Operations of Conception in Architectural Collaborative Design

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Abstract. This paper presents an ongoing research on computer supported collaborative design carried out by the ARIAM-LAREA laboratory at the Superior National School of Architecture of Paris-LaVillette. The aim of this research is to analyze computer mediated architectural design practices in order to identify the specific “operations of conception”. Two observations of architectural collaborative design supported by computer tool called “Studio Digital Collaboratif” have been conducted: one concerning collaboration between architects, in laboratory, the other one between architects and engineers in a real situation of design. Our analysis use two concepts to explain the collaborative conception in architecture: classes of operation of conception and operation of conception. They permit to identify the elementary operations of conception and pragmatic operations of collaboration. According to the first results it seems that classes of operation of conception are shared but operations of conception seem to be unshared.

Keywords. Collaborative design; architecture; cognitive operations of conception; architecturology; CAD

Introduction:

This paper presents an ongoing research on computer supported collaborative design carried out by the ARIAM-LAREA laboratory at the Superior National School of Architecture of Paris-LaVillette. The aim of this research is to analyze computer mediated architectural design practices in order to identify the specific “operations of conception”. We choose to use the term of operation of conception and not operation of design, because we distinguish “conception” from “design”. For us, “Conception” refers to cognitive activity aiming to create a new architectural space, while “Design” includes all the activities that are implied in architectural projects (Guéna and Lecourtois, 2009).

The assumption underlying this study is that there would be collaborative design when “operations of conception” are shared by the designers. So, modelling the collaborative architectural design and characterizing the specific operations of conception involved and shared in the collaboration could allow
us to propose a system that can support the architectural collaborative design in professional contexts.

Since 1990, many researches have focused on architectural collaborative design supported by computer. Most of the existing systems are used to share data between actors in the last stages of design activity (Eastman 1999). They cannot be used at the beginning of an architectural project. In order to define needs in tools for supporting the collaborative design, many researchers have observed and analyzed the activity of collaborative design (Case and Lu, 1996; Marshall 1998; Sminoff and Maher, 2000; Arjun and Pulme, 2006). Most of these experiments were done in laboratory or on populations of students. These experiments were rarely undertaken in professional situations.

This paper presents the first results from two observations of computer supported collaborative design activity. The first one is conducted between architects and engineers in a real professional context and the other one is conducted between two architects in the ARIAM-LAREA laboratory.

These two observations have been analysed with one of the methods of applied architecturology developed at ARIAM-LAREA by C. Lecourtois (Lecourtois 2005, 2006(a)). This method helps to understand the cognitive mechanisms of design from oral and graphical expressions. From this method, we have identified different operations of conception involved in these collaboration activities and we have observed, in each case, what kinds of operations are shared by the actors.

Four parts compose this article: the first part describes the context of the study; the second part presents the method of analysis based on applied architecturology; the third part describes the two experiments, finally the last part presents the results.

**Background of Experimental Studies**

Our study is a part of a multidisciplinary research on computer supported collaborative design named “COCREA” and supported by ANR (French National Research Agency) in its program “Creation: actors, objects, contexts” (Project ANR-08-CREA-030-02). It involves three laboratories: LIMSI-CNRS (Computing Laboratory for Mechanics and Engineering Sciences, research unit associated with the UPMC and the University of Paris-Sud) of Paris Orsay (ergonomic and cognition), ARIAM-LAREA (Laboratory of Research in Computer Aided and Modelling and Architecturology and Epistemological researches on Architecture in “Ecole Nationale Supérieure d’Architecture de Paris La Villette”) of ENSA Paris la Villette (architectural design and computer modelling) and LUCID-ULg (Laboratory for User Cognition & Innovative Design...
of University of Liege) of University of Liege (development of tools to support the collaborative architectural design).

The aim of this research is to analyze computer supported collaborative design activities from the ergonomic and architecturological points of view. The experiments are conducted with a computer tool called “Studio Digital Collaboratif” (SDC) created by Lucid-ULg (Leclercq and al., 2008). It is an interactive digital platform made of a digital desktop, a videoconference device and a software package named “Sktetsha” (Figure 1). Sketsha allows different users to share synchronously documents and free-hand graphical annotations and drawings. Thus, users physically located at different geographical areas can “collaborate” remotely in real time via Internet. The SDC tends to recreate the conditions of collaboration “in presence”.

