

Evolution of an International Collaborative Student Project

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Abstract

International collaborative student projects are inherently difficult for everyone concerned – the students working on the projects, the faculty guiding the students, and the clients submitting the projects. With more and more schools recommending, or even requiring, that their students have some form of international experience in their degree programs, these projects will become more prevalent in helping to educate computing students in the 21st century. Understanding cultural differences between countries helps students have a better appreciation for the global aspects of computing and the issues faced in making software work in an environment they are not used to. This paper discusses the evolution over four years of collaborative projects between computing students at two schools, one in Sweden and one in the United States. The projects are based in courses at both schools that deal with computing in society. We discuss what the faculty teaching the courses and guiding the projects have learned and how they have improved the experience, what the students learn through these projects, and how the clients interact with the students and faculty. Suggestions for further development of these projects are also made.

Keywords: International collaborative projects, computing and society, open-ended group projects, real-world problems

1 Introduction

Computer scientists and software engineers face many challenges with the projects they work on. The problems they solve are mostly open-ended and team-based. More and more frequently the projects are also international in nature, with many multinational corporations using around-the-clock approaches to getting problems solved. The challenge to computer science educators is how to get their students exposure to these types of problems and experience in solving these types of problems, so that when the students complete their degrees they are able to join the professional workforce with the

necessary skills to make them useful as quickly as possible to the companies hiring them.

Fuller et al (Fuller, Amillo, Laxer, McCracken, and Mertz 2005) showed that working on international projects facilitated learning for computer science students. The students should understand the needs of the local communities in which their project results will be used. However, in the past there has been little, if any, opportunity for students to experience, and overcome, language and cultural barriers that are inherent in international collaborative projects (Azadegan and Lu 2001).

Likewise, open-ended group projects facilitate student learning by allowing the students to reflect on and apply the fundamental computer science and software engineering principles they have learned to a larger, perhaps less well-defined, problem than they are used to working on (Newman, Daniels, and Faulkner 2003). These projects “can contribute to the development of professional and ‘social’ skills which will be essential for their future careers” (Newman, Daniels, and Faulkner 2003).

The work reported in this paper combines the desired educational goals of both international collaborative projects and open-ended group projects. The approach strives to overcome the educational shortcomings of international collaborative projects mentioned earlier and tries to provide a richer educational experience for the students.

2 Method

The findings in this paper are based on us working as reflective practitioners. The setting is two non-traditional courses and as such warrants attention in order to better understand the created learning environment. The authors have collected feedback using several mechanisms: examination methods, course evaluations, being part of the project process, and discussions with colleagues. In addition, several faculty colleagues interviewed students to find pedagogical strengths and weaknesses and ways to improve the course over several years. The actions and findings presented in this paper are strongly influenced by the authors’ active participation in the computing education research community, as well as a continuing scholarly interest in educational theories. The findings are presented in a narrative form.

3 Background

The Department of Information Technology at Uppsala University has offered a course titled “IT in Society”

(ITiS) since 1998. The overall goal of this course is to provide an understanding of the interactions between technology, users and designers. This involves examining several types of interactions – between users, between designer and user, between user and system, between designer and system – and looking at how other factors influence each interaction. It requires particular attention to interactions between people and to the ways in which technology influences them. For example, we examine interactions between users and how those interactions are affected by the computer systems employed. An important goal of the course is to provide a framework for, and experience in, evaluating social and ethical issues in the use, or construction, of technical products.

The course gives a brief theoretical exposé over areas like organizational psychology and group dynamics, in the context of interactions between users and the role of technology in those interactions. The issues are practiced in corporate projects with real work environments. This course views system design in its social context, showing how technical, psychological and sustainability issues are important considerations in system design, as are health and ethical issues. There is a focus on how to make individual groups of four to seven students function as well as how to structure collaboration between these groups in a wider context. Four years ago this wider context began to include students from the Department of Computer Science and Software Engineering at Rose-Hulman Institute of Technology in the United States, enrolled in a course titled “Computing in a Global Society.”

In this course, the Rose-Hulman students explore the importance and relevance of globalization, especially as it relates to computer science and software engineering. Readings, such as “Globalization and Offshoring of Software” (Aspray, Mayadas, and Vardi, 2006), and seminars provide the mechanisms for exploring this topic. Like the course at Uppsala University, there is a focus on team dynamics and collaboration in a wide context.

