

A simulation laboratory for teaching construction management

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Introduction

Students in our construction engineering program have often a tendency to perceive all their courses as separate entities. To prevent this we conceived a course-project where the students have to use the knowledge acquired in all the different courses. This course simulates the execution of a construction project starting from the signing of the contract to the final delivery of the project. Students are grouped in teams representing the consultants, the general contractor(s) and the subcontractor(s). The teacher represents the owner(s). During the semester the teacher creates situation where the students have to use all their knowledge to solve the problems. At the end of each activity, the teacher reviews the events with the students and comments if necessary¹. We have been organising this course for the last five years using a standard class room and a computer laboratory for the part of the work involving computer software. Recently we decided to design a special laboratory that would be used for this course and for other project management courses involving interaction between student teams and simulation technique. This presentation will describe the layout and the electronic equipment of this laboratory. It will also describe how we structured the user profiles to manage the simulation intended in this laboratory. Finally we will analyse our first experience using part of this new laboratory facilities and Primavera Expedition as our project management software.

Objectives

The space and the equipment necessary for this laboratory were to be taken from an existing general computer laboratory. We could rearrange the space as needed but the general purpose of

the lab had to be maintained. Priority would be given to project management courses and research but when it was not used for those purposes it had to be made available for other general applications.

We took note of this fact and defined the following objectives based on the requirement of our simulation course and of other management courses.

We should provide the students team with rooms where they would have the space and the necessary equipment to develop the feeling of being an employee of a general contractor, subcontractor or firm of consultants. Those teams normally involve 2 to 5 students.

There should be a room simulating in some way a job site meeting room that should be able to accommodate approximately 25 students.

The teacher should be able to see all the teams at all time without being obliged to move from one room to the other. It should also be possible for him to regroup all the students in one room with the necessary tools to instruct the student on common subject affecting all the teams.

The computers installed in this laboratory should be connected to the general network of the school and also to a special server dedicated to this laboratory where specialised software could be installed to simulate interconnection between teams trough an intranet and trough Internet.

For project simulation and research purposes we want the teams to be able to communicate with each other and with the exterior world using Email, intranet and Internet web sites.

We also want to provide the students teams and the teachers with standard project management software, with software's integrating all the project management functions being done by different company employees and with software interconnecting all the projects partners' trough internet.

The solution

Physical layout

We divided the existing laboratory in 5 small rooms and one large conference room as shown on figure 1. A large windows was installed in the walls facing the conference room of four (4) of the small rooms. This way the teacher can sit in the conference room and see all the teams working in those rooms. For the fifth room the door was positioned in such a way that the teacher could see trough the door. In each of the small rooms we installed a filing cabinet so that teams could maintain a filling system for the follow up of the simulated projects. We also installed a mail box to receive paper documents from other teams. Since the rooms were relatively small we combined the conference table, and the computer desks to serve all the needs. A T arrangement was found to be the most effective way. This arrangement makes it possible for two students to work at the same time on computers while the rest of the team is doing paper work or discussing

around the vertical part of the T (see fig 1). Two computers are installed on those tables. At this point we still have to design signs that will be installed on the walls to indicate what kind of company is working in this room (general contractor, subcontractor, etc.).

The conference room is furnished with a large conference table, two small tables with computers and another table with a common printer for this laboratory and enough chairs to sit 25 peoples. A projection screen installed on the wall of room “A” can be lowered when needed. The department has a mobile LCD projector that can be used as needed for presentation in this room. We hope to install a fixed one in the near future. There is also a transparencies projector available. We installed a black board on one of the walls. Under the conference table network connections can be used to connect portable or table computers as needed. A door gives access to a general computer laboratory containing digital tables and other computers that can be used if needed.

