

# Open Knowledge Community for Building Technology. An Approach on Continuum Design-Construction Teaching Methodology

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**Abstract:** *This announcement is an approach on continuum design-construction methodology. It presents the first results of pilot educational model for the teaching of building technology courses, as applied in the course Building Materials – Building 1&2 in the department of Architecture, University of Thessaly. It is the first phase of the development of an “Open knowledge community for building technology” (OKCBT). An “OKCBT” has double substance; on one hand there are the various “sites-nodes” where production of knowledge occurs, and on the other there is “digital network” connecting these. More specifically, “sites-nodes” are the places where the lessons –workshops take place, as well as the places where collectivities meet related to the production of the knowledge of Building Technology. The “digital network” is the pilot internet platform for interconnection of the Community. The ultimate goal of the research effort is two-fold. On one hand there is the broadening of educational tools and intelligent systems. On the other hand, there is progressive creation of an open catalogue of Building Technology which will be supplied by knowledge communities and will be capable of incorporating relative knowledge. The scope of reference extends from whole building and its construction modules to the building products and materials.*

**Keywords:** Open Knowledge Communities, Building Technology.

## 1. Introduction

Knowledge communities are self-organized informal groups, which have a social meaning for their members, who positively assess the relations formed in the community. Knowledge communities are learning communities and they are formed around common goals and things that make sense. Knowledge communities are about a joint effort to solve problems, they are warehouses of tacit knowledge, they can make tacit knowledge explicit, they can keep the organization at the cutting edge of knowledge creation, they can utilize their members’ emotional intelligence index and make a strong impact on education.

The pilot development of the Open Knowledge Community for Building Technology is basically aimed at the acquisition of explicit knowledge and tacit knowledge related to the subject of building. This is why the community is approached in the sense of its double existence, so as to include the transmission of knowledge through the written and the spoken word, but also through experience, with the development of laboratories.

A knowledge community cannot replace the bibliography of the science of building, nor is it solely based on the use of digital technologies for the transmission of knowledge. A knowledge community can, however, contribute to the update of knowledge related to the subject, the support of the educational procedure to incorporate new teaching practices, the extroversion and facilitation of the exchange of knowledge and experiences so much among professors as between professors and students, the strengthening of the role of students for the formation of a knowledge framework, the interconnection with extra-university collectivities and

bodies concerned with similar practices and sharing common interests.

## 2. Methods / Approach

In architecture, parametric logic involves the design of objects based on the description of the relationships between their properties. In this sense, it allows the re-definition of the final result by changing one or more of the item’s components. Based on the above frame, two basic research questions are formed:

- 1) How does one form an open knowledge community whose core cell will be the Architectural Technology and Research Unit?
- 2) How does one form an open segmentation of building elements and components with an aim to create correlated lists of fixed and parametrically defined properties of the whole, the building units it is made up of, the building products and materials participating in these?

Research states and evaluates a general hypothesis for the parametric definition of architectural / constructional elements and materials, and will identify the individual concepts related to this. For this reason, an Open Knowledge Community for Building Technology is being piloted, part of which is the digital platform.

A second series of questions that arise on a second level is: Does this assumption lead to a different way of training architectural engineers? Can part of the course be designed through the creation of active collectivities (e.g. students and professors) in such a way that it can accept changes and unforeseen events, without losing its identity? Can it finally

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lead to a definition of the architectural project different from those in existence to date?

As a general principle, the definition above is assessed by a triple process putting forward that during the definition of parametric properties:

- A segmentation is defined in elements that may also be constructive.
- The properties of each element are defined, which can be altered or redefined over time.
- Relationships between the above elements are defined, by defining their data and property relationship diagrams.

Question subsets are then defined:

The first relates to the comment of the fact that the segmentation of an architectural project into fixed and changing elements may be considered a basic design choice of the architect, allowing the production of multiple design solutions. In which direction does the architect want to allow changes? Which relations does he support and which does he reject, given that the possibility of everything affecting everything may result in a non-manageable complexity?

