

AC 2009-783: COORDINATION OF SENIOR DESIGN TEAMS USING INTERNET TECHNOLOGY: A CASE STUDY

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Coordination of Senior Design Teams Using Internet Technology – A Case Study

Abstract

This fall a new approach was undertaken in our senior design course that uses tools available on the internet to give the students means for improved communications between members within a team. Being reported on is the use of student laptop computers in the class room coupled with a number of internet resources for communication, shared documents, a free 3d CAD program, and a team structure the students bought into and work within. These changes provided the team members methods to rapidly share ideas, contribute to reports, check on each other's progress, and receive feedback from the course instructor. The individual teams were allowed to choose which communication resources they wanted to use. Their choices and reactions to them are provided. The perceptions of the student teams to this new experience are also provided in the conclusions.

Introduction

At the start of our three quarter biomedical engineering senior design course we teach a prescribing approach to design. The students learn design using a seven step method involving the client, problem definition, conceptual design, preliminary design, detailed design, design communication and final design documentation. There are numerous instruments involved with each step to assure that the final design has been optimized, meets the client's needs, and is well documented. At the end of the first quarter small teams are formed and a project is assigned to each team. These projects are all different and by the end of the third quarter a product is produced.

During the first quarter the class also forms teams of four or more and each team undertakes the same design project. They then use the methods being taught on their design. It has been observed that while the students learned the principles, they were frustrated with the experience. Usually one or two on a team would take the lead and the others coasted. A major problem was getting team members to coordinate tasks and communicate among themselves. Things that got in the way were different class and work schedules, intramural sports, physical location off campus, and energy levels.

Having taught senior design for a number of years and experimented with team leadership building¹ I started looking at what could be offered that would improve the communication between team members and enhance leadership. A review of the resources and methods used by others was interesting.

Most of the focus on teaming communications involving engineering design in the academic setting has been on inter-teams and little on intra-team. Text books involving engineering design stress teams.^{2,3,4,5} However, team development seems to be limited to teaching how team members interact as they proceed with a task. Typical are discussions on forming, storming, norming, performing and adjourning. Design tools such as Gantt and linear responsibility charts are emphasized and creative methods such as brainstorming and mind mapping are encouraged. When communication is covered it involves presentation techniques, report preparation, and feedback methods between the team and the client. But, these have nothing to do with how team members communicate between themselves.

The recent literature has some examples of team member performance evaluation used as a communications tool and communication methods between teams on joint projects. Eggert used the analogy of a professional football team in developing teamwork skills to produce a spreadsheet workbook that lets the team members evaluate team and individual performances.⁶ They concluded that the spreadsheet tool helped students improve their teamwork skills. Zoltowski, Oades, and Myers in a multi-campus project used the Access Grid, phone calls, emails, instant messaging, WordPress and MediaWiki to share project documentation between teams.⁷ They also made use of internet resources such as WordPress and MediaWiki. However, it appears that use was for communications between teams. Davidson, et al. reported on IT methods for distance collaboration.⁸ These methods involved distance learning classrooms, web-based collaboration environments and desktop/video conferencing. The web-based collaboration environment involved bulletin boards, threaded discussions, and a shared file structure. Again, with the exception of Eggert's spreadsheet workbook none of the others involve intra-team communications. This is the same thing noted in the text books.

Zelenka has a book with an interesting chapter "Connect, Communicate, and Collaborate" that presents some of the internet based techniques that could be used for team communications.⁹ These are email, blogs, twitter, wikis, instant messaging, video chat, videoconferencing, conference calls, message boards, social networks such as Facebook, MySpace and professional networks like LinkedIn and Xing. The actual use of these is not documented.

It was disappointing that the main focus in all of this was communications between teams locally or at a distance. If there were tools out there used within a team for communication, the application was not apparent. So, using the students themselves as a resource and exploring the internet, the following approach was taken.

Methodology

Teams of seven were formed that had the same task. Previous experience had shown that even teams of four had difficulty arranging meetings, staying on schedule, getting all members to be productive, and producing reports on time. Since information about the newer resources for team communications might overcome these problems, the teams were made larger than the normal four to provide a more challenging test of the internet tools. The task was to design an assistive living kitchen with drawings, resources, and pictures integrated into a client report. Periodically they had to present their progress using power point that included their solution to the five-stage prescriptive model for design. The teams were required to choose a team leader then proceed using the design concepts being taught.

After the teams were formed several web based communications tools were presented and the students were given time to experiment with them, add to them, and discuss them in class. The tools chosen for consideration were Google Docs, Google Groups, Blogs, Email, and Instant Messaging.^{10,11,12,13,14} They were then required to pick which ones their individual teams wished to use for the duration of their design.

