Virtual Capstone Design Teams:
Preparing for Global Innovation

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Global innovation requires collaboration between groups of people located in different parts of the world, and is a growing trend in industry. Virtual teams are often used to manage new product development projects. These teams are similar to traditional teams but are geographically separated and rely heavily on virtual methods of communication (email, Skype, teleconferencing, etc.) instead of regular face-to-face meetings. Experience working as a member of a virtual capstone design team can help prepare students for this growing trend. To begin preparing students for work on virtual teams in industry, we co-advised two virtual capstone design projects with students from Marquette University and Smith College. This paper describes our experience with managing two virtual capstone design project teams across institutions. Presented here are the challenges we encountered, the lessons we learned as a result of this experience, as well our recommendations for others who might want to include virtual project teams in their capstone design courses. We also include retrospective feedback from the students on these teams regarding their perceived value of their virtual team experience to their careers in engineering.

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Introduction

Global innovation requires collaboration between groups of people located in different parts of the world, and is a growing trend in industry. Often, team members from various departments of an organization who need to work together to design, develop, and introduce new products are not in the same location. For example, R&D personnel may be located in the United States, the production facility may be located in Ireland, and other key personnel may be located in Singapore. In this situation, a virtual team can be formed to complete the new product development project. Virtual teams are similar to traditional teams but are geographically separated and rely heavily on virtual methods of communication (email, Skype, teleconferencing, etc.) instead of regular face-to-face meetings.

Management of virtual teams presents some unique problems resulting from cultural, language, and time zone differences, and geographic separation. The biggest challenges to virtual teams are developing trust and effective patterns of communication.[1] Since virtual team members cannot see their distant team members following through on commitments, they must trust that the work is getting done correctly and in a timely manner. Trust is difficult to develop if team members have never met each other in person. Geographic separation does not allow the informal social interactions needed to build trust and camaraderie among all team members.

In RW3 Culture Wizard's recent survey of global business professionals, the vast majority of respondents indicated that they had worked on virtual teams but only 16% received training to prepare them.[2] To prepare engineering students to contribute to global innovation projects in industry, experience with virtual teams during their undergraduate years would be helpful. The capstone design course can provide opportunities for students to gain experience with virtual teams (domestic or global). Zaugg, et. al. state that "when completed correctly a global virtual team experience enhances the educational experience of students and prepares them for participation on global virtual teams in the workplace".[3]

In this paper, we describe our experience co-advising two capstone design projects run by virtual teams consisting of biomedical engineering students from Marquette University (MU - Milwaukee, WI) and engineering science students from Smith College (Northampton, MA) during the 2011-2012 and 2012-2013 academic years. Presented here are the challenges we encountered, the lessons we learned as a result of this experience, and our recommendations for others

who might want to include virtual project teams in their capstone design courses. We also include retrospective feedback from the students on these teams regarding their perceived value of their virtual team experience to their careers in engineering.

Rationale for Virtual Teams

We became aware of the growing trend in the use of virtual teams in industry from several part-time graduate students who worked for GE Healthcare in Waukesha, WI. We also heard presentations at previous *Capstone Design Conferences* on the use of multinational student project teams for capstone courses. We decided to conduct a pilot study with one virtual project team. Our intent was to eventually increase the number of virtual project teams as we gained experience in advising these teams. Instead of working with students in another country who spoke a different language, we decided to limit the number of challenges we would have to deal with by forming a team of students who shared a common language and only a one-hour time zone difference. This would allow us to focus on resolving issues related to communication, specifically the lack of face-to-face meetings, and not have to deal with other issues common to multinational virtual project teams.

Background and Methodology

We piloted our virtual team experiment in 2011-2012 and continued the collaboration in 2012-2013 on another project. On the first team, four MU and four Smith students designed an acidosis/alkalosis detector for Type I diabetics. On the second team, three MU and three Smith students designed a scalp cooling device to reduce hair loss during chemotherapy. We served as both the capstone course coordinators at our respective institutions and the local project advisors for the students on our virtual teams.

The capstone design courses at both institutions are taught for two semesters but had different semester start/finish dates and different vacation schedules. To simplify course administration, reduce confusion, and maintain consistency, we agreed that the virtual teams would follow the project schedule and produce the deliverables required by the course taught at Marquette University. Grading of deliverables was conducted by both instructors using the grading rubrics used in the MU course. We advised our respective students, and met with them weekly (or as required) for project updates. In addition to these meetings, the MU and Smith students set up their own schedule to meet as a team. Most of these virtual meetings were via Skype and most other communications were via phone, email, or text messaging. During both years, at the beginning of the spring semester (at the halfway point of each project), Smith student team members traveled to Milwaukee for the first and only face-to-face meeting with their MU teammates. Budget and scheduling constraints prevented additional face-to-face team meetings.