The second refers to stability over time, the uniqueness of a building segmentation model. Is it possible to change segmentation from one building to another? Is it related to the typology of the building and what is that? Can it change during the design of the architectural project? Can this change in segmentation also arise from the interchangeability of the individual elements, during design or due to the influence of the changes of other elements (when values of a construction element reach a threshold point, the possibility of a change with another element that meets the specifications is examined).

The third question subset refers to the education procedure per se, to open knowledge communities and their operational support tools. Can an open community constitute an open library? What role will the teacher have in controlling and managing information? How easily can the content be enriched? What must be the correlation with the laboratory course? Can design projects be correlated with the digital platform? What must the platform interface be like so that it is user friendly?

If we focus on the architecture school curriculum we will notice that it is structured around two forms of education: courses – lectures and courses – labs. Focused forms, they take place at a specific place and time. The theoretical question here is whether the lesson in the lab can be transformed into a course-event, that is a course with a changing curriculum that can receive and activate situations and activities other than those of the original education. Activities that presuppose the creation of dynamic information and knowledge maps for all, the use of open codes and freeware, and the cooperation of various collectivities (teachers, students).

The “Open Knowledge Community for Building Technology” refers to a large-scale research. The present project will focus on the presentation of the results of the

first phase and in particular the third subset of questions referring to the operational integration of digital tools.

### 3. Results / Discussion

As mentioned above, parametric logic seems to have a dominant role in architectural design, therefore the intention of design is initially described by the definition of the geometric limitations and freedoms, by the limits of the dimensions and by relational parametric equations. This logic seems to relate to the entire building and its constructional properties, even the building blocks and the construction materials. Parametric design thus seems to apply a practice of holistic control and manipulation of the item in all scales, from the individual to the whole.

Two issues arise during the attempt to apply a parametric logic in architectural design:

The first refers to the segmentation of the whole into individual correlated parts. Although the logic of associated individual parts is encountered in architectural theory and practice, with a certain degree of ambiguity, the introduction of rational segmentation encounters difficulties, seems to lack the theoretical background or in the best case applies a given segmentation that usually corresponds to a (local) model of the construction industry. The study objectives at answering the question whether one only segmentation should be applied to a given project or whether there should be a logic of multiple, co-existing, interconnected segmentations, and how this could happen. For instance, how it could be possible for constructional segmentation to coexist interconnected with the operational segmentation, when changes in one affect the other, or when limits set by the one define the other.

The second refers to the determination of the properties of the elements that may change and the determination of their influence on other elements and the whole project. Today the common trend is a technical determination of properties relating to performance specifications which are considered “objective” and are usually defined by the regulations of the construction. Is it possible to make a clear but subjective definition of properties on the basis of the architectural objectives set by the design of each project? How is it possible to describe these with relevant preciseness so that they can participate in parameter definition?

The proposed research will attempt a generalization and a broader definition of correlations for elements and properties, which in simple cases have already made their appearance. For instance, parametrization of the dimensions of an opening presumes the relative stability of the frame cross-sections, while at the same time it affects its bearing constructive unity (let us suppose that is the brickwork). How is it possible to also introduce parameters that relate to natural properties of the materials and not only parameters relating to their geometrical features, as is usually the case in the majority of cases? To what extent is the definition of parameters dependent on the limits set by the digital tool per

se? Is it possible to formulate specifications aimed at software developers relating to architectural construction?

The project scope extends beyond the whole building and its constructive units, to the construction products with a focus on the construction materials, for educational purposes.

Conceptual tools:

A transition is observed from the management of the architectural element as a static entity that can be analyzed to the management of possible and unavoidable changes. The objective is to control the architectural procedure to a unique and sole strategy of creativity. This control relates to the procedure from conception to materialization, the dissemination of the tools of application, the potential participants and finally the development of their theoretical frame per se.