An open-ended group project serves as the primary focus of the two courses, around which discussions and lectures are centered. The project is performed for a client external to both departments and has a clear societal impact. For many students in the courses this project is their first exposure to an open-ended assignment of great magnitude. At first this poses a daunting challenge for them. During the first class meeting, when students were asked to introduce themselves and tell what they hoped to learn from the course, most students expressed apprehension about what to expect from the course project. At the end of the course most students had high regard for the experiences they had and what they accomplished, and they clearly indicated they learned a lot from the project and were better equipped to handle such projects in the future. Open-ended group projects enable students to reach higher-order thinking skills (Hauer and Daniels 2008) and it was clear the students in these courses achieved those skills.

3.1 History of the Collaboration

In the fall of 2004 the Associate Dean of the Faculty at Rose-Hulman Institute of Technology was approached by one of the authors (Daniels) at the Department of Information Technology at Uppsala University about the possibility of collaborating on a project that was to investigate the feasibility of designing web-based modules for improving Swedish health care professionals’ abilities to interact with their patients. The associate dean decided this project best belonged in the Department of Computer Science and Software Engineering and asked the department head (author Laxer) if he was willing to pursue it. The two faculty members involved knew each other professionally and decided to attempt the collaboration. Neither department had attempted a collaboration like this on an open-ended project before (although Uppsala University has done international collaborative projects that have been well defined, such as the Runestone project (Daniels, Petre, Almstrum, Asplund, Bjorkman, Erickson, Klein, and Last, 1998, and Last, Daniels, Almstrum, Erickson, and Klein, 2000)).

Students at Uppsala University would receive academic credit for the project through the IT in Society course, in which the project was based. The Rose-Hulman students would earn academic credit through a Special Topics in Computer Science course. Since the nature of this collaboration was unprecedented, student participation at Rose-Hulman was invited – interested students were asked to submit a short application essay about why they were interested, what they hoped to get out of the experience, and what they could contribute. They were made aware that this was a new and experimental course, and that the project was open-ended and not well-defined. Four students were chosen for the initial collaboration.

The project was based at Uppsala University Hospital, thus the main effort would be in Sweden. A United States perspective on health care in the area of patient interaction was desired, which is where the Rose-Hulman students contributed. The research focus was training of health care workers in patient interaction, and the role of technology in patient interaction solutions. The two sets of students collaborated via e-mail and chat programs (such as Skype).

Toward the end of the semester-long project, the four Rose-Hulman students, along with their faculty member and the associate dean, traveled to Sweden for a week of interaction with their Swedish counterparts. The cost of the trip was covered by funds from the Rose-Hulman president, associate dean, and academic department. The students made a presentation on the project to the IEEE education workshop (CeTUSS) at Uppsala University, worked on the project report, and presented the project to the client. Although no software was written or prototype developed, the feasibility study proved successful and the client was very satisfied. The Rose-Hulman students also had a day of cultural activities, allowing them to learn something about the country with which they were collaborating.

For a first try, the collaboration was deemed successful enough that a second collaboration the following fall (2005) would be tried. The project that year consisted of three pilot studies for a European Union-wide project called SPEX (SPreading EXcellence in health care); one of the pilot studies was located in Sweden and based at the Uppsala University Hospital. Academic credit was handled the same way at both institutions as during the first year, and again four Rose-Hulman students were chosen to participate.

The SPEX project looked at ways that medical expertise could be provided by specialists at centers of excellence to general practitioners at points of care, with the goal of reducing the transport costs and time for both the patients and the doctors, as well as getting the needed health care to the patients in a quicker manner. Students were divided into teams, with each team responsible for different facets of the project (technology, information needs, cost, etc.). Each team had a faculty advisor, chosen from among the faculty involved in teaching the courses at each institution.

During that offering of the course students developed some software and used some technology (digital pens and explanograms (Pears and Erickson 2003), developed at Uppsala University) to offer a proposed solution to the project. The project was presented three times – to an IEEE education workshop (CeTUSS) at Uppsala University, to the client, and to a European Union-wide conference on the project in Barcelona. This time two Rose-Hulman students went to Sweden for a week and the other two Rose-Hulman students joined several students from Uppsala University, along with both faculty members, in Barcelona for the final project conference.