We noted student and faculty impressions informally during both capstone team experiences. We also surveyed the students after they graduated to capture their feedback more formally; of the 13 alumni for whom we had email addresses, 11 responded to the survey.

Student Impressions

Table 1 displays student responses (strongly disagree, disagree, agree, strongly agree) to a set of statements regarding the students' virtual capstone team experience. Interestingly, although the vast majority of the students did not specifically seek out the virtual team experience, and the respondents are of mixed opinion whether the benefits outweighed the challenges, most/all of the students believe that they learned useful skills from the experience that are relevant to their work and studies after graduation.

Table 1: Student impressions regarding their virtual capstone design experience (scale: strongly disagree (SD) to strongly agree (SA), n=11)

	SD	D	A	SA
I chose my capstone design project in part because I wanted a virtual team experience.	2	6	3	0
I learned useful skills from the virtual capstone team experience.	0	0	6	5
The benefits of the virtual team experience outweighed the challenges.	0	5	4	2
With the benefit of hindsight, I would still choose a virtual capstone team experience if I had it to do over again.	0	4	4	3
My experiences on a virtual team in capstone design are relevant to my work/study today.	2	0	4	5

Challenges

The students and faculty both identified a number of challenges with the virtual team experiences:

Communication – in the post-course survey, 80% of the students specifically mentioned communication as one of their biggest virtual team challenges. As one student commented, *"corralling eight students, in two time zones, proved nearly impossible."* Students noted difficulty communicating remotely without face-to-face interaction, trouble with communication technologies themselves, and inconsistent communication from the two faculty advisors.

Scheduling – time constraints and time zone differences led to difficulty with scheduling meetings, an issue exacerbated by team size. The class times at the two institutions also did not coincide, so joint presentations were rarely possible.

Lack of cohesive team identity – working with unfamiliar teammates from a different institution exacerbated the usual teamwork challenges faced in capstone design. During the first semester of each project, there seemed to be two distinct teams (MU and Smith) working on different parts of the same project instead of one team working on the entire project, leading to a, as one student called it, an "*us versus them mentality*". The eventual face-to-face meeting at the start of the spring semester was helpful in creating a more cohesive team, but would have been more useful earlier in the project to promote shared understanding and trust.

Peer reviews – as a result of task delegation and collaboration structure, students were usually more aware of the actions of their co-located teammates than those of their teammates at the other institution. This imbalance coupled with the lack of frequent face-to-face meetings made it difficult for both groups of students to effectively evaluate each other's performance on the team and project.

Construction of prototypes – each team had access to prototyping facilities and resources for prototype construction and testing. To divide the work fairly, different parts of the prototypes were made at the two institutions. This created some logistical problems related to coordination of testing activities and availability of prototypes for classroom presentation and demonstration.

Ability to provide comprehensive and similar project experiences – due to delegation of different tasks to each institution and the lack of frequent communication between the entire team, student experience was not consistent among the two groups. During the second project, for example, Smith students gained more experience with verification testing and prototype construction and the MU students gained more experience with technical writing and sponsor interaction.

Benefits

The students identified multiple benefits associated with the virtual team experience:

Communication – on the post-course survey, two-thirds of the students listed improved communication skills as one of the biggest benefits of the virtual team experience, demonstrating how facing challenges can lead to positive outcomes. Students commented on their ability to communicate ideas clearly, to select and use various communication tools effectively, to listen carefully, and to provide constructive feedback.

Teamwork/Trust – students noted the benefit of learning to work with people in different locations who may not be readily available and how to trust people they had not previously met. They also commented on their experience identifying strengths and weaknesses in self and others, collaborating with a large team to accomplish a goal, and establishing goals and common understanding.

Personal/Professional Growth – additional benefits noted by at least one student included confidence, leadership, self-assessment, documentation, time/task management, productivity, decision making, and preparation.

As faculty advisors, we noted several additional benefits:

Additional perspectives and opinions – creation of the virtual teams consisting of students with diverse backgrounds and different ways of looking at the design problem enhanced the pool of potential design solutions, which was also a benefit to the project sponsors.

Colleague as sounding board – the shared virtual capstone teams provided us the opportunity as faculty to collaborate as colleagues, share our pedagogical strategies, and calibrate our evaluation methodologies. Having such an opportunity is particularly valuable for faculty who are the sole capstone design instructors in their department and/or institution.