The wide spread of computers and the new possibilities of parametric design in the 90s lead to the first attempts to include the above concepts on materials in architectural design. The new way of thinking attempts to create works which do not operate either as independent creations of an architectural intellect, or as machines that satisfy building needs. It creates forms that change depending on the change of the external conditions, trying to retain their independence and uniformity. The discrimination of identity is sought through the multitude spatial interconnections with finite or non-finite powers:

Before we continue, “a minimal theoretical note is required: Latour states that the artifact, and thus the architecture, is considered a catalyst for collectivities, and it cannot exist outside these. Its conception, creation and use are ways of existence of collectivities. Society does not exist before and outside its artifacts, nor is it simply formed by them”.

We can define each organism or subject as an emerging entity within a field of such entities. “Such a field is not a simple hierarchy of levels, because it allows us to move ‘downwards’ through the sub-units or the factors from which the organism or the subject emerges and ‘upwards’ to the social mechanisms in which the organization or the subject is an element of an emerging entity”.

In this research, the building – construction is considered a multitude of elements and entities that interact with each other forming a different assemblage each time, depending on the scenario or the relational model.

In accordance with all the above and based on Manuel DeLanda’s assemblage theory, the concepts that will be researched are:

- Elements
- Entities
- Properties
- Assemblage
- Materiality

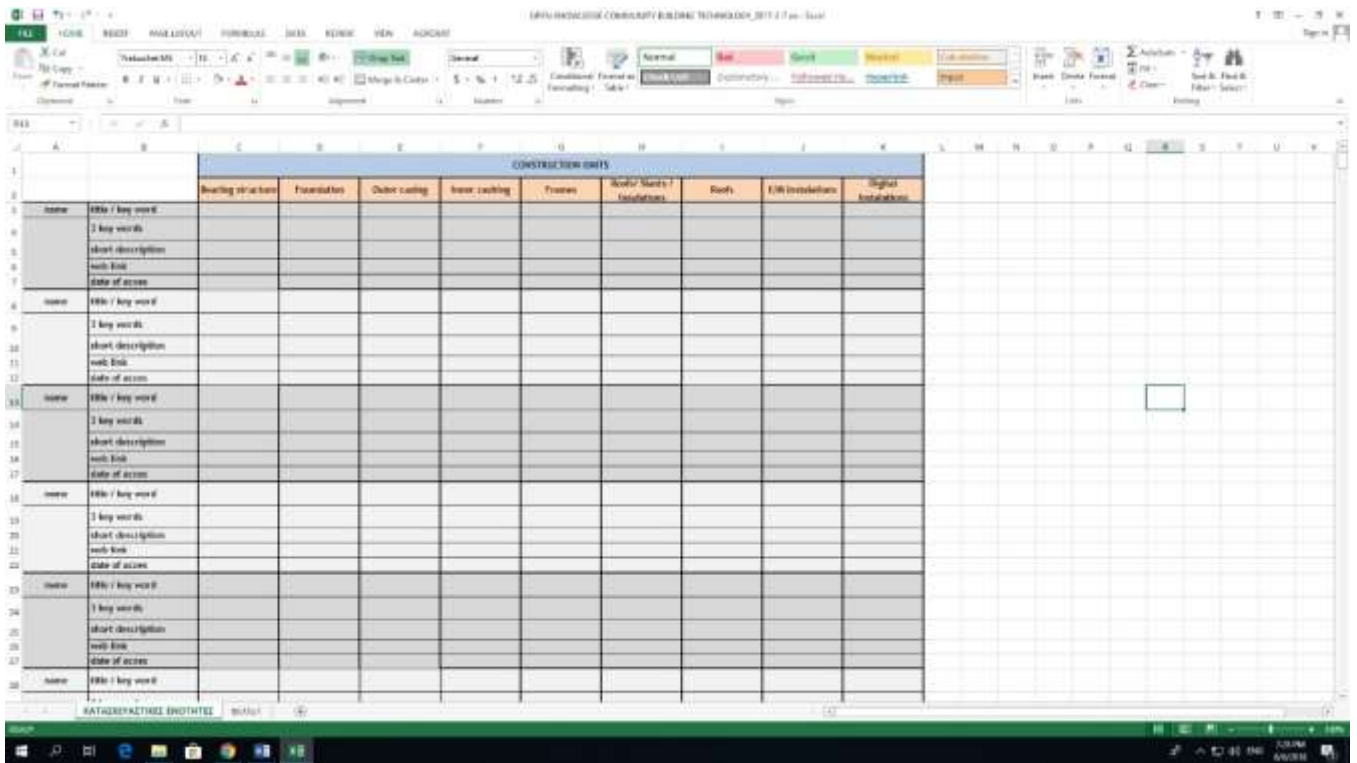
### **3.1 Digital Platform of the Open Knowledge Community for Building Technology – Version 0.1**

