2006-631: A GLOBAL COLLABORATION TO TEACH GLOBAL PRODUCT DEVELOPMENT: FACULTY PERSPECTIVES

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A Global Collaboration to Teach Global Product Development: Faculty perspectives

1 Introduction

In this age of globalization and diversification, it is important that our engineering students understand how to work effectively across cultural and geographic boundaries and exploit the intellectual diversities within a global team. Global Product Development (GPD) is a graduate course that was created because the instructors felt that one has to experience the challenges and rewards of working in a global team in order to understand it. Graduate students from the University of Michigan, Technical University of Berlin and Seoul National University study and experience the global development of products for global markets. GPD has been offered every Fall semester since 2000. Using videoconferencing, Groove Virtual Office for collaboration and other Internet-based tools a "global" classroom is created connecting Ann Arbor (USA), Berlin (Germany) and Seoul (South Korea). In addition to lectures on product development and engineering, guest speakers from different countries speak on diverse topics (e.g., culturally appropriate innovation, global branding, intellectual property and product liability, etc.) that are equally important to consider in such ventures. The students work in global teams throughout the semester and participate in two weeklong face-to-face meetings along with the faculty.

GPD is a collaboration experience not only for the students, but also for the faculty involved. Each university has a primary faculty member in charge of the course, a few participating faculty and an assistant (sometimes a senior research student of the primary faculty). Significant collaboration amongst faculty is necessary to determine almost every detail of the course, including the semester project, the associated lectures, project-relevant assignments, design reviews and overall grading strategies. The participating universities not only have different semester schedules, but also different guidelines and practices that pose significant challenges for the participating faculty. However, the course has been successfully offered each year since its inception in Fall 2000 and on each campus there is a strong student demand for this course.

The development of the initial content and format of this course took more than a year[1,2,3]. This is not uncommon for special courses. However, several issues have to be addressed in order to sustain such a course in the long term. These include the following:

1. How can such a course be integrated within the existing curriculum of three different universities?
2. How should students who have some basic skills in handling the challenges of distributed project work?
3. What are the financial requirements for this course and how can they be met?
4. How should infrastructure be used and maintained in such a "high-technology'' course?
5. How should evaluation and assessment be done consistent with the grading policies of three different institutions?
6. How can faculty from three universities collaborate effectively in a distributed global team?

This paper elaborates on these issues and how they have been addressed by the participating faculty from University of Michigan (UM), Technical University of Berlin (TUB) and Seoul

National University (SNU). Overcoming these challenges has strengthened their partnership, enhanced student learning experiences and sustained the course for six years.

2 Integrating GPD within existing curricula

The integration of a new course into the curriculum of a university may or may not be difficult based on the flexibility of the curriculum and the extent to which the content corresponds to the students' required studies at the institution.

At TUB, Global Product Development is not recognized as a design course in all fields of study due to the project's focus on the design of global but "unspecific" products. For example, the project topic for Fall 2004 was "(re)design any product with emphasis on its sustainability." The inter-disciplinary team of students selects the product after a detailed market analysis. It is thus not specific to any one field of study (a few sample product ideas are shown in Figure 1). For example, aerospace students may be required to design a better wing and in the process, calculate wing stiffness. They would not focus on the development of a more efficient household refrigerator by considering basic principles from the customer's point of view. In addition, students in GPD are expected to fabricate a working prototype and present plans for the global manufacturing, marketing and distribution. Therefore, the project also contains aspects from manufacturing and business planning, and does not end with just the design of the product. For this reason, it has been difficult to integrate GPD within the engineering curriculum of TUB. As a result, in the first two years, TUB students participated in the GPD course without getting any credit at all. The selling points for the course were the relevance of the topic to current business practice, the opportunity to work in a global team and foreign travel. However, the course is now integrated into the curriculum of Mechanical Engineering at TUB and students receive full credit.