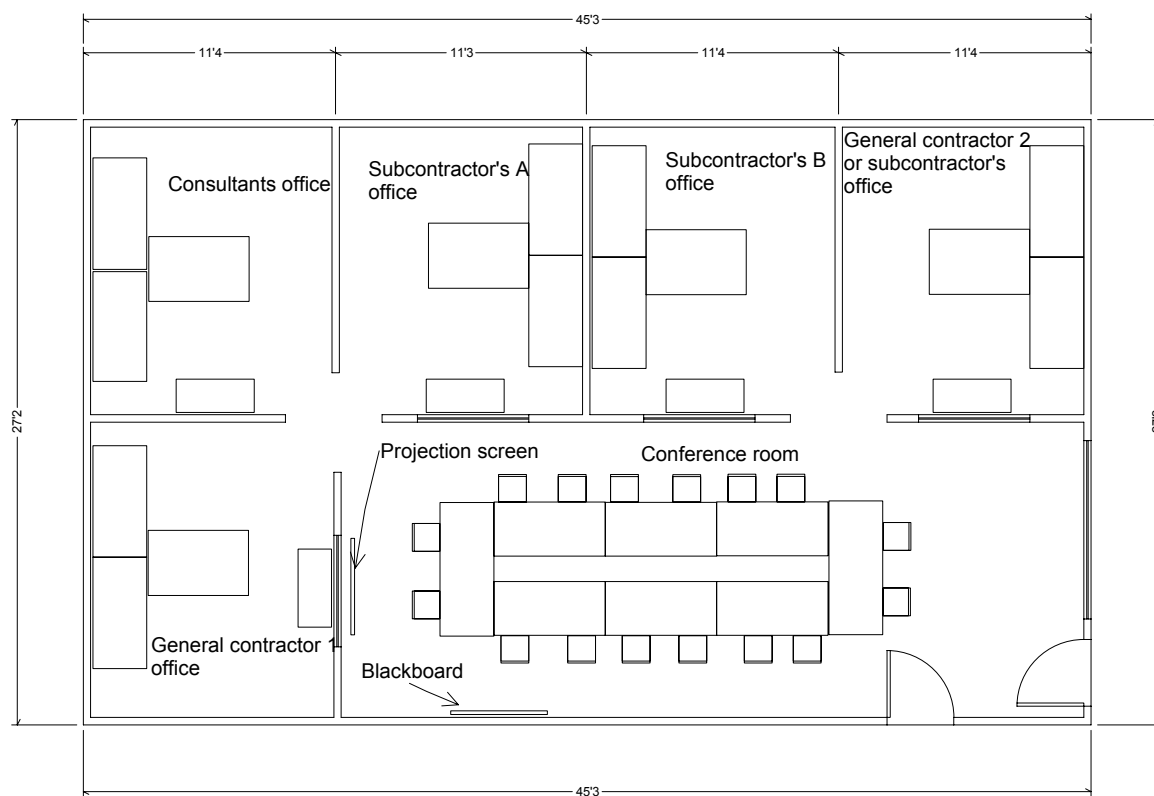


Figure 1

Computer requirement:

As noted above we installed two (2) computers in each company rooms and two in the conference room. Those computers were recently bought to be installed in the old general computer laboratory so we did not have any choice to make on the characteristics of those

computers. They are 800 MHz Pentium III computers. Those computers are connected to the general network of the school and to the server dedicated to this laboratory. The server for this laboratory is installed in a nearby room adjoining the other department's server room.

The laboratory server is a Compaq Proliant ML370 G2 PIII/1133MHz with 1.256Gb of RAM It is equipped with Three (3) 36Gb hot plug hard disk (one active, one for mirroring and one in standby), a Smart Array controller(RAID) and redundant power supply hot plug. The school IT service takes care of the backup of this server.

Software requirements

Server software

We wanted to implement Microsoft Project Central on the server this made our choice for an operating system very easy: this software works exclusively under Windows NT and Windows 2000. All the other software's we needed were also working with Windows 2000 server. For simplicity and compatibility purposes we installed Windows 2000 Professional as the operating system for all the workstations connected to this server.

We also installed Web server software to be able to use this server as a web server for Project Central and for other interconnecting software like Work2gether. We will discuss later the details of the server implementation.

We did not install a mail server on this machine. The school IT service offered us to manage the mail accounts we needed through their Microsoft Exchange mail Server saving us all the labour required to install and manage this server.

We also installed SQL Server which is required by the software Primavera Expedition.

Application software

Since this laboratory can be used as a general laboratory all the software normally installed in the department's computers laboratory are installed. It principally includes Microsoft office and Internet explorer.

For project management purposes we divided our needs in three sections. For scheduling software we decided on the two most popular scheduling software: Primavera Project Planner plus Primavera Sure Track and Microsoft Project 2000. For integrating project management functions we installed Primavera Expedition version 7.0. We will be installing shortly the new 7, 5 version. For web interconnection between project partners we have currently installed Microsoft Project Central and a limited version of Work2Gether for evaluation purpose.