Once again the collaboration was considered successful. The faculty committed to continuing the collaboration, and at Rose-Hulman a decision was made to formalize the project into a regularly offered elective course, Computing in a Global Society (which hopefully would attract more students). A decision was also made to have the Rose-Hulman students make two trips to Sweden during the project, one at the beginning of the project and one at the end. Face-to-face meetings for globally distributed teams are advocated in industry to promote collaboration between remote counterparts (Oshri, Kotlarsky, and Willcocks 2008); the faculty thought increasing the face-to-face contact for the students would thus be beneficial. The group of Rose-Hulman students would be split, with some traveling in September and the others traveling in December. Students could make both trips if they agreed to pay the entire cost of the second trip. With the larger enrollment, the department could no longer afford to pay for all expenses for every student, so the students were asked to contribute \$500 each toward their trip. Everyone did so.

The September trip proved to be a huge success. The goal was to build team spirit, meet the client, and begin the project planning. The students from both schools bonded well, and by the end of the week all the students felt the students from both schools were committed to the project, which was to improve the quality of electronic patient journals for the Uppsala University Hospital. Studies have shown that improving

interpersonal ties improves the collaboration on global projects in industry [(Jarvenpaa and Leidner 1998), (Majchrzak, Rice, King, Malhotra, and Ba 2000), (Robey, Khoo, and Powers 2000)]. The course faculty hoped that the collaboration between students could also be improved, as well as giving the students exposure to this aspect of team dynamics that would make them amenable to it when they began their professional careers. More details on how the team bonding was accomplished are given in section 6.1.

When planning the project students were placed into five teams, with each team having students from both schools on it. A faculty advisor was assigned to each team, who took part in weekly meetings of the team (usually held by Skype). At the end of the project the second trip by the Rose-Hulman students to Sweden took place, and once again, the project was presented to the IEEE education workshop (CeTUSS) and to the client.

During the 2006 visit, the Rose-Hulman faculty member (Laxer) mentioned to the Uppsala University faculty member (Daniels) that he had a sabbatical coming up the following year, and inquired if it would be possible to spend the fall term at Uppsala University, seeing the collaboration from the other side and working to improve the collaboration for both sides. This was well received, and for the fall 2007 the visiting appointment took place. Another colleague at Rose-Hulman (Wollowski) taught the course at Rose-Hulman while Laxer visited Uppsala.

This year the collaboration had a larger number of students (about 40 in total) and undertook two projects, an expansion of the SPEX project to several health areas, and development of a web portal for the rheumatics ward at the Uppsala University Hospital. Students could decide which project they wanted to work on, and each project attracted students from both institutions.

During the semester Laxer interacted with the Uppsala students in class and out. He gave several lectures to the class, and served as a resource about the Rose-Hulman students throughout the term. The constant interaction proved welcome on both sides, and certainly helped to make things run smoothly. Students at Uppsala University were also asked to write weekly reflections (in English) about topics chosen by all the instructors. Asking them to think about different issues associated with cross-cultural collaborations and project work helped them remain focused on the project and the collaboration. The instructors read the reflections and provided feedback on them to the students. It is anticipated that the reflections will be expanded to the Rose-Hulman students next fall.

4 Issues in this Course

There are some key characteristics in the course that we will highlight and discuss. Perhaps the two most prominent aspects of the course are that it is based on the use of open-ended, ill-structured, problems, and that it involves two groups of students from two different kinds of departments.

We will focus on a few particular issues in this section. They are:

- Using real-world collaboration
- Promoting self-confidence
- Having international collaboration
- Avoiding detachment and estrangement
- Focus on process rather than product

Having a real client and a real project from an interesting workplace, e.g. a hospital, is intended to lead to high motivation and maximum exposure to the benefits and challenges of international teamwork. It also gives insights into a potential future profession and provides opportunities to acquire valuable personal skills related to a professional life. It furthermore provides a connection between things learned in the student's education and its use in a real-world setting. Part of dealing with a real-world setting is that clients do not necessarily have a well-formulated problem in mind. Rather, they know that information technology can help them, but they do not know how it can help them. This means that when students ask clients for more detailed specifications, there are no "right" answers and that settings and requirements can change during a project. There is thus no single way to deal with a problem, nor any obvious way to distinguish between what is relevant and what is not. Dealing with such a setting and finding ways to successfully address the problems that arise leads to increased self-confidence about the capability to take responsibility for solving problems in real-life. The increased self-confidence and practice to select and judge potential solutions will ease the transition to future professions.

