Session 2525

On the use of Advanced IT Tools to Facilitate Effective, Geographically Distributed Student Design Teams

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Introduction

In industry and government, teams of scientists and engineers need to work together closely to achieve their project goals. In large projects team members may live and work at geographically distant sites, and may work for different organizations, making communication and interaction between the team members difficult at best. Advanced information technologies such as video conferencing and web-based collaboration systems are being adopted in business and education. These tools, in combination with existing technologies such as email and telephone promise to greatly improve the effectiveness of geographically distributed project teams.

To make the most effective use of IT tools for distance collaboration and to improve the design of the next generation of tools, fundamental research as well as practical experience with using the tools is required. With support from the NASA Langley Research Center, the State of New York and the AT&T foundation, Syracuse and Cornell Universities are conducting a study on the effectiveness of advanced information technology tools for facilitating communication and collaboration at a distance. This study combines fundamental research into the design and use of the IT tools as well as practical experience with using IT tools for distance collaboration. Our working hypothesis is that proper use of IT based collaboration tools can facilitate effective design collaboration at a distance and can enhance our student's education, better preparing them for tomorrow's workplace.

Course Description

To provide a formal mechanism to learn about, and subsequently teach students about, tools and techniques for harnessing the benefits of distance collaborations, Syracuse (SU) and Cornell (CU) Universities have been collaboratively teaching a senior-level engineering design course for the past two years. The two-semester course is taught to a roughly equal number of students at the two universities by faculty in the two universities from several different engineering disciplines.

For the first half of the first semester, the students were broken up into three groups, or discipline specific tracks, each taught by a different faculty member. Of the ten students in each track, five were from CU and five from SU. Each track studied a specific subject, (thermal systems, materials, and aerospace structures). Lectures and discussion sessions were given synchronously at CU and SU using distance learning classroom. All lectures were given using PowerPoint presentations. Generally the presentations were provided to the students ahead of time, although the versions given to the students generally had much of the derivations deleted, forcing students to pay attention and to take notes in class. Through these short courses, each student developed a specific skill and set of analysis tools to bring to their team design project.

In the second half of the first semester, five teams of six students were formed. Each team had three students from each school. Each team also had two members from each of the discipline specific tracks. Thus, within a team no student has all the necessary background, and hence must find ways to effectively communicate. Working at a distance (with one or two in-person meetings) each team developed a preliminary thermo-structural design for a portion of the proposed reusable launch vehicle shown in Figure 1. Design requirements included protection against re-entry heating, strength to resist many different load cases, and minimum weight.

Students completed individual assignments as part of the discipline specific tracks, and team oral and written reports as part of the preliminary design project. Each of the five design teams had a faculty coach assigned to it. The coach helped the team get organized, reviewed design concepts and reports and facilitated interaction among the team members. Grading was based on student's individual assignments in the discipline specific tracks, on team written and oral reports and on self and peer evaluations performed twice during the semester.

In addition to focusing on the technical disciplines and design project, the course included presentations and interactive exercises on design from the big picture, team formation, report writing, best practices for graphs, figures and slides, and practice sessions for giving oral reports in a distance learning setting.

In the second semester students again worked in teams. For the first half, teams consisting of only Syracuse or only Cornell students worked on detail design of thermal protection systems, incorporating thermal and structural finite element analyses and laboratory tests of prototype systems. In the second half, mixed teams consisting of Cornell and Syracuse students designed adhesively bonded and bolted joints for the proposed RLV. Teams were required to verify their designs by physical tests. Tests of the bonded joints took place at Cornell and of the bolted joints at Syracuse.

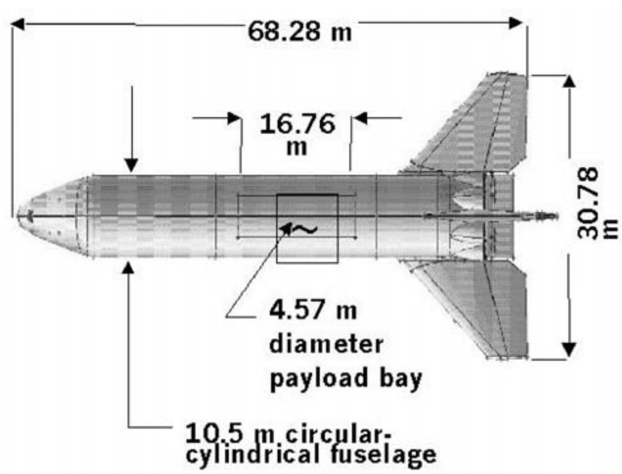

Figure 1, Proposed 2nd generation reusable launch vehicle. Students developed preliminary designs for thermal-structural systems at critical locations on the vehicle body.