As stated above, the “Open Knowledge Community for Building Technology” concerns large-scale research. The present project will focus on the presentation of the results of the first phase and in particular the third sub-set of questions concerning operational inclusion of digital tools. The first pilot issue of the digital support platform of the “Open Knowledge Community for Building Technology” was created in a spreadsheet on the open platform of Google Drive. We did not include matters of construction segmentation, the construction units were considered given and we focused on participation, the development of a dynamic library and mainly the evaluation of the first results. The digital platform (see figure 1) was organized as follows: Horizontally there are nine (9) fields corresponding to nine construction units based on which a small-scale residence can be described, as set as a project on the course during the fall semester of 2016-2017. Horizontally, the fields are:

- Bearing structure
- Foundation
- Outer casing
- Inner casing
- Frames
- Roofs / Slants / Insulations
- Roofs
- EM installations
- Digital installations

Vertically there are six (6) fields to be completed by users for as many construction units as they desire, and they are

- user name
- information title
- key words (up to three words)
- brief description of information (up to fifteen words)
- hyperlink allowing user to connect to the website where the initial information was found
- Date of last access to the hyperlink



**Figure 1:** Spreadsheet on the open platform of Google Drive

All students on the course receive an invitation to participate by the administrator and then have free access to the spreadsheet so that they can complete as many fields of information they want. The information must be correlated to the specific subject of the course (small-scale residence) and included in one of the construction units of the platform. The type of information (designs, texts, 3-Ds etc), the sources of the information (if it is from commercial, scientific etc. websites) is unlimited. Generally, there was no limit as to the search criteria. The only limit that was set was to not repeat entries. Students were to check the previous entries of their colleagues and add one new one each.

#### **4. Results / Discussion / Evaluation of the operation of the digital platform**

At the end of the fall semester of 2016-2017 a first evaluation of the data entered by participants, the results and diagrams of which are presented further down (see figure 2). In the first semester of pilot operation there were sixty-one (61) entries in total. Of these, twelve (12) were about Attics-Slants-Insulations, ten (10) about frames, nine (9) about foundations, eight (8) about the bearing structure and the outer casing, six (6) about roofs, five (5) about EM installations, three (3) about the outer casing and none (0) about digital applications. One first conclusion is that digital installations, the outer casing and EM installations were not popular, which may be connected with the non-

understanding of the construction units on the part of the students and the failure to transmit knowledge on the part of the teachers. Especially for digital installations, we can say with certainty that there was no reference to the course laboratories, but there was also no request on the part of the students for knowledge related to digital installations. We must also mention that there was a small percentage of failure (5%) in the use of the terminology, which corresponds to three (3) entries. Two out of three terminology failures are related to the organization and analysis of construction units. The analysis of the construction units is an important matter that needs further investigation. Finally, limited term repetitions were located in frames, foundations and entries, which may be associated with the wording of the exercise, which did not make it clear whether there should be repetition of the terminology, or the fact that one term may include many different interpretations or sub-units. For example, the term wooden frames in an entry included the interpretation of the term from a dictionary and in the second one it included specific details on wooden frames from a student dissertation. Respectively, the term wooden frames in one entry included an axonometric construction design and in another details on wooden roofs from a presentation on agricultural and greenhouse constructions. Both these examples display a need for further research in the matter of constructional analysis.