Part of the complexity in future employment will, for many of our students, be the ability to work in an international setting. Having experienced and mastered problems with working in a multicultural environment spanning several time zones and limited or no opportunities for face-to-face meetings will be essential in such settings. To have overcome the lure to become detached and ineffective due to being overwhelmed by complexity and lack of clear directions is another way to build self-confidence. Having a focus on dealing with the process rather than on the finished product is an important part of dealing with open-ended, ill-structured real-world problems.

These are some of the potentially good outcomes from this course, but it is important to realize that the students are not used to this form of education and that it is important that they get an understanding of these educational goals early on in the course. It is important to realize that part of running such a course is to deal with frustration and uncertainty. The students and teachers should have an understanding of the role of the teacher, and especially the fact that teachers are not there to give answers. There are no easy solutions when key people on the client side of the project are hard to contact and meet with. Misunderstandings due to cultural differences also pose problems that frequently are difficult to solve, nor is there a best way to set up and run a project. There is, however, learning to be gained by reflecting on these issues and the faculty have a role to inspire reflection as well as to give feedback on choices and nudge students when they get stuck.

One of the key challenges of this course is to make each member of the project feel like they are integral members of the team. This is not always easy when using real-world projects as opposed to carefully controlled artificial projects. In this context we wish to discuss the following issues:

- Differences in skill sets
- Language barriers
- Primary location of project

Rose-Hulman students are strong software developers and typically learn by developing software systems, whether through developing specifications or by implementing to a specification. Real-world problems do not always have those components. Some projects are more concerned with usability than with software development. Usability and issues in software adaptation are part of Rose-Hulman's software engineering program and as such those kinds of projects provide a valuable experience for Rose-Hulman students. The students from Uppsala University are typically from the Information Technology program and for them, adaptability and usability studies are much more central to their course of study. As such, for a typical software development project, the skills sets complement each other well. Naturally real-world problems do not always have all of the components of a software project; as such there is a risk of one set of students being not as enamored with the project as the other group.

Some projects require a good amount of interaction with clients and users. If some project members do not speak the language of the users and clients, then other members need to be the eyes and ears for the entire group. This is an interesting and useful experience for all project members and possibly one of the best reasons why students should be encouraged to participate in projects with language barriers.

Each of these issues can be managed, if they occur individually. However, if they co-occur, then there is the risk that their compound effects alienate one of the groups.

Up until now, clients for the course projects have been associated with the university hospital at Uppsala. This means that so far, Rose-Hulman students travelled to Sweden to meet with their fellow students and the clients at Uppsala. While those trips are enjoyed by students from both institutions, it would be desirable to create a situation where students visit each other's countries. The students from Uppsala expressed a desire for such a state of affairs. Additionally, it would ensure parity among the students from both institutions.

This goal is difficult to achieve with real-world problems as the software, at this point, does not have clients in Indiana. In principle, this should not be a problem as one of the primary teaching hospitals in Indiana has a rural health care program for communities within a fairly large reach of Terre Haute. Contacts should be made with the directors of these programs to see about the possibilities of international collaboration. As medical personnel are notoriously busy, this is a formidable challenge. Thought should be given as to project domains which offer both real-world problems

and an international scope. With a little bit of luck, standardization and globalization of software development and sales will provide for such opportunities.

5 Pedagogical Development

Each university sets its own requirements for what students can earn academic credit for. Thus, the courses at each school under which the international collaborative project is housed may be different, especially when it comes to lecture material and class discussions. The faculty involved in this project held several discussions about what to cover in class meetings; but, due to the differences in the students and in class scheduling at each institution the two courses were not identical. The following sections describe how the courses have evolved at each school.

5.1 Rose-Hulman Institute of Technology

During the first two years of the collaboration, the number of students allowed to participate in the project was kept small (four per year) to maximize the chance for success. The department had not undertaken an international collaborative project before and had a lot to learn. The course was run as a special topics course, with the students and faculty member handling it more like an independent study and undergraduate research course than a lecture course. Rose-Hulman students discussed in detail with the Uppsala University students what the project requirements were, what they (the Rose-Hulman students) needed to research and report on, and how to get their results back to the students at Uppsala.

It became apparent during those first two years that the client for the projects tended to be the Uppsala University Hospital, and thus the projects had a health-related theme to them. These projects provided opportunities to face and discuss issues that are not usually present in course-based projects, such as information privacy concerns; ethical and legal matters, especially between different countries; and software safety, since harmful consequences to people could occur if the software is not designed properly.