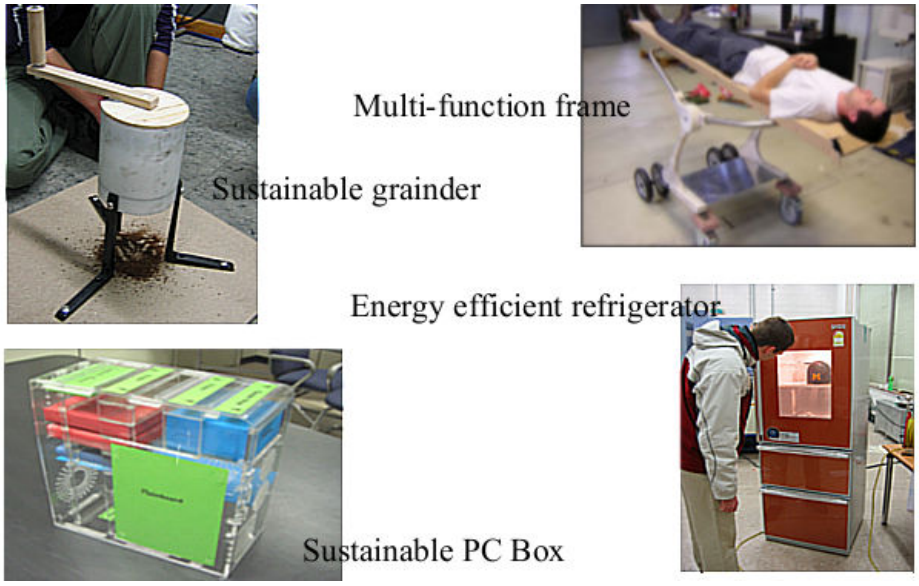

Figure 1: Products designed in GPD are not specific to any field.

At SNU and UM, the launch of the GPD course did not pose any problem. This is due to the inbuilt flexibility in graduate programs in the U.S. and Korea. The course was started as an "experimental" course in UM (ME 599) and as a "temporary" course at SNU (Advanced ME

Design Problem II with the subtitle of GPD). Such courses at the graduate level can be offered by any faculty at UM and at SNU and require minimal approvals.

The integration into the curriculum (i.e., conversion from experimental/temporary to a regular course) did require formal paperwork and approvals. There were unique issues that had to be addressed during this process. First, the offering of this course requires a guarantee of funds on a long-term basis (more on this in Section 4). Second, by design this course requires three institutions to commit to offer it jointly. These are important issues that a graduate committee or departmental committee has to be convinced about during the approval process. That was achieved at UM and since Fall 2004 the GPD course became a regular course (ME 581). The transition at SNU is also in process, and GPD is expected to be a regular course by the next offering (Fall 2006).

3 Selecting students in the project-based course

The GPD class has approximately 16 students at each site. This allows for the creation of eight global teams, each with two members from SNU, UM and TUB.

3.1 Selecting individual students

Combined with the considerable depth and diversity of the project task, the differences in cultural backgrounds provide the students with formidable challenges, requiring a well-considered choice of candidates. The student selection process at SNU is somewhat tied to the BK-21 funding and associated faculty (more on BK-21 in Section 4). An effort is made to include graduate students from the research groups of every faculty involved in the BK-21 program. The faculty recommend students for enrolment in GPD.

In TUB and UM, the course is hugely oversubscribed and the challenge is to devise a good and fair selection process. In TUB, every student is required to write an application to explain their motivation for the GPD course and must provide an academic CV. Potential candidates are invited to participate in a workshop to assess their ability to work in multinational teams for solving technical tasks. The assessment criteria include their social and personal skills, i.e., among other things, their ability to communicate, to be open-minded, to be proactive and to accept responsibility. Skills such as time management and competence in the English language are also assessed.

While at TUB and SNU, students are selected prior to the first session, at UM, all interested students are put on a waitlist and asked to attend the first session. The intricacies of the course are explained and the students are required to complete a questionnaire that indicates their design, manufacturing and teamwork skills and experiences, as well as their willingness and restrictions (if any) for international travel. After the first session, the three instructors participate to form the global teams. It is during this stage the UM students are selected, primarily with a view toward creating balanced teams. Students not selected in one year get highest priority the following year.

3.2 Assigning students to distributed teams

In GPD, the global project teams are formed very carefully to achieve a balance of technical and inter-personal skills. Although students fill in questionnaires to indicate their personal competencies, experience has shown that team assignment based on such questionnaires does not always guarantee successful teamwork. The instructors do not gain any insights on the behavioral aspects of the students as potential team members that have to interact with cross-cultural and distributed team members. An assessment workshop and final team formation during a face-to-face meeting is now being considered.

4 Securing Finances

A significant amount of funding is necessary in GPD for (i) acquisition and maintenance of IT infrastructure, (ii) manufacture of the prototypes and, (iii) for international travel of students to attend the two face-to-face meetings per semester. These weeklong meetings are critical and all students are required to participate. The first face-to-face meeting is immensely beneficial for team building and product conceptualization. It takes places as early as possible, typically during the third or fourth week. Not only should the finances for travel be settled by then, but visa processing times and other travel related issues must be also taken into account in the planning. The second meeting allows the team to complete/assemble their working prototypes, complete the final report and presentation and participate in the GPD exhibition (Figure 2).