technology, special interest is presented by these four examples stemming from the Technical Chamber, the NTUA School of Architecture, private initiative and a non-profit organization:

- The Construction Materials Guide of the Technical Chamber of Greece [http://portal.tee.gr/portal/page/portal/MATERIAL\\_GUIDES](http://portal.tee.gr/portal/page/portal/MATERIAL_GUIDES) (accessed on 09/03/2017)
- Student – research projects of the course “Information Management and Architecture” during academic years 2003-2004 and 2004-2005 <http://archtech.arch.ntua.gr/inman01/index2003.htm> (accessed on 09/03/2017)
- The online publication <http://www.buildinghow.com/el-gr/%CE%A0%CF%81%CE%BF%CF%8A%CF%8C%CE%BD%CF%84%CE%B1%CE%92%CE%B9%CE%B2%CE%BB%CE%AF%CE%B1%CE%A4%CF%8C%CE%BC%CE%BF%CF%82-%CE%91%CE%95%CE%B9%CF%83%CE%B1%CE%B3%CF%89%CE%B3%CE%AE-gt> (accessed on 9/3/2017)
- Wikipedia [https://en.wikipedia.org/wiki/Main\\_Page](https://en.wikipedia.org/wiki/Main_Page) (accessed on 09/03/2017)

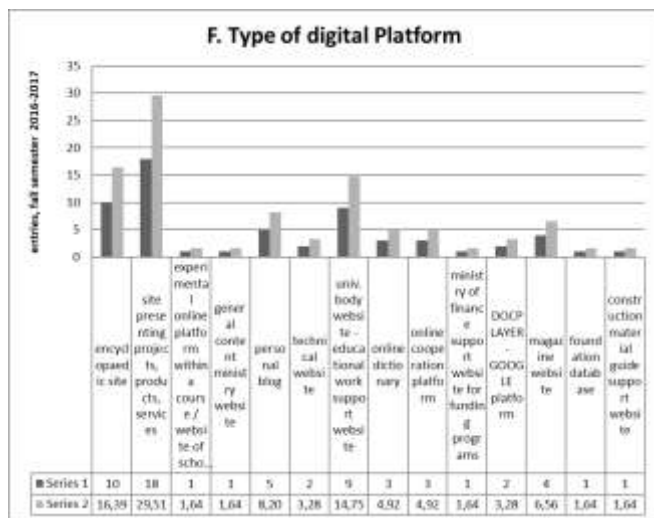


Figure 4: Type of digital platform

The type of information, the method and the tools of representation are an important element for the successful development of a knowledge community. As shown in Figure 5, 90% of entries contained text, 46.67% a photograph, 46.67% a three-dimensional design, 43.33% a sketch, 25% hyperlinks and references, 23.33% a linear design, 15% a moving image, 3.33% an animation, 1.67% interactive applications, 1.67% a chat, 1.67% a forum, and 13.33% there were other types of applications. As it is evident, a large number of applications and information representation tools concerning building technology were presented. The combination of the tools seems to be the basic guide for an operational digital platform related to the subject of building. Another important criterion is the type of scientific information and the way it is segmented so that it is presented in a suitable manner. Another ascertainment is related to the fact that most applications concern static information, and that there are no examples of user

participation. The only application that has participation features was <http://www.koufomata-myconstructor.gr/>. The application does not provide knowledge related to the construction units of frames but it is a cooperation platform among candidate buyers and aluminum installation teams. Candidate buyers can input information related to the type of frames they are interested in buying and then receive quotes.

