

# Cooperative design studios in education

## Lessons learnt from two experiments

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**Abstract.** *This article describes experiments of IT-supported cooperation in AEC pedagogical context. The Digital Cooperative Studio (SDC) places students in a situation of distant design cooperation. This experiment allows students to be confronted to a cross-disciplinary approach of the architectural design and leads to the analysis of their own cooperation processes. Two editions of the Digital Cooperative Studio have been carried out in 2007-2008 and 2008-2009. This article presents the lessons learnt from these two experiments.*

**Keywords.** *Virtual Design Studio, Cooperation, Education, AEC (Architecture, Engineering and Construction).*

## Introduction

For many years now, ICT has become a full-fledged field of education in the AEC curriculums. Following the professional practices changes, schools and universities have integrated new courses to prepare the students to the use of emerging tools. For example 3D CAD is largely taught in the architecture and engineering schools (Penttillä, 2003). Moreover literature review lets us observe that the latest research innovations are also applied, often in experimental ways, in some AEC-related teaching courses: decision support, virtual learning environments (Martens and Achten, 2008) or 4D simulation (Sampaio and Henriques, 2007, Wang et al., 2007).

The issue of cooperation is becoming more and more essential in the construction projects. In education many interesting cooperation-related activities also emerged. The topic that interests us here is the one of cooperation between members of a construction project. In the "Virtual Design Studios", numerous aspects of cooperation have been described: the roles' distribution approach (Van Leeuwen et al., 2005), the scenarios to build project-organizations, to favour trust relationships, especially between geographically distant students (Cheng, 1998, Donath, 1999), the cross-disciplinary approaches (Forgber and Russel, 1999, Fruchter et al., 2007).

## SDC (Digital Cooperative Studio) context

Thomas Kvan (Kvan, 2000) distinguishes between collaboration (a highly-coupled and personal synergistic process) and cooperation (a loose-coupled activity based on negotiation and compromise). SDC is clearly oriented towards "cooperative design" assuming that architectural design between distant students relies on the division of tasks and roles, and on highly compromised decisions.

SDC is the result of an association between two academic institutions (Architecture School of Nancy & University of Liège) and three research laboratories from France (CRAI), Belgium (LuciD Group) and Luxembourg (Public Research Centre Henri Tudor). The institutional partners are closer: they provide architecture study curriculums, but they also carry out closer research projects, both in the topics of Computer-Aided Architectural Design and of Assistance to Cooperative Activities in Construction.

## Pedagogical approach

For some years, the initial objective of our pedagogical experiments has been to sensitize the students to the cooperation issues in Architecture, Engineering and Construction activities, which is also one of our major research topics.

## SDC objectives

In 2004 our first "virtual design studio" has put distant French and Thai students to design an exhibition (Kubicki et al., 2004). Since 2004 we experimented cooperative design each year with Master students. In 2007 we created the "Digital Cooperative Studio" experiment, a design studio for distant students. Our aim is to put together students from different geographical and cultural origins, and of different skills, in collective design situations. The scenario of the projects is: working distantly (mixed teams from Liège and Nancy), involving different skills (curriculums are different in the two universities), in both synchronous and asynchronous ways. SDC duration is approximately 3 months. The initial aim is to teach cooperation issues to the students: i.e. negotiation, compromise, personal behaviours... But placing them in real-life cooperative situation allows them also to learn from cooperative design experiments.

This cooperative scenario is the ideal situation to sensitize the students to the use of cooperation-support IT-tools to communicate, to share tasks, to setup coordination in their synchronous and asynchronous tasks.

## SDC collective process

The cooperation process could be described in three weekly stages. The central stage is the Wednesday's synchronous meeting. Each part of the teams virtually meets at the same time in Nancy and in Liège. This coordination meeting is the essential stage enabling to share ideas and to take decisions.

Prior to this meeting the preparation task consists in preparing the documents to be discussed. It is also demanded to prepare a meeting agenda. After the meeting a task of meeting report consists in writing what has been decided. This essential document is the "written trace" of the exchanges and of the taken decisions.

