

The Teaching Construction and the New Materials and Techniques

What should be the necessary competences and skills acquired through construction education that allow architecture graduates to be capable of following the rapid development of the building industry in producing new materials and new construction methods respectively ?

What should be the necessary educational methods and strategies to ensure these competences and skills ?

I will answer the question, in the field of materials and components for architecture. I teach this subject at two stages of the curriculum. For the bachelor's degree and the master's degree.

I will conclude with some ideas about the Ph.D. ; to complete the european LMD.

In general, we never know what type of new material will come to market in the future. We can note 2 major trends in the production of building materials, which influence future evolutions :

- scientific progress elaborates new materials, every day, especially with composites, polymers, and mixed materials.
- Due to diminishing mineral and fossil resources, it is necessary to find feasible substitute materials for the future.

One didactic strategy to teach « unknown knowledge » is to allow open reflection.

I try to apply this principle in my two courses.

During the bachelor's degree, students may be able to analyse and understand how and what materials are made of and to identify technical and architectural characteristics of the materials.

To reach this aim, I organize the courses about principal materials in 2 parts.

Principal materials are :

- mass materials such as clay, brick, stone, concrete
- structure materials such as wood and steel
- enveloppe materials such as glass, polymers and also plaster.

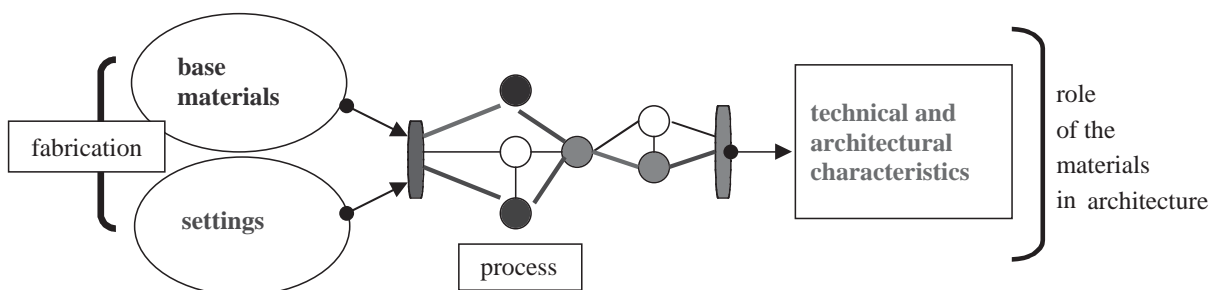
In the first part of the lesson, I show that the transformation of base materials belongs to a systemic process, with interchangeable elements and settings, composed in different manners to obtain technical and special specifications.



*Mass, structure and envelope materials.
Examples of Peter Zumtor's architecture:
Thermal Baths. Vals. Switzerland
San Barnabe Chapel. Switzerland
Kunsthau. Bregenz. Austria*

In the second part of the lesson, I show the material's role in an architectural design, with case studies from contemporary architecture, or from vernacular and traditional architecture.

The understanding of this systemic process, makes the students conscious of phenomena which appear in the fabrication of any material and thus any architecture, without binding them within a limited knowledge of present day techniques.





*Base materials of concrete:
Each new material depends on type
of base materials*

To summarize, the 2 major trends mentioned above, are integrated in the manner of teaching :

- first, in the future, students will be able to ask appropriate questions to discover any new materials and so, will be able to understand their composition and fabrication, related to architecture.
- second , sustainable development requires knowledge about materials and energy. It begins with the analysis of the process to identify renewable or recyclable materials and low energy settings.

The second course that I teach, is offered during the master's degree.

A this stage, I think that students (only interested students) must be able to design components for building, using the possibilities of tomorrow's technologies.

This idea is founded on several trends of evolution.

First trend

The first trend that I have identified concerns the reality of the building site.

The « value added » of the materials moves from the building site to factories. Trades of building are changing in a deep way. Labor intensive work is disappearing from the building site. Construction workers become people who assemble complex components which are produced in factories. These complex components require design. Architects are able to design these products with engineers, but are not specifically trained to do this.

Second trend

Base material notions are enhanced through the association between different materials. For example, the use of polymers transformed traditional materials :



The value added of the materials moves from building site to factories.

- laminated glass would not exist without butyral film
- new high performances concrete would not exist without admixtures (adjuvants)
- laminated wood or OSB panels would not exist without glue.

and so on...

This infinite variety of products requires the definition of expected performances for the building construction. We must know the specific functions of a material in a building before fabricating it. It is like the definition of a program for architecture. It is an integral step of the design.



*Definition of the materials for architecture.
The concrete of Pont de Normandie (France) is not the same that Roland Simounet used for the Musée de Nemours.*

Third trend

Computers allow the management of more and more parameters in the process. So limited fabrication to the scale of one building is possible today. But architects must be able to specify and order this kind of production.

Fourth trend

New trends in architectural design are created with surface materials. For example, the skin of a building becomes a major element of the architectural composition. New software modelling programs have liberated the boundaries of forms to various non standard conceptions. Architectural concept design is focused on materials and textures in a more sensitive manner. For example, acoustic qualities of a material are

considered with as much attention as the visual design quality of these materials.

In addition, the study of the envelope is focused on the dialogue of the building with its surrounding environment. And this is a very important aspect of contemporary building.

So, presently, architectural design works a lot with materials 'specifications.

Fifth and last trend

In certain cases, the client, or the contacting authority, makes decisions about material choices, their lifecycle and their upkeep. They may even elaborate technical systems which determine these requirements at the first stages of concept development of a building.

These five points of evolution, observed from factory to building site, show the necessity of materials design. It has become a foundation element of architectural design. It is an integral part of the design process if architects want to control the realisation of their building.

The teaching method elaborated to respond to this development is composed of theoretical courses on materials, meetings with members of the building materials industry, visits of factories and special building sites.

In addition, the project design is divided into two parts :

1. definition of the role and the functions of materials, in other words, specifications writing.
2. materials design.

These 2 steps are studied simultaneously and in conjunction with each other.

The problem formulated by the project, to be appropriate to the evolution, is the choice of the subjects. To be sure that students will be interested, I let them choose by themselves the project they will study. Clearly, their motivations and ideas belong to the culture of the future. They will be the actors of the future, more than their professors will be. With this didactic strategy, this year, for example, they have studied components for renewable energy related to architecture and urban design.

Finally, I would like to formulate wishes for a future Ph.D. The concepts that I have exposed above, may be continued in a Ph.D. degree with experimental research on materials for architecture.

Such as methods used by scientific researchers, we should build research protocols and their validation, which include the complexity of architectural criteria, where artistic creation, which is related with the meaning, is as important as rigorous scientific criteria.

If we succeed in achieving this kind of research, maybe european research related to the Grands Ateliers, we could pretend to produce alternative technical knowledge in opposition to engineers rules which supervise the construction today -as CSTB in France- , it will be a chance to provide the necessary technical evolution in architecture, including its own quality criteria.