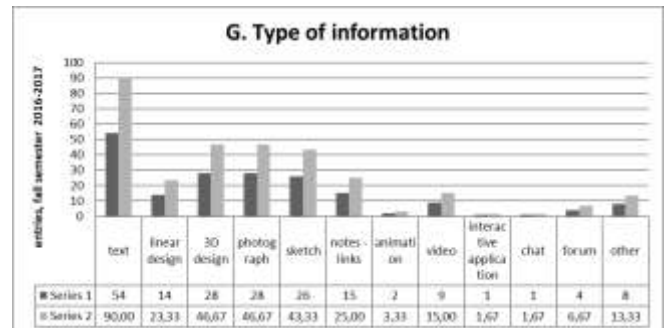


Figure 5: Type of information

### 5. Conclusion

This proposal introduces innovative elements on three levels: Firstly, the change from the perception of architecture as a form or (and) an operational organization responding to a given architectural programme, to the perception of architecture as a segmentation of elements, at the same time defining the properties of the elements and relational properties of different elements.

Secondly, the approach of the knowledge community as a system with a double entity made up of sites-nodes where the knowledge producing activity takes place and of the digital network that connects them.

Thirdly, the connection of the two above levels for the creation of an Open Knowledge Community for Building Technology (OKB4BT) which is a different approach to the method of teaching the subject of Architecture.

With respect to the contribution of the project to theoretical and applied science, we can state that the perception of architecture as a segmentation into elements, while at the same time defining properties and relations of the various elements, corresponds to design requests in changing environments for the housing of constantly changing uses. At the same time, this concept considers architecture as a field of forces, and architectural projects as a catalyst of the consensus of these forces which are at a potentially changeable balance.

The above concept of the subject of architecture requires a different approach to the way of training architects and the design tools in the subject of Architecture. This is exactly where the contribution of the proposal in applied scientific knowledge focuses.

It is the development of a Tool/Knowledge Community that aspires to interconnect architectural education with architectural practice, become the “Common Place” based

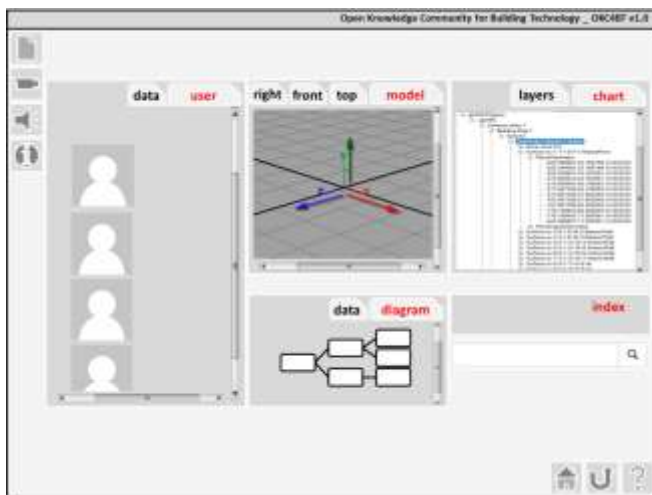
on the cognitive proximity of local and global knowledge communities.

On a level of software development, a pilot open platform is being developed (educational tool) which, among others, will allow for the evaluation of the research and open perspectives for the addressing of issues such as access to specific groups of people, the development of further evaluations, the optimization of the user interface, the investigation into matters of intellectual rights

## 6. Future Scope

The next steps in research and development of the Open Knowledge Community for Building Technology must focus on:

- The further development of the digital platform. The user interface must be improved, the graphic design must be improved, as well as the functionality and the possibility for easy finding of terms and information.
- The development of construction analysis and interconnection of the terms. There must be the possibility of adding fields relating to construction units and interconnection of construction units.
- The further evaluation so much of the digital platform as of the educational procedure used in the laboratory. Within this frame, it is important for the evaluation to include the educational material given in the course, the methodology of the course, the student projects and the operation of the digital platform. A part of the material above should possibly be included in the digital platform.
- The opening of the community outside the university area and the technical response of the digital platform to a larger number of users.



**Figure 6:** Indicative pilot print screen of the digital platform for the support of the Open Knowledge Community for Building Technology

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