The following is a brief description of these tools:

1. **Google Docs** is easily accessible online and access can be limited to approved group (team) members. It allows the upload, download and editing of a number of file formats, i.e. MS Word, Power Point, Excel, and PDF. Anything uploaded or created can be seen by all invited members of a group. Editing is not limited to one team member at a time. If more than one team member is editing a document they are identified by the program.

2. **Google Groups** provides a number of applications that can be viewed, edited, added to and updated by any member of the group. Discussion can be utilized to post and read tasks that need to be completed by team members, to answer questions and clarify problems. Pages can be utilized to post and read tasks that have been started by team members as a way to complete assignments and brainstorm ideas. Pages allow any team member to make changes to existing pages and add new pages within the group. Files can be utilized to post and read files that have been completed for different portions of the project. Once open, you can read it but you can only make changes if you save the file and reload it under another name. This helps to keep a clear track of the work that has occurred.

3. **A Blog** can be use as a brainstorming tool or an organizational tool. Individual team members can be invited as contributors for posting things such as pictures, data or text. Things called “gadgets or widgets” can be added that allow RSS feeds, polls, member lists, slideshows, pictures, ads, or just about anything else you can think up. One can also create their own gadget. Posts are useful for sharing your ideas and solutions. When a post is accessed it is automatically time stamped so the team leader can see who has participated. Team members can comment on posts, add pictures and with gadgets do polls or a list of goals to accomplish. Videos and slideshows can also be posted.

4. **Email** is a basic tool of the internet. It has the advantage that most if not all internet users have access to email. Email is good for quick communication. It is not good for task management. It has the advantage and disadvantage, depending upon one’s view, that one member of a team can communicate with another without sharing with the whole team. This might be done when one is starting to develop a concept and would like input from a more experienced team member before posting it to one of the other modalities for all to see.

5. **Instant Messaging (IM)** is another way to communicate. Once a message has been started all members of the team can respond real time. It provides immediate acknowledgement of replies and web cams can be used that provide face-to-face communication. Unlike email, all members of an instant messaging group usually use the same IM software. There are IM aggregators that allow contact between IM networks. But, these add more complexity.

In addition to these tools the students had previously requested a means for producing engineering drawings. Our program does not provide a course in

engineering CAD which has been a student concern as drawings are one of the fundamental communications tools of an engineer. We had offered training on Saturdays using Solid Works¹⁵ but while the student desire was there the response was minimal. So after searching the internet I decided to provide the students with the free Google SketchUp program.¹⁶ This is a 3-d CAD program that can be use dindividually and in teams. It also has nice video demonstrations of the drawing tools for student review. For the lectures the students were required to down load and install the program on their laptop computers and bring them to class so they could follow what was being presented. SketchUp was presented to the students during two lectures one week apart. An overhead computer projector was used to demonstrate the program. During the first lecture basic tools were covered with the students using them real time and homework was assigned to emphasis the lecture. During the second lecture the students were required to render a complex 3-D drawing based upon a series of photographs of an abstract designed building on campus.

Results

CAD--Using laptops real time in the class room made it surprising easy to introduce 3-d CAD over two weeks. The students demonstrated that they master enough of the program to render complex drawings. This was considered a satisfactory learning experience and was confirmed as the team projects progressed. During their presentations all of the teams used Google SketchUp to make drawings of their solutions for the adapted kitchen. Their final reports also incorporated them.

Communication tools--The teams were very independent in their choice of these tools. As shown in Table 1, one chose Google docs and IM, one chose Google docs, a Blog, and Email, one chose Google groups, and one chose a Blog.

Table 1. Team Communications Choices

Team	Google Docs	Google Groups	Blog	Email	Instant Messaging
1	X				X
2	X		X	X	
3		X			
4			X		

Team one considered using a Blog but it did not provide the ability to upload, edit and comment a word document in real time. Hence it was not chosen. They liked the easy access of Google Doc's online, and five of the team members had already registered for the Google interface before the project began. Using IM the team members were able to communicate quickly while editing. They also used Picasa to edit photos and figures.¹⁷ They considered that these tools made team work efficient.

Team two wanted the features of a blog and the document sharing of Google Docs. They found setting up a blog using BlogSpot easy to do. They customized their blog using a conservative and professional template. They liked being able to post a page and receive comments from the team members. Pages were used for specific tasks and they found team discussion and communication on a topic to be a "great" feature. They liked being able to see how many times a member had logged into their Google Docs site and edited a page. This also provided data on how the members were responding. Email turned out to be the fastest method to get responses.

Team three liked the rapid access of pages from the home page of Google Groups. They used a discussion board for each task and found it easy to start new discussions. The files section was used to post and read files that had been completed by the team members for different portions of the project. The requirement that edited pages had to be filed under a new name was a bonus as they could track changes easily. They did not report any need for faster communications using email or IM.