Figure 2: Students work on their projects and exhibit their products at the final meeting

In Korea, the Brain Korea 21 (BK-21) program funds in the School of Mechanical and Aerospace Engineering are used for the GPD course expenses. BK-21 is a Korean Ministry of Education program launched in 1999. Approximately 60% of the budget is allocated for graduate student support and activities including global education and collaboration. Hence, these funds have been used for GPD since its inception. The current BK-21 program ends in 2006 and a renewal submission is planned by the School of Mechanical and Aerospace Engineering. The GPD course was nominated as one of the best achievements of the BK-21 program at SNU.

At UM, funding for GPD has been generated through corporate sponsorship except one year when NSF (Office of International Science & Engineering) provided funds. Corporate sponsors have included Caterpillar, United Technologies, General Motors, Daimler-Chrysler, Whirlpool and others. While corporate sponsorship is not difficult to generate, it requires a continual effort and takes faculty time away from content and delivery improvements. The Office of Corporate Relations in the UM College of Engineering has graciously assumed the task of highlighting GPD to corporate sponsors with very good results. This partnership (between faculty and the college office) appears to be a business model that will sustain the course in the future.

At TUB, four sources of financing are available: the university's budget, donations from industry or private individuals, donations from public and non-profit organizations, and course projects sponsored by industry partners. The first three of these do not provide guaranteed or sufficient financing for covering expenses in GPD, although some short-term (not enough) funding may be available through government initiatives for improving teaching quality. A university professor at TUB does not get enough departmental funding to cover expenses such as international travel and accommodation for the students. Alumni networks are not very well-developed and the industry is often unwilling to donate for such individual courses. Public and non-profit organizations rarely support such education and non-research undertakings. However, since 2003, Volkswagen foundation is sponsoring a research project at TUB to develop innovative learning/teaching modules for global and sustainable engineering education. GPD is one of the courses that are being evaluated through this undertaking.

In general, courses like GPD require reliable and long-term financing plans. This can be a critical issue particularly when the academic partners have different sources of finances as is the case now in GPD. Without government support (like BK-21 in Korea), a common practice is acquiring industrial partners for student project work. The challenges thereby are in convincing these partners of the benefits of the cooperation, acquiring a sufficient number of global projects with appropriate financing, and defining project tasks that correspond to the needs of both education and industry. Furthermore, the results of the project work must be of a high level in order to maintain the enthusiasm of the industrial partners to fulfil their financial commitment and to participate in future projects. However, industrial participation in projects also requires the handling of Intellectual Property issues. In GPD, this is more complicated due to the global aspect. Finally, problems can also result from disagreements amongst institutions (i.e., faculty) concerning the alignment of educational objectives and industrial aims.

5 Maintaining infrastructure

The three participating universities use and maintain state-of-the-art infrastructure for communication, collaboration and manufacturing to efficiently manage the global classroom and support distributed teamwork.

5.1 Communicating and collaborating in the classroom

Due to its increasing stability and zero cost, the Internet Protocol (IP) has replaced ISDN as the primary medium of communication in GPD. Occasionally the IP quality is unacceptable and SNU has to use ISDN. Therefore, UM now maintains state-of-the-art videoconferencing

hardware that supports mixed-mode bridging. UM also bridges all the Internet-based videoconferences mainly because it has better connectivity to both TUB and SNU. Both UM and SNU use the same hardware (Polycom) while TUB uses hardware from Sony. Through several experiments and with the use of standards-based communication codecs, the connectivity problems are being resolved for better and sustained quality. It is worth noting that in Fall 2005, ISDN was not used at all and the teaching team is finding Internet to be more reliable each year.

Previously, lower bandwidths at TUB and SNU and firewall in TUB has affected file sharing, which is required for effective collaboration and "live" presentations. The faculty has explored several software options, from in-house SNU software to the higher-end Centra Symposium and more recently Groove Virtual Office. However, the three universities support different operating systems and different versions of Microsoft Office. Hence, some features (e.g., regular PowerPoint animations in the presentations) cannot be used although the collaboration software supports it. In the next offering (Fall 2006), it is planned that all sites will use the same versions of all the software used in the course.