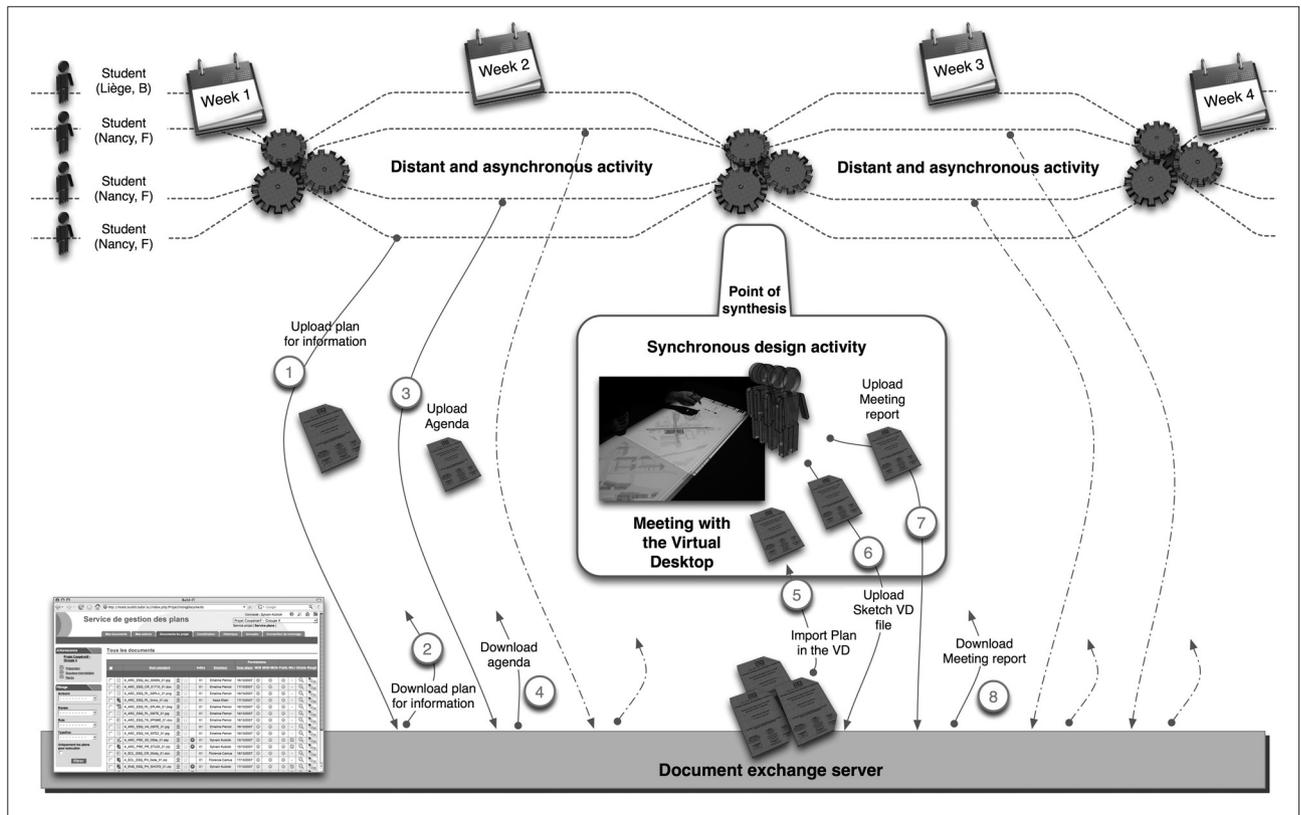


Figure 1: Overview of the SDC cooperation process.

## Tools

SDC is a Master course where students are confronted to the use of IT-services resulting from our research projects: [1] a Virtual Desktop for sketch sharing and [2] a Document Management System (CRTI-weB). This course aims to sensitize the students to the benefits of IT to support their cooperative practices.

### Virtual Desktop

The Virtual Desktop is a tool developed by the University of Liège (LuciD Group laboratory) for the distant and synchronous design activity (Eisen and Leclercq, 2008). It allows its users to draw and sketch on a shared virtual workspace. This tool comprises both a hardware and a software part:

- The desk is composed of a large tactile table with which the user can interact with a stylus. Two video projectors display a Mac OS X computer environment.
- The software “Sketsha” allows the users to draw on the table with the stylus, manage sketch layers and the imported reference images. Sketsha displays the sketch on the two distant screens and manage coherence and changes in real time. The users can therefore co-edit the project while they discuss in real-time thanks to the Web conference system.

### CRTI-weB “Document management”

The document exchange server “CRTI-weB” is a Web platform developed by the Public Research Centre Henri Tudor for the construction sector in Luxembourg (Kubicki et al., 2009). It consists of a shared project space, available for all the project’s participants connected on the Internet. It allows them to upload the documents that they produce in order to design the architectural project, and to share them with the others. The aim is to centralize the documents and to trace their updates and modifications.

## Results

The first result in each group consists of the design of an architectural project itself. Variations on the quality of the collective projects essentially depend on the time the students could allocate to the project, but are also linked to the behaviours of the students in each group. As the studio targets cooperative design learning and CSCW IT-tools experiment, we provide in this section the results related to 1) the IT tools usefulness and 2) to the students’ feedback about cooperation process.

### Cooperation support

Cooperation support is assessed in terms of utility and usability of tools on the basis of qualitative feedbacks of the students (gathered through final surveys and/or informal discussions). The results are based on two iterations of the studio (07-08 and 08-09).

The Virtual Desktop system provides the students with the ability to communicate and share drawings during synchronous meetings. It appears that utility is not really an issue, as distant students have to communicate in real time and have to share design representations to make decisions. Therefore, as the system was enough stable we did not noticed relevant utility issues. Usability were also assessed in qualitative ways, and results show that some ergonomics aspects could be improved such as decreasing waiting periods related to documents initialization or electronic pen sharing between designers. The random overloading of the Internet connection also interfered in the videoconferencing. In conclusion, despite of these minor aspects, the Virtual Desktop is really fitting the basic requirements of the weekly synchronous coordination meetings.