Those are the currently installed software but it is the purpose of this laboratory to be able to install and evaluate new software as they will be made available.

Profiles defined

Our main objective is to create an environment mimicking the real world. To do so we create through our simulation course a structure of company participating in the project(s) resembling real life like the one shown on figure 2

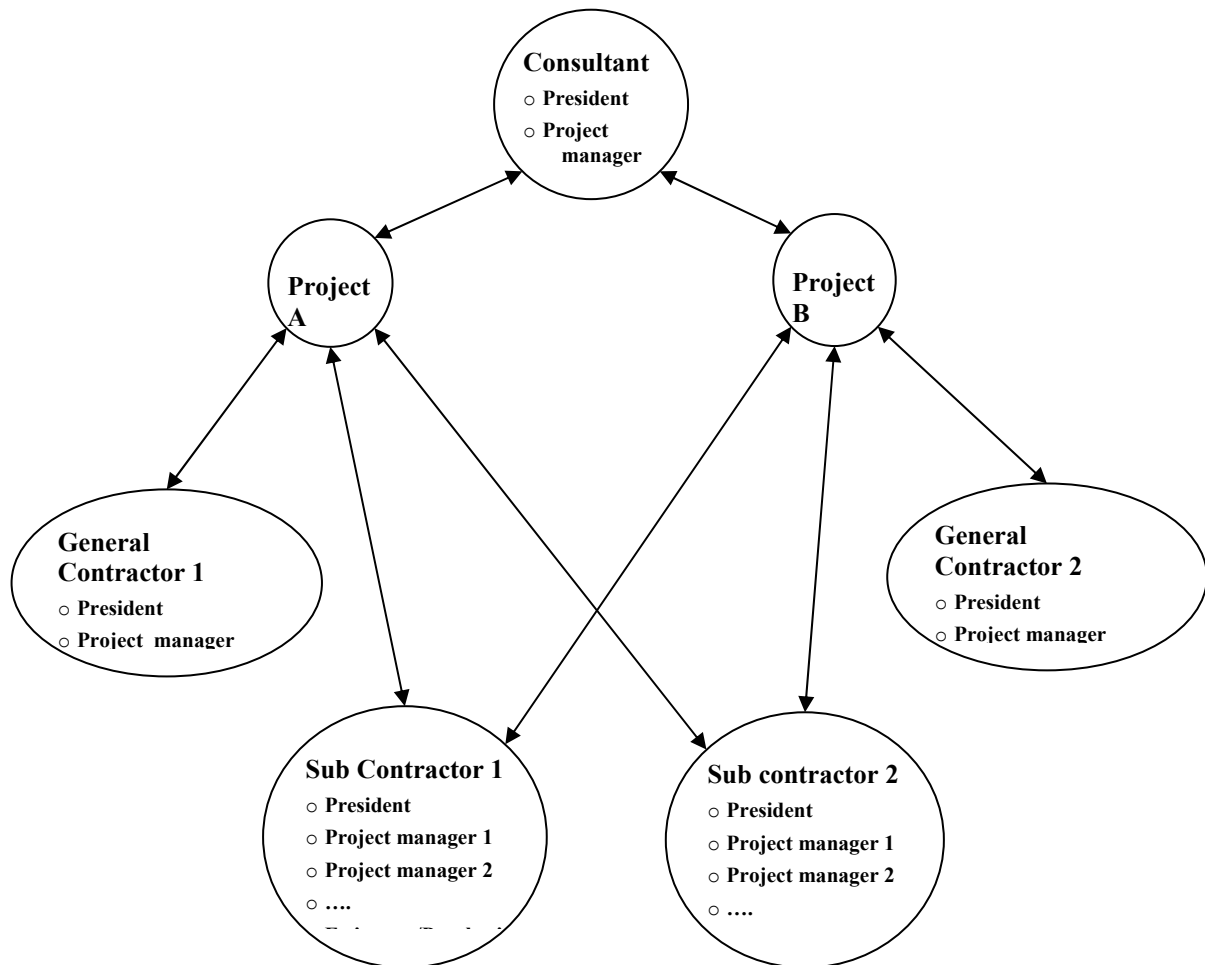


Figure 2

For different reasons students will not always use the same room or the same computer to do their work. But we must assure them that they can find the same computer configuration when they connect themselves. To do so we used the profile property of windows 2000. We have created roaming profiles representing the structure shown on figure 2. This way a student logs himself on a computer not with his name but with his job. For example the project manager for general contractor 1 will log himself as DPEG1 with a password unique to him. We have defined for DPEG1 a profile that will show always the same desktop to the student give him the right

access to hard disk on the server will also give him access to his email account to the right group in expedition etc... . Those profiles are managed through the server making it simple to modify those profiles when needed.