Figure 3: Global Classroom at SNU – Lectures (video and slides) are transmitted "live" from UM to TUB and SNU

Figure 3 shows the global classroom at SNU with the lecture from UM. The class starts at 8:00 AM in the morning at UM, at 2:00 PM in the afternoon at TUB and at 9:00 PM in the evening (10:00 PM after the time change in October) at SNU. While each university has support staff (for IT) to help with start-up in any class, this is not available at odd hours in SNU (8:30 PM) and UM (7:30 AM). Therefore, at UM, the faculty have to keep abreast of the IT/communication facilities in the classroom. UM also maintains the bridging hardware separately. At SNU, a graduate student who has taken the course earlier works as a paid assistant for the course activities. At TUB, departmental support staff interacts closely with the teaching group. Yet, part of the teaching group remains acquainted with the facilities so that daily activities and emergencies can be handled without delays in the class.

5.2 Managing facilities for student projects

Students determine for themselves the communication software available at the three universities and find most innovative ways of using them in the course. Figure 4 shows a case where GPD students combined two different software tools to get the medium that they preferred as a team. At the same time, cultural differences may prevent effective use of some methods of communication. For example, the Korean students prefer writing rather than talking during teamwork. This is because English is not their native language and it is often difficult for them to understand native English speakers. However, in Instant Messaging (IM), the feedback is slightly asynchronous and it is difficult to moderate a session effectively with six participants writing simultaneously. So, if the Korean students do not get to write effectively in the IM sessions, their US and German teammates find it hard to understand what exactly they might be thinking. In Fall 2005, the teams were provided with additional videoconferencing facilities every week that they used to great effect.

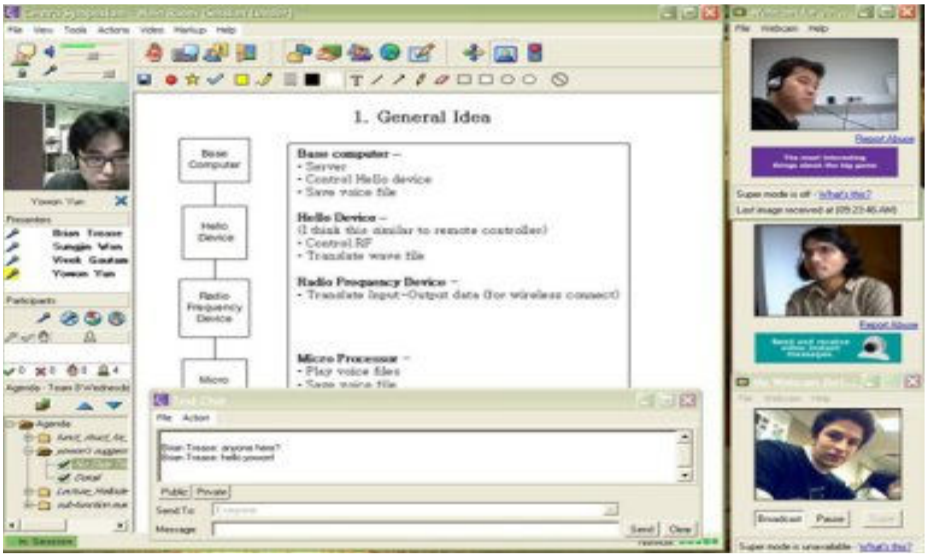

Figure 4: Students combine different available software for distributed team-work

In addition to IT support, GPD like most other courses requires manufacturing facilities and suitable space for fabrication and assembly of prototypes. The disparities in the available resources frequently affect the student teams and may lead to conflicts within the teams. At the same time, GPD staff restricts the amount of funding available to every team at every site. These situations provide the students with the chance to learn to deal with the reality of managing within limited and available resources. However, sometimes the faculty may provide extra facilities/funding to certain project groups on a case-by-base basis because the project ideas are very different and a certain team may require additional facilities/funding for their project work.

It is clear that in its current format, GPD is very restricted by the infrastructure needs, both for the classroom and the student projects. For example, limitations on the available bandwidths prevent additional sites from participating in this course from a purely technological point of view.

6 Assessing performance and assigning grades

In GPD, all instructors jointly assess the performance of every student and team using a combination of various mechanisms and at various stages. There are two formal design reviews (presentation + written reports), a few homework assignments, the final project presentation, report and prototype. Standard techniques are used, i.e., point-based schemes for various categories that are converted to letter grades. The quality and innovativeness of the design contents, the degree to which the initial design idea is realized at the final stage and the aspects of global product design are the important factors taken into account in the overall grading.

6.1 Supervising projects

Two models of project supervision have been tried out in the course. In the first model, the entire teaching staff (3 faculty members) supervises each project team. The local team members become the liaison for communicating between the team and the faculty. The benefits of this model are that the teams get the benefit of all three faculty and there are no surprises either way in terms of expectations and deliverables. This model requires all instructors to be "on the same page" and speak with a single voice. If the instructors give different points of view regarding the students' problems, the students view this as conflicting guidance and may be confused. This situation does occur, especially since the faculty have different cultural and academic backgrounds or if they have not been in continuous communication.