This team also developed a method to rate individual member's performance. The team leader set up a point system based upon team member's use of the group.

- 1 point for every comment or input on the discussion board
- 2 points for editing or adding ideas to an assignment/page
- 5 points for every paper or power point presentation typed
- 2 points for presenting in class

Since Google Groups keeps track of what every member writes on the page, it was easy to record this information and then put it together using Excel. An example of the group's progress is shown in Figure 1.

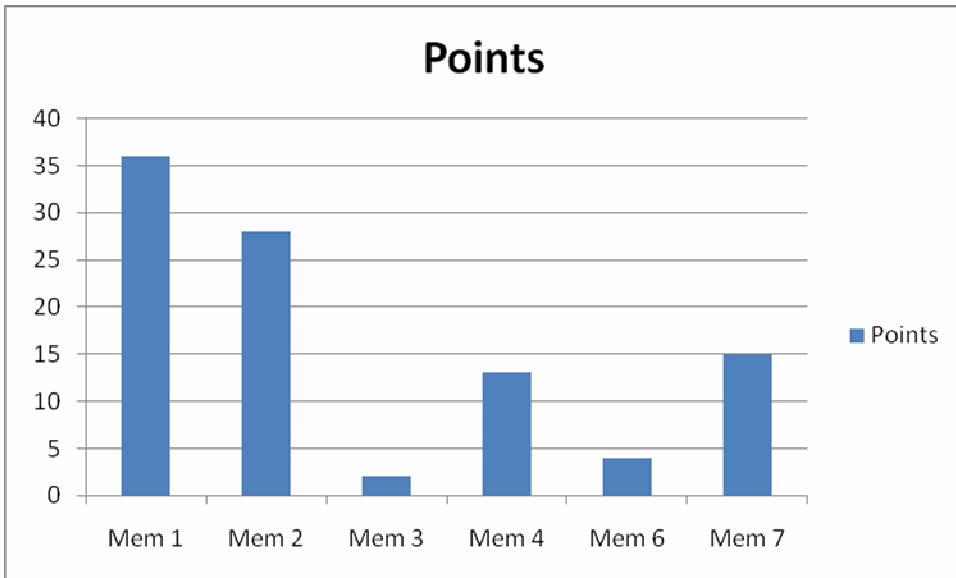


Figure 1. Example of team member's progress using data from Google Groups

Team 4 liked using a blog as they considered it easy to communicate for brainstorming and to use as an organizational tool. Tracking posts by the built in time stamp they were able to settle disputes over who came up with an idea first. They found that creating posts helped the team get a sense of each other's ideas and solutions. The team members could also comment on posts to discuss how an idea or solution was or was not the best possible one. They included pictures to help visualize ideas and used the "add gadget" to help determine team direction by adding goals, videos and slideshows. They felt that these features and tools made team communication easier, more efficient, and better organized.

Discussion

It was surprising easy to introduce to these seniors 3-d CAD in a very short time using a real time approach during lecture with laptop computers. They were quite receptive of the program and quick to incorporate the tool into their teaming activities. This is a good method for incorporating CAD if not provided in a formal course.

Between the teams all of the internet tools presented in class were used. Some use more than one. All of them presented reasonable discussion as to why they chose a particular one. Google Docs was preferred when a team wanted their members to be able to edit pages on line. Blogs were chosen for being able to track changes members made to pages. One team used email and one IM for quick communications. The other two teams saw no need for the service. Team three's leader came up with a neat way to track member activity and report it using a spreadsheet. This was similar to Eggert's spreadsheet tool.

Conclusions

Using laptops real time in the class room is a quick way to introduce complex technology such as 3-d CAD.

Allowing the students to use internet tools that are cutting edge for communications makes their teaming experience more appealing. The use of these technologies removes the difficulty of team member communications. This was apparent in that no problems were reported with the enlarged teams.

It would be interesting to see if incorporating video technology for group face-to-face meetings would improve the teaming experience more.

At the end of the course the class was divided in two or three member teams and given a final senior design project to finish over the next two quarters. Several of the teams reported using the communication methods over the Christmas break. One of these teams had a member who went home to Columbia. This certainly indicates that the experience was beneficial.

Specific conclusions from the teams were:

1. "All in all, a Google group is a great way to communicate within a group. All of the applications that Google groups offers allow for the best communication when a group is unable to meet and wants to stay in contact at all times"
2. "With all of these features and tools team communication becomes easier, more efficient, and better organized."
3. "Through the development of this project, the accessibility, convenience and diverse applications available using Google Docs has made communication extremely easy. Additional features recently made available like Video conferencing makes the Google interface increasingly appealing. More importantly, as we continue to develop into researching scientists, familiarity with this interface, which is used commonly in the professional world, is extremely relevant."

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