Our first experience

In autumn 2001 the construction part of the laboratory was completed and the software Expedition from Primavera was installed on the department server. The course simulating the execution of a project was scheduled for this semester. That was enough to do our first experiment in using the new physical facilities and using integrated software for the first time.

Let's first resume how the course works. The simulation starts when the owner accepts the general contractor's tender and mandate his consultants to prepare the contract. As soon as the general contract is signed, each team starts doing all the tasks that are normally done by the party they represent. The general contractor negotiates, prepares and signs all the subcontracts based on his tender. He also prepares a schedule for the project with the help of his subcontractors. A start-up meeting is scheduled as soon as possible and job meetings are scheduled every week. From there on all teams negotiate contracts, manages change orders, shop drawings, deficiencies, request for substitutions etc. From time to time situations are created like change orders, errors, job site conditions etc. forcing reaction from all the teams. Every project month the subcontractors and the contractor prepare invoices based on the work progress. At project completion, the contractor schedules all the tests and inspection required, prepare all the manuals and proceed to an inspection of the project¹.

The preceding semesters the students were using manual systems to manage all their documents or systems based on MS Project and or Excel. This time we asked them to use Expedition from Primavera.

This software was designed to manage all the communications and documents involved in a construction project. It is normally used by one company with multiple sites and/or participants. It can manage shop drawings, request for payment, letters, phone calls letter of transmission, contract, invoices, cost etc. It can also be link to the project schedule if it is done with a Primavera product (Project Planner or Sure Track).

At first we wanted to use it to interconnect all the partners of the project. We found out this was not the purpose of the software. We decided to use it anyway by creating a project for each team in such a way that each was managing his project with expedition and communicating with the other team through the email facilities of the software. Because the students were familiar with Ms Project as scheduling software we did not use the schedule linking possibilities offered by Expedition.

The new laboratory facilities worked great. All the students were happy to be able to work in their own room. During this semester we made some correction to the furniture design based on the input from the students. The teams could easily get the attention of the teacher when needed

because he could see all of them at the same time. The possibility of regrouping all the teams in one room with an LCD projector was also very helpful especially with the difficulties created by the use of new software.

Our main problems came from the use of the software. Since the computer part of the laboratory was not ready during this semester. The necessity of an independent server became again evident. To create special groups we had to shut down the SQL server which could only be done on the department server. The Emailing was difficult because we were using Hotmail accounts channelled through Outlook express for each member of each team and Expedition had problems finding those Email. The students found the software not very user friendly and thought at first that using Excel would have been a lot easier and more efficient.

As the project evolved the interconnection the software makes between contract change orders and request for payment began to prove very useful and at the end the students were finding great advantage in using software as Expedition.

On the teacher part it was a lot easier to follow the evolution of the simulation because all the documents generated by the students were available through the software. It remains that this software is not very user friendly and it is sometime very complicated to do simple tasks.

This experience demonstrated that we really need the computer part of the laboratory which should be in operation in February 2002.

Future project and research

We look forward to using Expedition with a better controlled environment. We also wish to use Project Central which seems to offer the interconnection needed between the different partners in a project but not the documentation management. We will try linking the possibilities of Project Central with those of Outlook to have a full solution. We think that this laboratory will help us develop better teaching technique and will also permit a great number of future development. We are also thinking of using this laboratory as a show case for Construction Company. They could come at our facilities and see or even try some project management software.

Bibliography

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After a career in the construction industry as a project manager and estimator, Jean Paradis is now a project management professor in the construction engineering department of l'École de technologie supérieure de l'Université du Québec. He teaches courses in planning and control, estimating and project management. His main research interests are in the use of the computer technology for managing project.