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Building International Collaboration Experiences among LACCEI Institutions through Global Design Projects

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Abstract
The formation of an engineer in this new millennium is being greatly influenced by the globalization effect. Almost all major corporations now operate globally, and engineers are expected to design and develop new products that will impact a worldwide market. Due to this, the academic institutions are facing the challenge of educating the future engineers with competencies which are indispensable to compete in the global market. One of the most efficient ways to provide the required international formation is to expose the students to international experiences in their curriculum so that they can develop the necessary skills for their success in the global market. This work describes the international collaboration among LACCEI institutions through multi-national global design projects. The students at different institutions are required to work in global design teams with students from other countries. In the first year, more than fifty students, from eight different institutions from five different countries have participated in this initiative. Students have been challenged to solve a design problem and to use effectively the available technology for communication. This multi-national project provides students the opportunity to work in a global distributed team, learn the value of different ideas from different cultures, gain knowledge of design opportunities in other countries and become skilled at how to use collaborative tools effectively. The global design project is used to foster cultural awareness and to stress the importance of diverse teams in the solution of real engineering problems. The engineering work field also benefits from international projects since the students that have worked on these projects have the necessary knowledge to excel in the global economy once they graduate.

Keywords
Global design, international collaboration, multinational projects, design education

1. Introduction

Globalization has had a tremendous impact on the way the companies are organized and are doing business today as explained in Beamish et al. (2003). The international structure requires having corporate executives dealing simultaneously with local and worldwide markets. Besides that, regional managers work usually under an international division where all of them have to interact facing the typical problems of communication between the home division and distant overseas affiliates. In addition, they have to deal with the difficulties that affiliates usually have to adopt corporate policies, and the perception that local power is being challenged by international policies. Additionally, the global market implies to design and manufacture new products, and being more efficient to be able to reach a more diverse population. Due to this tendency, the future professionals must be prepared to face those new challenges by getting the necessary competencies as part of their formal higher education to succeed in the global workforce.

In the particular case of engineers, it is evident that they are challenged more and more to design and develop new products for the global market (see Esparragoza and Devon (2005)). They are also required to be part of international structures in the corporate world where they have to interact with customers and colleagues overseas. Therefore, the new engineer should understand and accept diversity, be prepared to work in multi-national teams, be able to communicate and socialize with people of different cultures, and be prepared to use the technology for communication, solve problems and present their solutions. So, the formation of engineers nowadays requires not only teaching them mathematical and scientific concepts but also providing them training to develop the necessary skills to succeed in the global workforce.

It is important to expose the engineering students to international experiences as part of their formal education from the very beginning and in a consistent and productive manner. One of the most effective forms of doing this is through multinational global design projects as can be seen in Ion et al. (2004), Pollard et al. (2002), Devon et al. (1998), and Hager et al. (1998) among others. This type of initiative allows the students to work with diverse teams geographically disperse while they solve an engineering problem. There are challenges in building trust in such teams (Jarvenpaa, et al., 1999) and in getting the desire performance (Prasad et al., 2002), but they are here to stay. It has been shown by many authors that the benefits surpass by much the difficulties that might appear when implementing this type of projects.

The technology available for communication has made possible to develop global design projects with teams disperse in different countries. This type of collaboration can be easily incorporated in the engineering curriculum of any engineering institution without compromising a big amount of money. Students participating in this initiative will benefit of an international experience while studying without leaving the country and with no extra expenses associated with this work.

This work summarizes the efforts of several institutions members of the Latin American and Caribbean Consortium of Engineering Institutions (LACCEI) in building international collaboration experiences for the students through multinational design projects. The structure of the collaboration, the network of institutions, as well as the difficulties and benefits of this program are discussed in this paper.

