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EFFECTS OF A WEB-BASED COLLABORATION TOOL IN ENGINEERING DESIGN COURSES

Junichi Kanai and Mark W. Steiner

ABSTRACT

A web-based bulletin board system was introduced for use in the engineering design courses. Although students required little encouragement to start using this system instead of e-mail, many project teams used the system productively and obtaining good results. The system allowed sponsor mentors to share project information with a broader audience within their organization. It enabled them to provide better and timelier feedback to students and faculty; therefore, the students were able to explore more realistic design solutions. The system also enabled the faculty advisers to assess a team's progress, problems, and individual contributions more effectively. Their ability to respond to the students' needs quickly made significant impact on the out come of the project results.

Keywords: collaborative environment, design management, education

1 INTRODUCTION

On-line collaboration tools, also known as groupware, are widely used in many organizations to improve their productivity and the quality of their products. Types of collaboration tools include bulletin (discussion) boards for threaded discussions, public folders for sharing documents, and version control systems for concurrent editing source codes or CAD files. The benefits of using bulletin boards in traditional teaching and e-learning were reported in [1].

The O. T. Swanson Multidisciplinary Design Laboratory (MDL) at Rensselaer Polytechnic Institute (RPI) is an educational laboratory that supports capstone design courses. Our experience has shown that organized teams tend to perform well in the courses. To improve students' organization, an on-line bulletin board system was introduced to the course as a collaboration tool for managing project related information in the spring of 2005. The system was also utilized in the fall of 2005.

In this paper, we study the benefits and issues in using a bulletin board based collaboration system in engineering design courses. In particular, we focus effects of the system on students, sponsor mentors, and faculty advisers.

2 BACGROUND AND PROBLEMS

RPI offers studio-based engineering design courses. In capstone design courses, a multidisciplinary team of senior engineering students work on a problem specified by an industrial partner that is typically a global company [2]. The course goals are to develop a solution to a problem and to demonstrate its feasibility within a 15-week semester. A faculty adviser from RPI and a sponsor mentor from the industry partner

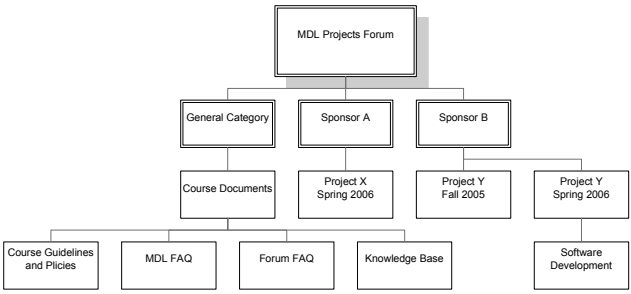

Figure 1. Structure of the Bulletin Board

assigned to the team serve as coaches and consultants. The MDL provides the infrastructure necessary for meetings and prototype fabrications.
Due to the nature of the courses, this study focused on the following three issues.

- Does a collaboration tool make a team (students) more productive?
- Does a collaboration tool enhance interactions among sponsor mentors and students?
- Does a collaboration tool improve faculty advisers' effectiveness?

2 SYSTEM OVERVIEW

A pilot system consisted of Simple Machines Forum (http://www.simplemachines.org) running on a LAMP (Linux, Apache, MySQL, and PHP) server driven by a surplus Intel-based PC. Only authorized students, sponsor mentors, and faculty advisers were allowed to access it.
Figure 1 summarizes the structure of the pilot system. The Course Documents and its sub-boards contained information useful to all students, such as a course syllabus and report templates, and are available to everyone. On the other hand, project specific boards were restricted to the project members. For example, students who were working on Project Y had access to their working board, i.e., Project Y Spring 2006, and a board containing past work, i.e., Project Y Fall 2005.
Students could start (write) new topics (messages), read messages, reply to a topic, and attach files to a message. A sub-board, such as Software Development, was created by the system administrator upon a team's request.