Beginning with the fall 2006 course offering, enrollment was enlarged to twelve students. It was decided to have weekly class meetings in which the discussions mentioned above could take place. The April 2006 issue of *Computer* magazine (*Computer* 2006) focused on engineering clinical software, and provided many good articles to have the students read and discuss. In particular, students were required to read the articles on “Coping with Defective Software in Medical Devices” (Rakitin 2006) and “High-Confidence Medical Device Software and Systems” Lee, Pappas, Cleaveland, Hatcliff, Krogh, Lee, Rubin, and Sha 2006), which were then discussed in class meetings. The project that year dealt with electronic patient journals, and in a very timely way *IEEE Spectrum* published an article on electronic medical records in its October 2006 issue (Charette 2006); this article was posted for students to read as well.

As described earlier, the fall 2006 collaboration was the first one in which the Rose-Hulman students made two trips to Sweden. During the early one, in mid-September, the students were asked to make three presentations to the Uppsala University students and faculty in a combined meeting of the two classes. These presentations focused on (1) electronic patient journals, the focus of the project that term, (2) the Therac-25 incident, to show what could go wrong with medical software development, and (3) Rose-Hulman Institute of Technology, so the Uppsala University students would learn something about the school they were collaborating with and the students that go there. These presentations were very useful, and helped show the Uppsala University students that the Rose-Hulman students were fully committed to the project and the collaboration, and that they would be valuable colleagues in the collaboration. The Uppsala University students also made presentations to the combined class.

For the fall 2007, the course was put in a globalization context. Students were assigned readings from Wikipedia, the book “Global Sociology” by Cohen and Kennedy (Cohen and Kennedy 2000), and the report from the ACM Taskforce on Globalization (Aspray, Mayadas, and Vardi 2006). The book does a wonderful job explaining the long history of globalization and explains the benefits and drawbacks of it. If students see themselves as part of this trend, they have a better understanding of the power and limitations of globalization, ultimately giving them the ability to take advantage of it. Students were again asked to make presentations to the combined class meeting during the mid-September trip to Sweden.

5.2 Uppsala University

There was a change in the organization of the project that occurred before the collaboration with Rose-Hulman Institute of Technology started that is relevant – to have a large overall project with several connections to real-world collaborators. The overall project is broken down into subprojects and if a subgroup runs into problems with getting access to the real-world client they can potentially get a real-world experience through the connections of another subgroup. Another change that also occurred before the collaboration was to use the hospital as the setting for the project. This provided a client that all students readily agreed to spend time on trying to improve the workplace for. The hospital environment also provided an excellent example of where IT is an important part of the workplace and yet needs to be introduced with care.

Even though health care is an endeavor relevant to both Sweden and the United States it is still difficult to find projects where international collaboration can lead to a clear benefit. It is also more difficult to collaborate over the Atlantic Ocean than with local students. We felt that it was important to make both the value of the international collaboration tangible for our students, as well as lower the threshold for active collaboration. Face-to-face meetings were seen as an important ingredient in this effort and funds were allocated to support the stay for the Rose-Hulman students. Regular group meetings were considered important and Skype

was introduced as a required media for weekly meetings in 2006. Guest lectures by previous students that could serve as role models for how to communicate in an international setting were also introduced in 2006, and in 2007 this was complemented with a guest lecturer covering cultural aspects of collaboration, especially between Sweden and the United States. Both of these efforts have been seen as valuable and important among the students, as evidenced by the students' written responses to reflective questions posed to them.

Up until now there have been more Swedish students involved in the projects than American students and some subgroups have been purely Swedish. There has been an effort to have the mixed subgroups balanced since we have seen that it is easy for a lone student to become detached from the work of the group. More detail on how we devise group membership is presented in section 6.2.

We have also seen a tendency to view problems as someone else's, that if things do not go well it is due to the other side or someone else in the group. Both the open-endedness and the international component of the course lend themselves to such thinking. Weekly reflections were introduced in 2007 partly in order to address this issue, by making each student reflect on what problems they faced and what they personally could do about it. This had a smaller impact than hoped for, partly due to slow response from the teachers and partly due to some issues not being relevant for all the students. This will, in the 2008 course offering, be addressed by having both general reflections and subgroup specific reflections, with the general reflections being given early and mid-way through the project. The teachers involved in the 2008 course offering will share the load of responding to the reflections and the subgroup specific reflections will be handled in the weekly group meetings instead of as written individual responses.