Course Technology

Communication in the course included synchronous lectures given using distance learning classrooms, asynchronous communications facilitated by a web-base collaboration environment and off-hours meetings between students and faculty using computers equipped with cameras, microphones, and speakers.

Lectures and other full class activities took place in distance learning classrooms (DLC) at CU and SU. Images of the CU DLC are shown in Figure 2. At each site the classroom is equipped with a PolyCom based video conferencing system and with a separate PC and projector for sharing presentations. This PolyCom system provides high resolution, real time audio and video communication between sites. In the student view of the CU classroom, shown at left in Figure 2, students see either the SU classroom or the SU instructor on the left screen. The instructor sees the remote classroom projected onto a screen at the rear of the classroom. Students can ask questions and participate in discussion using push to talk microphones located on each desk. The presentation is shared using NetMeeting and is projected onto the screen at the right side of the classroom. Using an interactive projection screen (SmartBoard) or monitor (Sympodium) the instructor can annotate the presentation during lectures.

In order to help the student design teams communicate more effectively, a web-based collaboration environment called the Advanced Interactive Discovery Environment (AIDE) has been developed. This environment, developed using IBM Lotus QuickPlace, contains bulletin boards, threaded discussions, and a shared file structure. A screen shot from the AIDE is shown in Figure 3. It uses a room metaphor to organize information. For example, the faculty team developing the class has a room accessible only to the faculty for sharing documents, tasks and calendar information. Rooms containing course presentations, assignments, handouts and discussions were provided for each of the discipline specific tracks. Each student design team had its own, secure room for document sharing, discussion, calendar and tasks. In addition each individual student and each team had a drop box into which they turned in their assignments.

Figure 2, Student view (left) and instructor view (right) of distance learning classroom. In student view, the remote classroom is seen on the left screen. Shared presentation is seen on the right screen.

The inset in Figure 3 shows a screen shot from the synchronous portion of the AIDE that uses IBM Lotus SameTime. It facilitates audio-video conferences using desktop computing. In a typical session, two or more participants sit in front of their own computers, equipped with cameras, microphones and speakers (or headsets). Participants can talk to each other, can share documents and applications and can mark-up documents or sketch ideas using a whiteboard. All meetings can be recorded and played back for future reference and for research purposes. SameTime meetings were used extensively by student teams, both with and without their faculty coach present, to discuss their design progress. SameTime meetings were also used by the faculty to conduct on-line office hours and discussion sessions throughout the semester.

