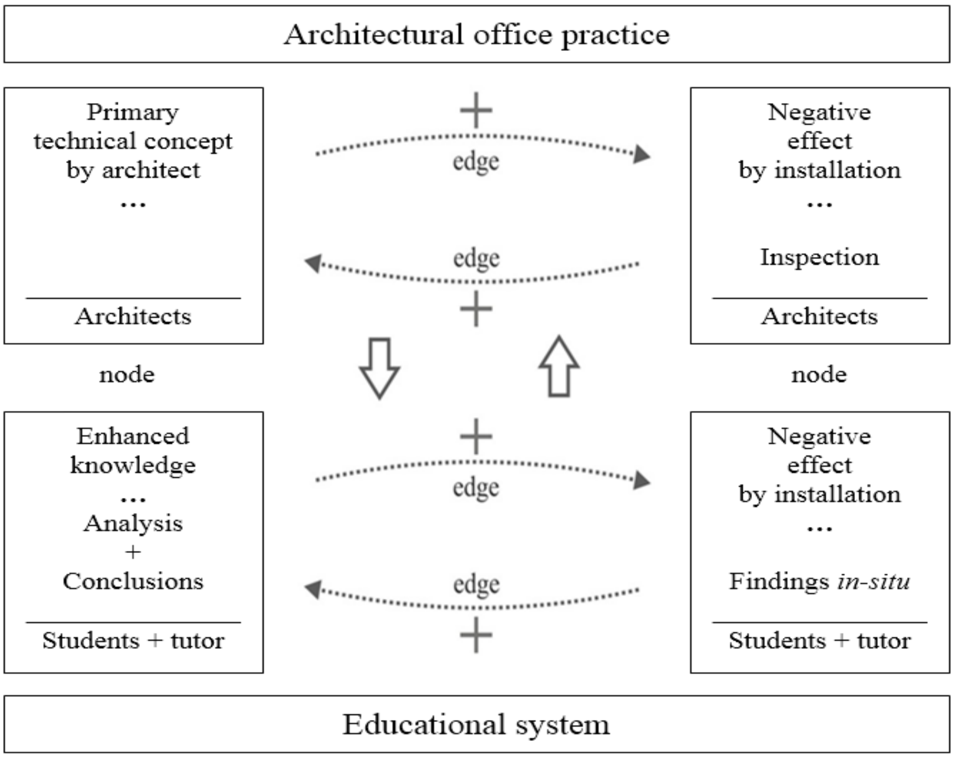


Figure 3. Causal loop diagram (feedback loop) in architecture technical design and education. Interrelations between architectural practice and educational system.

The appearance of the first signs and evidence of degradation, inspected by the architect *in-situ*, should influence his or her future work in a sense of optimising the concepts produced, so that previous imperfections are not repeated.

This would lead to a substantial improvement in the technical quality of buildings and to a postponement of the appearance of damage. The resulting increase in the durability of buildings, in particular of their envelopes, provides an opportunity to fulfil the durability paradigm for sustainable architecture.

Another causal loop would appear between the findings in building envelopes during inspection and the resulting analysis and conclusions, enhancing the educational system. Borrowing the causal loop from professional architectural practice and its introduction into the educational system would instil good habits in architecture students, and it would better prepare them for taking up technical challenges in their future professional activity. This would give them the edge over competitors in the market, who have been educated in a traditional way.

The systematic repetition of inspections and their findings *in-situ* can enhance the store of professional knowledge. This can be depicted as a superposition of causal loops, each of them representing singular cases of mutual relations between the technical state of a building detail or component and the relevant resulting expertise of the architect (Figure 3). Figure 3 presents the so-called positive reinforcing causal loops as they depict progressive processes both relating to the rising quality of designed buildings and the higher quality of education in technical modules.

CONCLUSIONS

The proposed method of empirical educational research applied to the subject *Building Construction* taught in architectural schools would contribute to an increase in the durability of designed buildings, which is a basic paradigm of contemporary sustainable architecture. It requires certain modifications in curricula, as well as in the timetable of courses.

Field visits, as a basic and indispensable feature of the method, are time-consuming so some shifts in the routine planning of courses seem to be unavoidable. This could lead, in many cases, to the resulting extension of teaching load for technical modules. However, a good organisation of field trips and prior investigation of sites along with an effective transport arrangements for students and instructors could reduce the increased teaching load and other relevant inconveniences. A higher level of competence of prospective graduates in architecture would certainly permit an improvement in the quality of designed buildings and their durability, thus, also contributing to an enhancement of their sustainability.

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