It is not only collaboration between the students that is difficult; there is also the matter of communication among the faculty involved. Site visits and making efforts to arrange face-to-face meetings (e.g. at conferences) have been arranged. The issues have been both about the collaboration in general as well as about the actual projects.

Another issue that will be addressed in the next instance of the course is the communication with the client. There will be one main contact from the faculty side. Communication between the students and the client will be addressed by agreeing on when the students need consent from the faculty member before agreeing to something from the client.

6 Guidelines for International Student Collaborative Projects

There are several aspects to international student collaborative projects that should be considered to maximize the chances for success and insure the students get a meaningful educational experience. These include how to build team camaraderie and trust, how to manage the project work, and how to handle communications.

6.1 Building Team Camaraderie and Trust

Team projects of all types require interaction among people of varying backgrounds. It is important that team members get to know one another and build a sense of camaraderie and trust amongst themselves. This is easy to do when all team members are in one physical location. When teams comprise students from two locations, in different countries, speaking different languages, it becomes a more challenging task to build that camaraderie and trust amongst the team members. Thus, the faculty involved need to make efforts to facilitate meetings between the students from the schools involved. It is much more meaningful when the students can meet in person, but this necessitates one group of students making an international journey, which has inherent costs – not just financial, but time away from classes as well.

As mentioned earlier, throughout this collaboration the project client has always been based in Uppsala, Sweden, so it has made sense for the Rose-Hulman students to travel to Sweden so they could meet their counterparts as well as the client. The faculty involved in teaching the courses at both institutions, as well as senior academic administrators, all agree that learning something about the country the project is being done in and the culture of the people that live there is an important part of this educational experience. Thus, the visits to Sweden by the American students have always included a day of cultural activities in addition to the socializing with the Swedish students. The social activities included formal and informal meetings in a dedicated laboratory. Students enjoyed exchanging ideas about the project, and were sharing personal experiences. Other social activities contributing to camaraderie included dinners and attending social events in the evening.

The international travel aspect of this course is one of the biggest reasons students are drawn to the course – the Rose-Hulman students eagerly look forward to meeting their Swedish counterparts and working with them. Many of the Rose-Hulman students have not travelled overseas before they took this course; going with their fellow students and faculty member provides an easy introduction to international travel for them. Most of the students have remarked that they could not wait to do further international travel, or to return to Sweden.

During the first year of the collaboration one trip was made to Sweden by the Rose-Hulman students; that occurred at the end of the project, when an IEEE education workshop (CeTUSS) was being held on the Uppsala University campus and the presentation to the client would occur. The faculty valiantly tried to arrange some video conference calls early in the term for the students to meet, but were unsuccessful in doing so. The students introduced themselves via e-mail, and the Angel Learning Management System at Rose-Hulman was used for course collaboration. At the end of the project, while the Rose-Hulman students and faculty were in Sweden, there was a project debriefing amongst the faculty and students from both institutions. Everyone thought the first collaboration was successful. When

both sets of students were asked if a trip to Sweden early in the term would have proven useful, both groups of students said they did not think it was necessary. The faculty listened to the students and for the following year kept only one visit, at the end of the project.

At the end of the second year's collaboration, the faculty decided to try two visits to Sweden by the Rose-Hulman students for the following year. The faculty wanted to see if the students getting to know each other early, and working together early in the project would lead to better team dynamics. The early trip occurred in mid-September, about two weeks into the courses at both institutions. Students at Uppsala University arranged some ice-breaker and team-building exercises that were very successful in building camaraderie and trust among the two sets of students. Having the Rose-Hulman students in Sweden early on, meeting with the client and working with the Uppsala University students, also built a better sense of ownership in the collaborative project for both sets of students. Communication throughout the project between the students of both schools was improved from prior years. Both schools' faculty members decided to keep the two visits for the next year's collaboration, and will continue to keep them for subsequent collaborations. The challenge will be to foster and support the interpersonal contacts among the students between the two visits, perhaps by arranging videoconference calls. It is cost prohibitive for educational institutions to have "managerial" (i.e. faculty) visits to the other location to help motivate the team members, as is done in industry (Oshri, Kotlarsky, and Willcocks 2008).