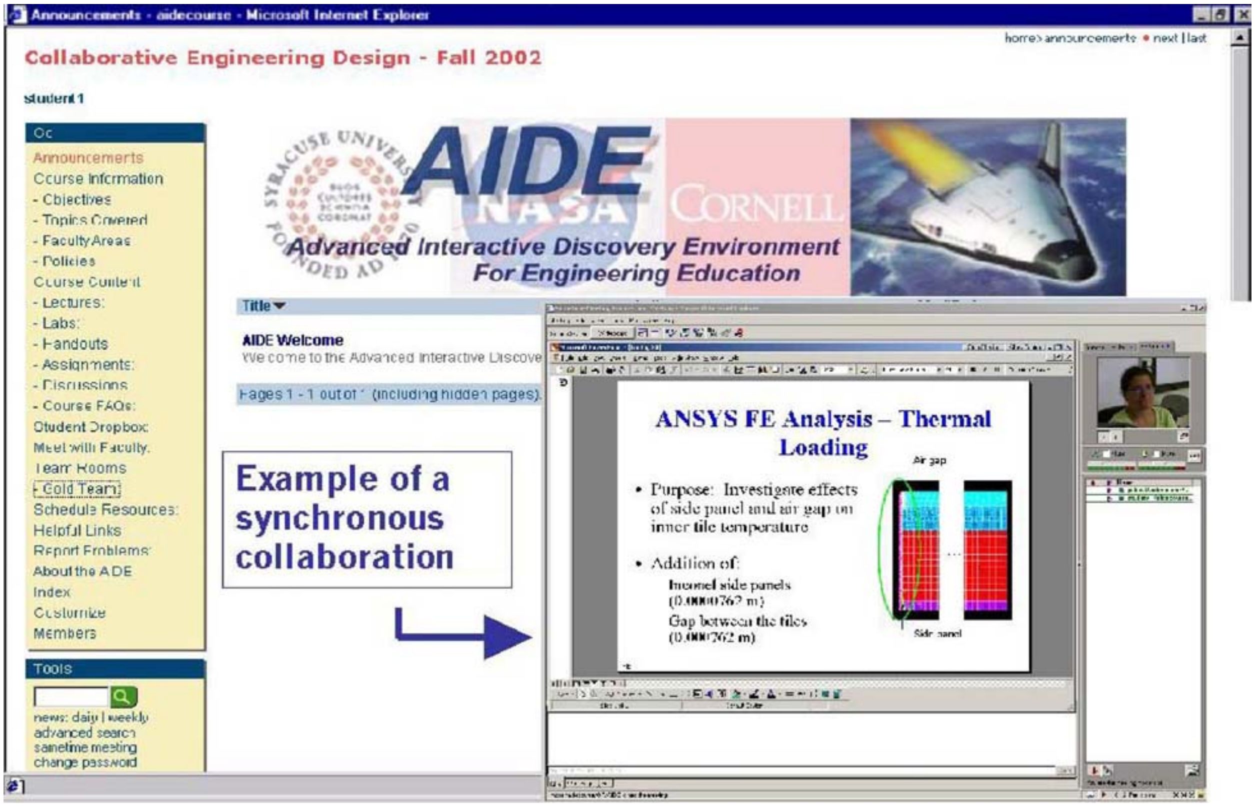

Figure 3, Screen shot of web-based AIDE. The asynchronous part of the AIDE is based on IBM Lotus QuickPlace. The synchronous part (inset) is based on IBM Lotus SameTime.

Evaluation Procedures and Results

The effectiveness of the IT tools and of the overall course is being assessed through an on-going process of evaluation via surveys, logging of student interaction with the IT tools, focus group interviews with students, and exercises in which teams of students complete specific tasks using the IT tools.

The evaluation, to a large extent, focuses on the social aspects of technology use, specifically in the contexts of learning and collaboration. Many researchers argue that learning is fundamentally a social process and the purpose of a knowledge community is to create and sustain knowledge, culture and social infrastructures (i.e., social networks) that foster seamless conversations and networks of connections and relations among members (Haythornwaite & Wellman, 1998; Lave & Wenger, 1991). As such, a social network perspective is being used to visualize emergent communication network structures.

Three surveys were administered during the Fall 2002 semester. These surveys measured the structure of the existing friendship (social) network at the start of the class, as well as the emergent information sharing (task) network during the course of the semester. Figure 4 represents the structure of the friendship network (social) at the start of the semester. Letter-number combinations (i.e. A7) represent students from each of the two participating universities. The presence of a line between students indicates the existence of a communication tie. Clearly, at this point two distinct networks exist. Figure 5 represents the emergent information exchange network (task) which was in place at the end of the semester. This network is much denser than the initial social network, and multiple links exist between students at both universities.

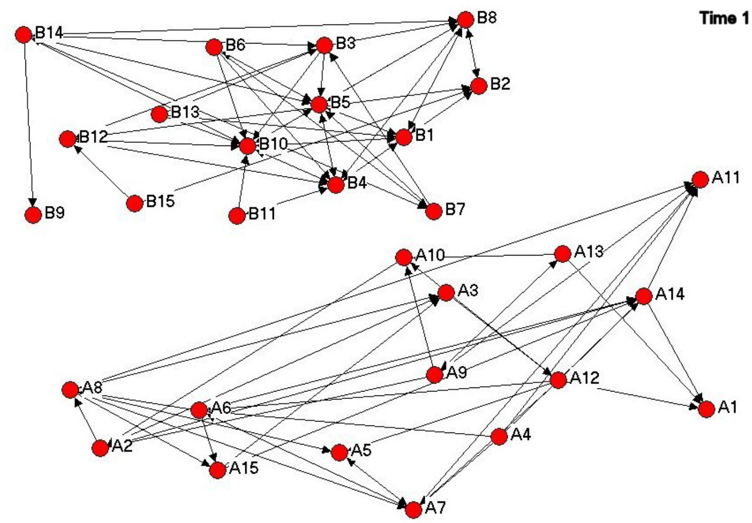

Figure 4. Social network structure measured at the beginning of the semester. "A" represents Cornell students, "B" Syracuse students.