Currently two experimentations have been recorded and analyzed. The first one in a professional context and the second one in laboratory. In this research ARIAM-LAREA team uses “Architecturlogy” as a method for identifying the architectural “operations of conception”.

Methodology

Architecturlogy constitutes fundamental knowledge about architectural conception developed by Ph. Boudon, since 70s. Its scientific object is “how designers conceive spaces in giving them relevant measures?” (Boudon 1992)

The two main architecturological concepts used here are “Classes of operations of conception” and “operations of conception”:

- **“Operations of conception”** concept designates an elementary cognitive operation by which the architect thinks and assigns measurement to an architectural space relative to different reference domains.
- **“Classes of operations of conception”** defines the concept of “architecturological scales” (Lecourtiois 2006(c)). Twenty-one “architecturological scales” had been defined: economic, functional, symbolic, geographic, sociocultural, geometric, semantic context, global mapping, human, technical scales, etc..

The three elementary operations of conception are:

- **“Referenciation”:** that consists in using references in order to measure an object.
- **“Segmentation”:** operation of cutting by which the designer segments the entities of project in parts in order to measure them.
- **“Dimensioning”:** operation of sizing that give measure according to a relevance.

These architecturological concepts (Boudon and al., 2000, p.154) have served as a grid to analyze the two sequences recorded in the experiments. So, “Applied architecturlogy” was used here to analyze data recorded. It consists on “reading” drawings and words as signs of classes of operations of conception. Each drawing and word is analysed to identify the different classes and operations of conception used.

The following section presents the description of the two experiments. The analyses of these experiments help us to point new results about the specific operations of distant collaborative design brought by these two means of exchange (drawing and words). These results take the form of new concepts built from concepts presented above.

Description of two experiments with Studio Digital Collaboratif:

The first experiment is conducted in an architectural firm and the second one at the ARIAM-LAREA laboratory

1. Experiment in architectural firm:

   This experiment was done in situ, in an architectural firm (Franco-Belgian) whose offices are located in geographically distant areas (Toulouse/Brussels). The case analyzed here was a meeting that gathered three architects and two engineers who worked with
the SDC on a competition project (Figure 2).

The project consists to conceive building of Emergency and Intensive Care. The objective of this meeting was to put in security the building and to resolve technical problems related to its functionality.

2. Experiment in laboratory:

In this second experiment “Sketsha” runs on two different workstations. On one side the first actor uses the digital desktop of the SDC and the other side the partner uses a Cintiq Tablet Wacom (Figure 3). This experiment associates two architects who collaborate for designing a “school of 240 students”. The objective of this experiment is to produce a sketch that can be communicable to the client.

Operations of conception of architectural collaborative design aided by SDC:

An architecturological analysis was done for each situation. The objective is to clarify operations of conception involved in these situations of architectural collaborative design.

The analyses showed distinction between “elementary operations of conception” and “pragmatic operations of collaboration”.

1. Elementary operations of conception:

In the experiment between Architect/Architect (Figure 4), two classes of operations of conception have been identified: one linked to the topography of the site and the other one linked to the program and functionality of the project. Architecturology names these two classes of operation “geographical scale”, Geographical scale: (Boudon et al. 2000 p.173), and “functional scale”, Functional scale: (Boudon et al.
Unlike these two classes of operation that seem to be shared by the designer, the operations of conception do not appear to be shared. By working on setting the project up in the site, the designers propose two different projects in which each of them puts in work his own operations of conception (segmentation, referenciation and dimensioning).

In the experiment between architects/engineers (Figure 5) two others classes of operations named “technical scale”, Technical scale: (Boudon et al. 2000 p.167), and “functional scale” are shared. However, operations concerning these two classes of operations of conception are not shared by the designers.

If classes of operations of conception can be shared by the SDC, operations of conception seem to be singular to the designer.

Our analysis permits to find out other kinds of operations. These operations seem to help to collaborate but appear different from the operation of conception. We have chosen to call them: pragmatic operation of collaboration.