6.2 Project Management and Process

Open-ended group projects, such as those undertaken in these collaborations, are large in scope. For the past two years, there have been between 30 and 40 students total to work on each project (10-12 from Rose-Hulman and 20-30 from Uppsala University). Under the guidance of the course faculty, the students are asked to think about the project and how it could be divided into component parts, with each part having a small team (four to eight students) working on it.

Once the project has been appropriately broken up into smaller parts, students are asked to identify which part they would like to work on. In the past, students were very good at ensuring that each part of the project had a sufficient number of students associated with it. Students were also very good about ensuring that project teams contained students from both schools. This is a good indicator that students enjoy international collaboration. It should be pointed out that due to the nature of how a project is broken up, it may be prudent for students of only one school to work on certain parts, in particular those that require interaction with people who only speak one language (although the collaboration is done in English, and the Uppsala University students speak English very well, many of the Swedish people that get interviewed as part of the research only speak Swedish). The course faculty insure that each project sub-team has adequate and appropriate student representation on it. Each sub-team is asked to choose a leader, who is responsible for making sure that

sub-team's work gets done in a timely manner. The team leaders are also responsible for the communication between sub-teams and with the course faculty. Each sub-team is also assigned a faculty advisor.

The sub-teams are asked to meet at least weekly, and to include their faculty advisor in the meetings. Meetings that only involve students and faculty from one school usually take place in person, in either the project room or the faculty member's office. When students from both schools are involved, a computer video chat program, such as Skype, is used to conduct the meetings. People can choose to gather at one location at each school to conduct the meeting, or can choose to have a conference call and be at several locations (this usually depends on the time of day and obligations before or after the meeting).

Each sub-team is responsible for writing their part of the project report (see next section). A report writing team, comprised of a student from each sub-team, brings together the individual parts of the report, adds the appropriate introduction and conclusion sections, and insures that the final report flows smoothly.

6.3 Handling Communications

Communication between team members of any project is vital. When team members are located in different countries that are several time zones apart it takes extra effort to insure communication goes well.

The obvious first choice for communication is e-mail. In addition to the students' regular e-mail accounts, each student had access to the e-mail service included in the Angel Learning Management System at Rose-Hulman. Within this system teams could be formed, which permitted e-mail to be sent to all members of that team. The instructors arranged "Angel teams" that corresponded to each project sub-team, as well as Angel teams for all students, just Rose-Hulman students, just Uppsala University students, all faculty, and everyone. The Angel e-mail system has an option to forward Angel e-mail automatically to the user's internet e-mail address (so students wouldn't need to log in to Angel to see if they had Angel e-mail), and everyone was encouraged to enable this option.

As mentioned earlier, Skype was used to conduct team meetings when team members were located at different locations. With web cameras being inexpensive and Skype supporting video as well as audio, students were encouraged to use web cameras so that they could see each other while they were talking. Some teams experimented with the use of cameras but found it awkward to reposition the camera to the speaker. The camera can instead be used to point to the whiteboard, in case students wish to refer to materials developed there. Students were also encouraged to use Skype between meetings when they needed to talk to one or two other people on their team (or anyone else in the course, for that matter).

Written communication is an important component of the courses. Students are required to produce a project report that detailed the nature of the problem they were solving, what research they undertook to understand the problem and the needs of the client, what their results were, the justifications for the approach they took, and

recommendations for further work. As this report is typically very large, each project sub-team was responsible for writing their portion of the report, as well as contributing to the overall structure of the report and to the sections that were not associated with a particular sub-team. Small portions of the report were typically written in Microsoft Word for sharing amongst the sub-team members. Google Docs was used for putting the whole report together and editing by the report writing team. In general, students found Google Docs useful to edit and distribute documents of various natures.

7 Conclusion

Working on open-ended, international collaborative projects is a challenging task for professionals, let alone students, but the ability to do so is important in today's professional workplace. This paper has described the evolution of a collaborative project between students at Uppsala University in Sweden and Rose-Hulman Institute of Technology in the United States. Students have faced and successfully overcome the challenges of working on ill-defined, open-ended projects for real-world clients and of collaborating with their peers in another country and another culture, several time zones away. During debriefings between the students and the faculty at the end of each project the students reported that although they were initially apprehensive about the project and how it would proceed, they were proud of what they accomplished and satisfied with what they learned in the process. The faculty involved agree with this assessment and are continuing to improve the process for future collaborations.

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