3 RESULTS AND ANALYSIS

3.1 Students' Acceptance and Usability of the System

Figure 2 shows how quickly students joined the bulletin board. In the spring of 2005, the system was an optional tool. Because of no immediate needs for students to start using the system, approximately 10% of the students did not join the board in the first two weeks of the semester. Moreover, it took 42 days for the last student to start using the board.
Since the fall of 2005, in an effort to encourage all students to use the board, all students have been required to post their first assignment to the board, which is typically due at the beginning of the third week. This made all students join the board by the end of the second week. The results showed that it is important to encourage students to start using the system.
Table 1 summarizes how the teams utilized the system in the fall of 2005. Although students used the system, the amount of activity varied widely from student to student

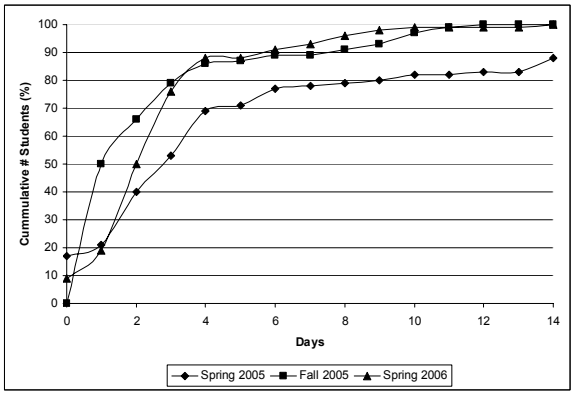

Figure 2. Cumulative Number of Students Joined the Board Since the Beginning of a Semester

and from team to team. At the end of the semester, the students were asked to rate the usability of the system and to suggest ways to improve it. Sixty-two out of 92 students responded to the survey, and Tables 2 and 3 summarize the results. These results and our observations identified factors affecting the students' use of the system.

- When one of the team members started posting many messages, it encouraged the remaining members to post messages.
- When advisers and/or mentors actively used the board by posting messages or running meetings based on the information posted in classes, it encouraged the students to post messages.
- Students were able to attach a file that was smaller than 2MB to a message. This limitation was not sufficient for complex CAD files and high quality

Table 1. Students' Uses of the Board in the Fall of 2005

Team ID	Students	Messages Posted by Students					Messages by Advisors
		Total	Min	Max	Median	Mean	
A	4	11	1	5	2.5	2.7	0
B	6	31	1	13	3	5.2	1
C	5	35	0	22	4	7	1
D	7	35	2	17	4	5	5
E	7	35	3	8	5	5	7
F	3	35	9	13	13	11.67	2
G	3	46	11	22	13	15.3	23
H	6	47	3	17	6.5	7.8	9
I	5	50	4	22	8	10	5
J	5	54	3	25	9	10.8	2
K	5	60	5	17	12	12	4
L	5	66	6	18	14	13.2	7
M	6	76	7	30	9	12.7	6
N	6	81	2	25	16	13.5	10
O	8	138	4	44	19	17.5	11
P	5	154	12	52	16	30.8	9
Q	5	170	17	61	28	34	2

Table 2. Usability Survey Results (Fall 2005)
Teams E & J and Teams L & M worked on the same problems.

Team ID	Subjective Usability (1 is low)						Messages Posted	Members in Team
	1	2	3	4	5	Total		
A	1	2	1	0	0	4	11	4
D	1	1	4	0	0	6	35	7
E & J	1	6	3	1	0	11	89	12
F	0	1	1	0	0	2	35	3
B	0	2	2	0	0	4	31	6
I	0	0	3	2	0	5	50	5
K	0	0	4	1	0	5	60	5
C	0	0	0	3	0	3	35	5
H	0	0	0	1	0	1	47	6
L & M	0	0	3	6	2	11	142	11
Q	0	0	1	2	2	5	170	5
G	0	0	0	0	2	2	46	3
P	0	0	0	0	3	3	124	5
Total	3	12	22	16	9	62	905	77

images. Approximately one third of the survey respondents identified this as a problem. Students could store large files in their home pages and include the URLs in messages, but they typically disseminated large files using e-mail. (Note: In the spring 2006, the size was increased to 4MB. No student has requested a larger limit as of March 31, 2006.)

A student commented that he had difficulties using the system from his home because of a 54KB modem connection. Text messages can be comfortably written and read using a narrow band connection, but a broadband connection is critical to effectively exchange large files and collaborate with team members remotely.

3.2 Students' Productivity

The bulletin board system is a tool, and its contributions to projects depended on how well the students used it. High performance teams used the system as follows.