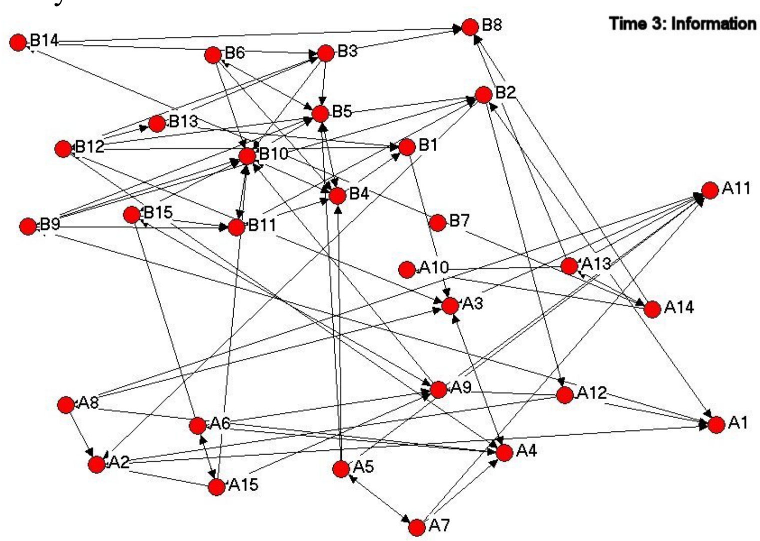

Figure 5. Information exchange (task) network structure measured at the end of the semester.

Figure 6 indicates the structure of the friendship network at the end of the semester (measured at the same time as the information exchange network in Figure 5). Other than actor B7, the friendship networks are clearly differentiated by university affiliation. It is interesting to note that, contrary to the expectation/belief that technology makes it easier to maintain diverse, geographically disperse social contacts, our findings reveal that the social structure of communication ties between students is quite rigid over time (Figure 6). Increased effort should be directed at fostering cohesive teams over time, especially when these teams are faced with geographical barriers. These findings are important considering the increased likelihood that students, as well as professional design team members, will have to collaborate from geographically remote locations.

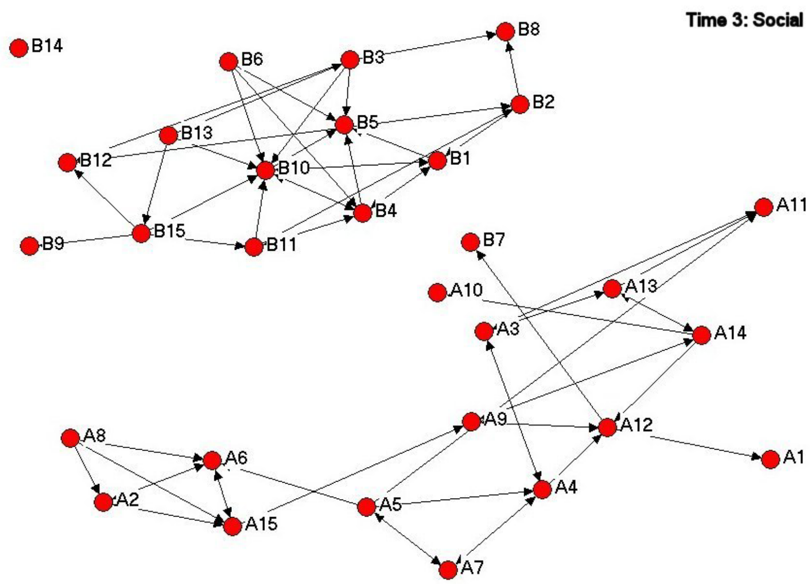

Figure 6. Social network structure measured at the end of the semester.

Summary

In global organizations it is not uncommon to have design teams composed of engineers and other technologists from geographically dispersed sites. All the issues that make any team collaboration hard are compounded by the difficulties caused by non-face-to-face communications. To learn about, and subsequently teach students about, tools and techniques for harnessing the benefits of distance collaborations, Syracuse and Cornell Universities have been collaboratively teaching a senior-level engineering design course for the past two years. The course uses an array of advanced IT tools such as distance learning classrooms, web-based collaboration environments and desktop audio/video conferencing. All aspects of the course and the IT use are closely monitored and evaluated to extract research findings on the design and use of the tools and best practices for distance collaboration. These lessons not only apply to the university environment, but should be applicable throughout industry and government. Further information may be found at our public website, http://www.tam.cornell.edu/~aidecourse/ and our collaboration environment, http://aello.syr.edu (login as guest).

Acknowledgements

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