Quality of collaboration in a distant collaborative architectural educational setting.

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Abstract. This paper describes an experiment of collaborative distant architectural studio and the analysis of the quality of collaboration of two groups of student. Based on a simple method to assess this quality of collaboration, we show the main results, and discuss the interests of the method and some insight to the understanding of mechanisms of collaboration.

1 Introduction

This study aims at assessing the quality of collaboration in a distant collaborative setting, in the domain of architectural design. We aim to seek the determinants of collaboration, thanks to a longitudinal study. This paper describes collaborative studio with groups of student, which collaborated remotely during several month.
This study has taken place in the framework of a collaboration between the Nancy School of Architecture (F) and the Faculty of Applied Sciences of the University of Liège (B). 16 students, 5 in Belgium and 11 in France, worked during one term (3 months, 4 hours a week) on an architecture program. The students, by groups of 4 (2 in Belgium and 2 in France, or 1 in Belgium and 3 in France), had to design collaboratively and remotely a polyvalent concert hall. The program was completely defined, and the proposed site was visited during the first meeting in presence of all the participants. Each student in a group had two predefined role, from the following: Architectural design, interior architecture, structure, environmental quality, acoustics and lighting, special techniques, coordinator. The groups had several tools at their disposal:

- Asynchronous collaborative tools (mails, file exchange servers, …)
- Synchronous collaborative tools (chat, videoconferencing…)
- An exclusive multimodal collaborative environment, the Distant Collaborative Digital Studio (DCDS), allowing students to share voice, gestures and graphics productions in real-time (see following section). They were allowed to work one hour per week on this environment.

The entire experiment has taken place under the supervision of a pedagogical staff on four persons (2 in Belgium and 2 in France). During each of the collaborative synchronous sessions on DCDS, two teachers were present (one in each place). At the end of the term, the students proposed their architectural solution, as well as a critic analysis about their collaborative work and about the tools proposed to support this collaboration.

We followed two groups during the entire experiment: all their exchanges have been recorded and their weekly meetings on the DCDS have been entirely videotaped. In this paper, we are interested in the synchronous work sessions, on DCDS. We aim to seek the challenges of a good collaboration, and its evolution regarding the design process.

2 DCDS

Our prototype, named Distributed Collaborative Design Studio (DCDS) is composed of

- a hardware part – the Design Virtual Desktop – (fig 1) which consists of an electronic A0 table with a suspended ceiling equipped with a projection system offering a large working surface (approximately 150x60 cm). An electronic stylus allows the drawing of virtual sketches onto this surface. The central unit is located in the ceiling. This leaves the stylus as the only interaction tool, so that the computer can disappears from designers’ mind.
- a software part – SketSha (for sketch sharing), (fig. 2) which is a shared drawing environment allowing several virtual desktops to be connected to the
same drawing space. Various functionalities, such as importation of CAD plans and bitmap images, a panel of colored pens (and an eraser) and a navigation functions (zoom, translate, rotate), are proposed through intuitive graphical widgets. This software captures the strokes that compose the sketch and shares them between the different distant locations (through a classic internet connection).

- a 24 inches display with an integrated camera and a videoconferencing commercial module, that allow the participants to see and talk to each others, in an almost 1/1 scale, during a real-time conference. (see fig 3 for the whole environment).

![Fig 1: Virtual Desktop.](image1)

![Fig 2: SketSha Interface.](image2)

![Fig. 3: Distributed Collaboration Design Studio.](image3)

### 3 Methodology

As mentioned above, we followed two groups during the entire experiment. These groups have been chosen regarding to their efficiency, as assessed by the pedagogical staff at the beginning of the project (after 3 weeks). One group (G1) has been evaluated as efficient, while the second (G2) has experienced a difficult start.
The whole process has been followed by a researcher, and three selected extracts per groups have been more deeply analyzed to assess the quality of collaboration and the role of the pedagogical staff.

To assess the quality of collaboration, we use the method previously developed by us (Burkhardt et al., 2009a, 2009b), based on the grid of Spada et al. (2005). This grid allows a quick coding of video extracts and allows the assessment of collaboration on 7 dimensions: (1) Fluidity of collaboration, (2) Sustaining mutual understanding (3) Information exchanges for problem solving (4) Argumentation and reaching consensus (5) Task and time management (6) Cooperative orientation (7) Individual task orientation (note that in the Framework of this paper, this last dimension has not been investigated). This method has proven to have a strong reliability based on inter-raters correlations (see Burkhardt et al., 2009a, 2009b).