- Students posted the minutes of meetings, including To Do lists, and conference calls and/or progress reports regularly. The system was useful in visualizing the status of a program and keeping track of their progress.
- Threaded messages were used as ad-hoc version control systems. Students

Table 3. Usability Survey Results – Students' Comments

Comments	Usability (1 is low)					Total Responses
	1	2	3	4	5	
Support larger files as attachments	2	7	5	3	4	21
Prefer e-mail	1	3	4	1	0	9
Notify new messages by e-mail	0	2	3	2	1	8
Support more file types as attachments	1	1	1	2	1	6
Allow users to organize messages	0	0	0	2	1	3
No comment	0	1	5	9	2	12

gained experience in version control without spending time to master another tool.
- Students conducted informal design reviews by posting comments on partial design document posted to the board.
- Any change to specifications or design change was posted to the board immediately. Thus, they minimized problems later.

Faculty advisers created the FAQs (knowledge bases) as shown in Figure 1. The students accessed information that was obviously useful in getting good grades, such as report templates in Course Guidelines and Policies, but hardly used the FAQs without their advisor's advice. The FAQs by themselves did not add much value to the courses.

3.3 Sponsor Mentors

The on-line system enabled sponsor mentors to monitor the students' progress from anywhere and at any time. Some mentors were out of town. Not only distances but also time differences made communications difficult. For example, mentors in California were three time zones away from RPI. On several occasions, sponsor mentors invited their colleagues to join the board. The system allowed them to share information about the project with a broader audience within their organization. It enabled them to provide better and timelier feedback to students and faculty about the problem; therefore, students attained solutions that are more realistic. Broader dissemination of successful project results has also led to easier justification of future project sponsorship.

3.4 Faculty Advisers

When the system was not available, faculty advisers heavily relied on face-to-face meetings in scheduled classes to assess students' progress and problems. The system allowed faculty advisors to monitor the students' progress made between classes. Therefore, in classes, the students and a faculty advisor were able to avoid trivial housekeeping issues and focus their attention on important design issues. When students posted their design ideas and plans, not only teammates, but also faculty advisers were able to review the information and provide any necessary feedback to the students without waiting for the next scheduled class. Similarly, faculty advisers can respond to students' questions and concerns. This quick turn over of information had significant impact due to a 15-week time limit of the semester.

Assessing individual performance in a group project is a difficult task. The system provided the following additional information for evaluating students' contributions.

- Figure 2 summarizes students' account activation. Approximately 10% of the students did not join the board until the second week in the fall of 2005. In other words, they did not study the project information posted to the board during the first week. Monitoring account activation activities allowed the faculty advisors to identify students who might need attention and guidance early in a semester.
- On the other hand, students, who were self-starters, joined the board before the beginning of the semester (Day 0) as shown in Figure 2. These students studied available information and led their teams from day one. The system was useful in identifying self-starters.
- The system records users' latest access to the board. Students who did not access the board for more than three days often could not report any progress made in that period. In addition to monitoring the quality and quantity of

messages posted by students, the access records were helpful in detecting students who were not productive or those having difficulties.

- Threaded messages allowed the faculty advisers to observe the process taken to generate results. In addition to the student(s) who was primarily responsible for the task, students who made valuable suggestions and provided reviews were recognized.

Although the board is a powerful and useful tool, the faculty advisers agreed that some types of information might not be appropriate for the board. For example, reports with the advisor's comments and negative comments to a team must be private. Such information should be communicated with the students by e-mail or in a face-to-face meeting. A sub-board that can be accessed by the students and the advisor only could be used for this purpose.

CONCLUSIONS AND FUTURE WORK

We showed that the bulletin board system was useful for the students to get organized and achieve their goals in engineering design courses. It also enabled sponsor mentors and faculty advisors to provide timely feedback to students. Thus, the system made them more effective, and the students were able to gain more valuable experiences from the courses. In this study, the students utilized a subset of available features of the system. We plan to study if other features (such as notification of a new message posted) make students more productivity. The current system has difficulties in managing large files, and this problem must be resolved. We also plan to use a commercial collaboration tool in some design projects to find out the value of a more sophisticated but more complex collaboration tool in engineering design courses.

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Contact Information:
Dr. Junichi Kanai, Associate Director
O.T. Swanson Multidisciplinary Design Laboratory
School of Engineering
Rensselaer Polytechnic Institute
110 8th Street, Troy, NY 12180-3590
USA
E-mail: kanaij@rpi.edu
Phone: +1-518-276-6626
URL: http://www.eng.rpi.edu/mdl/

Coauthor Information:
Dr. Mark W. Steiner, Director
O.T. Swanson Multidisciplinary Design Laboratory
and
Clinical Associate Professor
Department of Mechanical, Aerospace, and Nuclear Engineering
Rensselaer Polytechnic Institute