In the second model, each instructor supervises two or three teams. This reduces the supervisory time and allows the instructors to focus deeper on their teams. However, there are drawbacks in this model too. Students often seek advice from the local faculty, and communicate it to their team members. This may lead to conflicting views as described earlier, although the chances of such occurrence are low. More importantly, although the instructors grade GPD projects and teams jointly, the "local" instructor determines the final grade for each student at his/her institution. The instructor has a much deeper knowledge about the teams and the project work s/he has supervised. It is difficult for the "local" instructor to understand the subtle decisions made by a team s/he did not supervise. Currently, the "local" instructor follows the progress of his "local" students independent of their teams by interacting frequently with the other faculty.

6.2 Grading

Institutional requirements and grading practices are met when a "local" instructor assigns grades for students in their institution. The credit system in UM and SNU is very similar. However, the German credit system is different. Although one system can be converted to other systems, the actual level of student achievement can still be quite different. For example, a graduate student from TUB receives six credits of the required thirty credits per semester, while a graduate student from UM and SNU receives three credits for GPD. These imbalances result in a differing level of student commitment and thus to conflicts in multinational student teams.

The final grade of each student depends on the local assessment criteria. At TUB, each student in a team receives the same grade for the project work but receives an individual grade for oral exams based on the lecture content. At UM and SNU there is no written or oral final exam. The

team members initially receive the same points based only on the project work, but the final grade may be different. The final grades are assigned after considering the confidential peer evaluation of each student by his/her team members. Instructors are aware that peer evaluations can contain subjective and misleading contents and therefore they are handled in the context of the close tracking that is done throughout the semester.

Explaining the importance of peer evaluation across different cultures is a difficult task. Peer evaluation is used in every teamwork-based course at UM. It has been observed that the students from Korea usually give all team members the same (maximum) grade. The German students often decline to undertake the peer evaluation, unwilling to voice internal issues. There have been not many cases when the final grades of each student at one team varied. In 2005, all the students participated in peer evaluation. During the next offering (Fall 2006), the anonymous peer review process will be presented to the students as a technique that is not only useful to evaluate their performances, but is also an important aspect of teamwork as they will gain experience in giving honest feedback to co-workers on the quality of the efforts they contribute to group work.

7 The global team of instructors

Institutional partners in a course like GPD have to be chosen very carefully in order to have and achieve a common goal. All problems that may occur in multinational teamwork readily apply to the global teaching team of GPD. In addition to differences in cultural background, age and academic standing, the scientific backgrounds of staff are issues to be considered for cooperation. The less similarity in the fields of activities of participating departments, the broader the requirements become and the harder it is to find a compromise for the project task, and to find students who are interested in the course and capable of fulfilling these extensive requirements.

The faculty collaborates to determine and agree upon the course objectives, philosophy and format. In GPD, the teaching staff has been careful and deliberate in their efforts to let multiple perspectives co-exist. For example, the TUB staff view the main objective of the course is for the students to gain personal, methodological and soft skills for working on technical tasks in multinational teams. The UM and SNU staff view GPD as an environment for students to understand the global dimension of product development (global products and globally distributed development) and the challenges and benefits of cross-cultural team work. Another difference in perspective comes from TUB's view of GPD as a unique course where students actually get to create physical prototypes of their designs. At UM and SNU, this is usually the case in most design courses.

The GPD staff is a cross-cultural and distributed global team that creates and sustains the global course (satisfying local needs and considerations). The motivations of the professors at each site are very important to initiate and sustain such a global course. Every year, many opportunities for conflicts arise in every facet of the course (content, delivery and evaluation). The co-operating partners communicate intensively by taking advantages of the infrastructure facilities described in Section 5. More importantly, the shared conviction among the GPD faculty that this course is uniquely preparing our students to develop innovative products to address unmet needs

globally has prevailed over all challenges. It has been the good fortune for all the co-authors to be involved in the GPD course.

8 Summary

The realization and acceptance of how globalization has dramatically altered the way engineers work together inspired the creation of the Global Product Development course. It is an unprecedented cooperative project by three universities that involves collaboration on all levels by the faculty and students. Technology does not just enhance this course, it is the tool that ensures the course's global character by creating the global classroom. GPD is neither a standard product engineering class nor a glorified distance learning class. It provides realistic training for future engineers how the world of global business and cooperation works. In doing so, it requires the faculty to address several unique issues that this paper has described.

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