4 Results

At first, it is important to notice that the two groups didn’t manage the process in the same way. The figure below show timelines of the two processes, decomposed in 3 stages: (1) a stage of definition of the main components of the building, (2) a stage of decision about the whole set of building components and (3) a stage of production of representations (plans, 3D). There has been 12 meetings (the first in copresence in Liège, the last in copresence in Nancy and 10 on the DCDS). The analyzed extracts come from the 3rd, the 6th and the 10th collaborative synchronous sessions.

Fig. 4: Process timeline for the two groups.
The scores on the quality of collaboration grid are the following:

<table>
<thead>
<tr>
<th>Meeting M3</th>
<th>Meeting M3</th>
<th>Meeting M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1</td>
<td>G1-M3</td>
<td>G1-M6</td>
</tr>
<tr>
<td>G2</td>
<td>G2-M3</td>
<td>G2-M6</td>
</tr>
</tbody>
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Figure 4: Scores on the Collaboration Quality Scale
F = Fluidity of collaboration; MU = Mutual Understanding; IE = Information exchanges; AC = Argumentation and Consensus; TM = Task and time management; CO = Cooperative orientation (balance of contributions)

The results show the following main conclusions:

**Between-group comparison**

At the meeting M3, results show obviously that the two groups do not collaborate on the same basis: G1 is far more efficient in collaborating than G2, except on the dimensions linked to the process management (TM) and the balance of contributions (CO), which are comparable. These two latter dimensions refer to the “form” of the collaboration, rather to the “contents”.

At the meeting M6, G1 is still better than G2. In the two groups, the TM and CO dimensions are enhanced. G2 experience a trouble in the Argumentation and Consensus (AC) dimension, which is problematic.

At the meeting M10, however, the situation seems inverted: G2 is much more efficient than G1, regarding our grid. The two groups have excellent scores, but G1 experience a weakness in the balance of contributions (CO).

Those first results give us some strong insight in relation to the collaboration mechanisms: (1) there is no determinism about the quality of collaboration. G2
which was badly rated become excellent in regard to our grid; (2) collaboration is multidimensional. Our results show clearly that the whole set of dimensions is necessary to assess the quality of collaboration: the different dimensions evolve quite independently, and giving a unique score would weaken the richness of our observations.

**Intra-groups comparison**

For the first group, we identify the same pattern during the meetings M3 and M10 (strong collaboration with a weakness in the balance of contributions), whereas during M6, there is an equilibrium between participants. In the second group, starting seems quite difficult (M3 scores are quite low, particularly in management and balance of contributions), the M6 seems to show a crisis, visible throughout the weak score on the Consensus dimension. In the last observed meeting, the collaboration seems very efficient.

Those results, which may be surprising from a certain point of view, must be observed in the light of the process stages (see figure 4: timelines). On the M3 meeting, although G1 is more advanced than G2, the two groups experience difficulties in collaborating (management and balance), that may be explained by the fact they start the process: they are able to agree about content but lack to manage their time and process due to the novelty of the collaboration group and of the collaborative environment. In M6, G1 is collaborating efficiently. The group is engaged in the core design stage, where all decisions may be taken. G2 will have the same collaborative pattern, once the design stage reached, at M10 (M10-G2 is comparable to M6-G1). The Meeting 6 for G2 shows a “crisis”: the group experience difficulties in collaborating, and difficulties to take the core decisions (they are still in the definition stage of the project). At this moment, the pedagogical staff had to intervene, to unblock decision process. After that, the group is characterized by a great quality in collaboration, and is much more efficient in the design process. Finally, the decrease of the balance of contributions in G1 is due to the fact that the group has entered the production stage. The themes of discussions are related to specific issues relative to the work of only a part of the group, which explain that the contributions are out of balance.

It therefore seems that the quality of collaboration and the design process have a double relation: a good collaboration allows the design process to progress, and the progression of the process gives the conditions for a good collaboration. Another part of our study (which is not described here) shows also relations between the quality of collaboration and the role assumed by the teacher.
5 Discussion

These few results show us a number of interesting conclusions. At first, the method, quite simple to apply, allows us to make comparison between and intra groups, which is quite useful to understand the mechanisms of collaboration. They also show that it is necessary to take in account the context to draw conclusions about the quality of collaboration: depending on external factors (here, the design process), some dimensions may be judged differently.

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7 References.