2. Pragmatic operations of collaboration:
Five pragmatic operations of collaboration has been detected: interpretation, pooling, autonomisation, evaluation and segmentation.
• **Interpretation:**

Interpretation is a cognitive operation by which designers appropriate themselves the proposition of others. Interpretation would insure a thought of continuous adjustment between both architects during the process of collaboration.

For example, in the Architect/Architect experiment, while Architect the first designer reads program, he re-draws on the plan. In the same time, the other architect does another interpretation of program by sketching (Figure 6). In the Architects/Engineers experiment, while engineer lists the regulation, the architects interpreted words by drawing (Figure 7). The Interpretation participates to build a conversation between the various collaborators. This conversation stimulates a continuous cycle of re-interpretations in the design process.

• **Pooling:**

Pooling is an operation by which the context of project is defined. It participates in the confirmation of the context. By this operation of Pooling, the architects registered a set of essential and relevant indications on the design project. It allows specifying the essential information to collaborate and conceive the architectural project. For example, in the Architect/Architect experiment, designers re-write the entire program and draw one kind of classroom. By this operation, the two architects specify and share the essential information to collaborate and conceive, together, the architectural project (Figure 8).

Operation of Pooling was involved in both situations of collaboration. It participates in the definition of relevant elements linked to context of the project and program that can operate directly on object to be conceived. But, we can see that when the designers come from different domains, the adjustment of
the informations to which all the co-designers refers, is continuously be updated.

• **Autonomisation:**

  *Autonomisation* is an operation in which each co-worker conceives autonomously by taking into account the work of the others. For example, in the Architect/Architect experiment, when each designer received the program of project, everyone began to think independently about it. Here, *Autonomisation* was done individually during it every designer stood back one moment to think of the architectural space. However, In the Architect/Engineer experiment, each pair (architects on one side / engineers on the other) thinks independently the architectural space (Figure 9). Here, *Autonomisation* was done by group.

• **Evaluation:**

  *Evaluation* is an operation by which a designer gives his point of view on the propositions of others. Whereas one makes propositions, the other estimates and criticizes. For example, during collaboration between Architects and Engineers, when the designers think together the functionality of the project, architects proposed some alternatives and engineers evaluated. In contrast, when designers speak about the security of building, engineers proposed and architects assessed. Therefore, it was an *Evaluation* between architects and engineers (one suggests and the other evaluates). This generated new choices and perspectives involved in design and development of architectural project. In the observed cases the *operation of evaluation* seems to be unshared. It would be pertinent to investigate for the possible situations where *evaluation operations* could be shared.

• **Segmentation:**

  *Segmentation* is a collaboration operation linked with the organization of the work. It consists in defining the work of each designer. The definition of the topics of tasks can be proceeding from the competency of each or from the specificities of the project. For example, in the situation between Architect / Architect, the two designers were given two distinct roles in their design. One designer begins to think the project, the other provides a point of view and offers others ideas for further development. In the situation between Architects / Engineers, different roles were “defined” for all the designers, during project. One engineer reads the regulations for securing the building; the second verifies that the technical changes respect and respond to the intentions of architects. One of the architects verifies that all co-designers respect too the program and the organization of architectural space. And the others architects try to ensure the good functionality of the project. Otherwise, another operation of segmentation is
considered in this situation: It’s Segmentation by competency. It’s also a result of collaboration but it occurs before or after the meeting. The meeting, between Architects and Engineers, ended with the sharing of work to every co-designers. This creates a new division by speciality of each designer.

**Conclusion**

This paper reports an architecturological analysis of two situations of architectural collaborative design supported by SDC: one concerning a collaboration between architects (in laboratory), and the other one between architects and engineers in a real situation of design. The aim is to identify operations of conception shared by the designers.

Our analyses permit to distinguish three scientific tools for trying to explain the collaborative conception in architecture: *operation of conception, classes of operation of conception and pragmatic operation of collaboration*. According to the first results it seems that *classes of operation of conception* are shared but *operations of conception* seems to be unshared.

From this study it would be interesting to investigate the specificities of *classes of operation of conception* in different cases of collaboration and the implications of *pragmatic operations of collaboration* on *operations of conception*.

**References**


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