Recommendations for Virtual Teams

As a result of dealing with the challenges and issues described above, we plan to implement several changes to our future virtual team collaborations. These recommended changes are based on our own observations, student feedback, and recommendations from the management literature:

1. Schedule a face-to-face meeting as early as possible to create and nurture a team culture and build trust among team members.[1] In our next collaborations, we will allocate travel funds for Smith or MU students to visit the other's campus for a face-to-face meeting within the first few weeks of the project. This will provide opportunities for a) informal social interaction to build trust, b) setting goals for the project, c) discussing project expectations, and d) assigning roles for each team member. Trust in virtual teams grows as team members display reliability, consistency, and responsiveness. This process can be initiated by assigning each team member a task that can be completed quickly, allowing them to make an immediate contribution to the project.[1]

2. Make better use of appropriate communication and collaboration technologies to establish effective methods of communication and match the technology to the communication need: email to distribute important information; videoconferencing when it is important to observe facial expressions and body language, especially in the early phases of a project when relationships are being built; conference calls for project status update meetings and to sustain camaraderie among team members.[1,4] Provide a designated space for virtual teams equipped with reliable communication technologies. Develop a communication plan that defines what communications are needed, who needs to be involved, frequency, purpose, point of origination, and the communication medium to be used.[5]

3. Encourage student pairs across institutions to work on tasks together instead of assigning tasks to sub-teams from the same institution. This will create new sub-teams consisting of students from both institutions who will be required to work and communicate with each other on their assigned tasks.

4. Require more frequent meetings of the entire team that include both faculty advisors. This is a better alternative to having separate team meetings of each group with their respective faculty project advisors, and helps create and nurture a cohesive team culture and identity. Our goal is to prevent two geographically separate teams from working on different tasks for the same project and ensure everyone receives the same communications and understands a common set of expectations.

5. Provide opportunities for both faculty advisors and all students to interact with the project sponsor. The two virtual team projects described above were solicited through MU. As a result, one student from MU was assigned the role of sponsor contact, which prevented other team members and the Smith team advisor from interacting with the sponsor. A more collaborative structure should result in a better understanding of the goals and expectations of the project as well as a higher level of buy-in from all team members.

6. Align expectations across students, faculty advisors, and institutions. Require the team to create a team operating agreement that includes items such as procedures for working together, resolving issues, reporting project status, assigning work, attendance at team meetings, and scheduling of meetings and deadlines around holidays and key academic calendar dates.[3,5] Ensure faculty establish unified guidelines and communicate a consistent message to the team.

Summary

Students who worked on our virtual capstone design project teams experienced some of the same challenges and benefits encountered by members of virtual teams in industry, including communication difficulties related to the lack of face-to-face interactions and lack of team cohesion and trust. Additional specific challenges were related to prototyping, peer reviews, and experience parity. Benefits included improved communication and teamwork skills, professional development (of both students and faculty), and an enhanced pool of potential design solutions.

We recommend that when managing virtual capstone design teams faculty should facilitate a face-to-face meeting early in the project to build trust, provide the team with appropriate virtual communication technologies, and require teams to agree on how they will operate and communicate as a team. Faculty should also communicate clearly and consistently with all team members and consider creating subteams consisting of students from both institutions to ensure collaboration.

Implementation of the recommendations discussed here should help future virtual teams run more smoothly and lead to better outcomes for the students and industry sponsors. We value the virtual team experience for our students and encourage other capstone faculty to provide a virtual team experience to their students as well.

References

1. Gray, C. F. and Larson, Erik W. *Project Management: The Managerial Process*, 5th Ed., McGraw-Hill Irwin, New York, 2008.
2. RW3 Culture Wizard Report: (2012) The Challenges of Working on Virtual Teams. http://rw-3.com/2012VirtualTeamsSurveyReport.pdf.
3. Zaugg, H., Parkinson, R.A., Magleby, S.P., Jensen, G., Davies, R., and Ball, A.G. "Best Practices for Using Global Virtual Teams", Proceedings of the 2012 Meeting of the American Society for Engineering Education, San Antonio, TX.
4. 3M, *Leading a Distributed Team*, www.3m.com/meetingnetwork/readingroom/meetingguide_distribteam.html. Accessed June 6, 2006.
5. Dargin, S. "Top 6 Best Practices for Managing Virtual Teams", White Paper, Corporate Education Group, 2013, http://www.corpedgroup.com/resources/pm6BestPracticesMVT.asp