The CRTI-weB Document Management System supports all the other asynchronous exchanges and communications through its related services: sharing (documents upload/download), requests (e.g. asking someone to validate a document, inform someone), reactions (discussing asynchronously about a document), standard naming control, privacy levels management. The assessment of usability issues has not been performed in the SDC context.

<sup>1</sup> <http://www.arch.ulg.ac.be/Lucid>

<sup>2</sup> Demonstration access: <http://demoged.buildit.tudor.lu> (login: “demo”, password: “demo”)

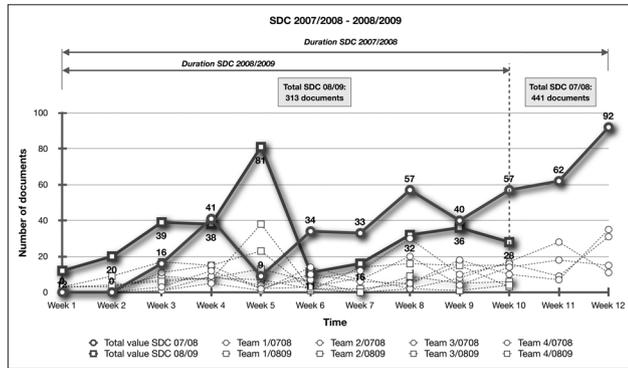


Figure 2: Statistical data about the number of documents shared via the document management server.

However, the utility of its different services in a pedagogical experiment context could be evaluated through the analysis of information exchanges and students' feedback. The Figure 2 shows the amount of documents shared via the Document Management System. The peaks are related to projects deadlines: intermediary presentations and final evaluation. The holes are due to vacations periods. The figure also shows that the utility of document sharing via a Document Management System is slowly increasing during the semester. It is closely related 1) to the increasing need to exchange information about the design project, but also 2) to the time needed for the appropriation of the new technology. Requests and reactions services also appear useful to support asynchronous communications. However, the utility of the other professional services appears more limited. The naming standard service (enabling the verification of documents filenames) is probably too rigorous in pedagogical projects, in which the design is unstable and the documents representing it also. The privacy level management service is also useless because the students do not manage the diffusion of their documents to owners or contractors...

### Students' analyses of cooperation process

The architectural project is the first part of the students' results; the analysis of cooperation process is the second part and results are really interesting.

We report on four teams, which formalized their own experiences of cooperation (see Figure 3):

- Team 1 studied the cooperation as a problem resolution process. When people cooperate, conflicts emerge and it is necessary to resolve the problem and to find the well-adapted solution.
- Team 2 observed the process and the different points of view on the project (i.e. architecture, structure, acoustics, etc.). Students saw the cooperation as a problem resolution process in which the diverse points of view have to negotiate.
- Team 3 considered that cooperation is linked to the group and more specifically to group size. Students highlighted that cooperation is more difficult when the group size increases.
- Team 4 analysed the individual behaviours inside the group during the project. Students distinguished situations in function of the cooperation between people having strong and/or weak characters.

## Conclusion

Cooperative Digital Studio allowed students from the University of Liège and the Architecture School of Nancy to cooperate in the framework of an architectural design project by using Cooperation Support tools: a document management platform (CRTI-weB) and a Virtual Desktop device. This experiment was really rewarding for students because it conducted them to ask themselves how to cleverly exchange information, how to work in group, how to detect and resolve human conflicts, how to integrate all the points of views within the project, etc.

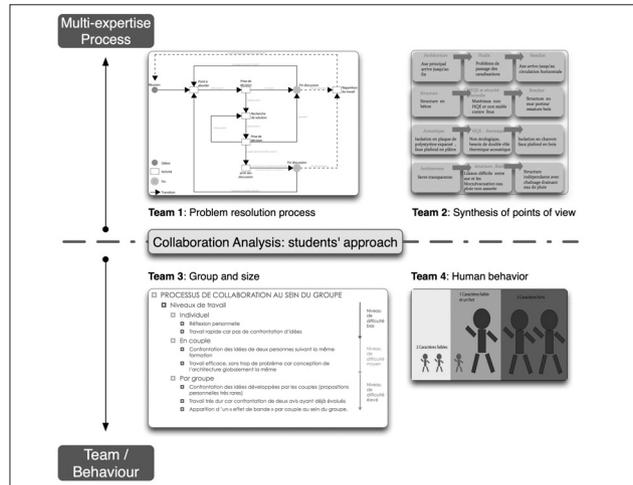


Figure 3. Cooperation analysis: students' approaches

The results obtained by each group at the end of the course were firstly composed of an architectural project and secondly, of an analysis of the cooperation process. As we recurrently observed that students place the human dimension at centre of the cooperation, we envisage to extend the course program in order to include this dimension in a theoretical point of view (i.e. notion and conditions of trust (Jarvenpaa and Leidner, 1999), individual behaviours in cooperation (Van Leeuwen et al., 2008)...). Moreover, in order to provide coherent and unidirectional feedback, teachers have decided to introduce a new role in the SDC: the role of the owner. This role, attributed to one of the teachers, will allow us in the 2009-2010 edition to make corrections of the architectural project more uniform and efficiently guide choices.

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