2. Background: The International Network

There was a general interest in establishing a collaborative partnership among institutions members of LACCEI and a particular desire of Penn State University to find Latin American partners interested in multinational design projects to provide international experiences to freshman engineering students through global design projects. As a result, the professors leading this effort in Penn State sent a general call to professors of institutions members of LACCEI inviting them to initiate an international collaboration by means of short multinational design projects. As an additional stimulus to this initiative, an illustrative paper regarding this type of collaboration was presented in the 3rd Latin American and Caribbean Conference for Engineering and Technology (Esparragoza and Devon (2005)) to provide the basic foundations for those institutions interested but with no previous experience on this kind of work.

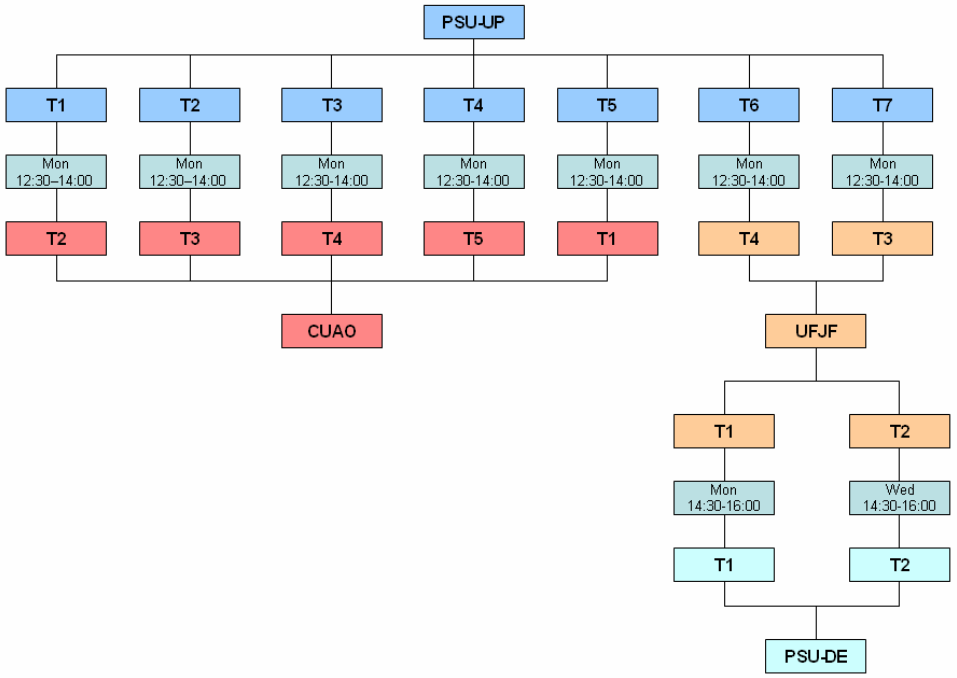

Fig. 1 International collaboration network during Spring 2005.

The initial call from Penn State was responded by two institutions: Universidad Autónoma de Occidente, Colombia and Universidade Federal Juiz de Fora, Brazil. During the Spring 2005 four different campuses, from three institutions in three different countries participated in the first experience. Eighteen teams distributed as shown in Fig. 1 worked together in the first project.

During Fall 2005 the network grew up. In this opportunity the following institutions formed the international network: Penn State University, USA, Universidad Autónoma de Occidente, Universidad del Norte, and Corporación Universitaria de la Costa, Colombia, Universidad Tecnológica Centroamericana, Honduras, and Universidad Católica de Santa Maria, Peru. Therefore, seven campuses, from four different countries participated in the international experience. In this opportunity twenty four teams distributed as shown in Fig. 2 worked together.

3. The Design Project

There are different types of projects that can be adopted as described by Jenkinson (2000). The complexity and resources necessary to implement them vary from simple and low cost projects to more complex and expensive ones. Usually the simple and less expensive project consists of a case study where the students just report the final result to their international partners. Minimum interaction is required and is usually a one-time in class experience. In contrast, the international projects named “integrated teams” require more interaction between the students since they work together in multinational teams. These projects are usually a long term, professional projects, and demand high level of commitment of students and staff. Some personal interaction might be required and they might be expensive.

The criteria to select the appropriate type and level of collaboration depends on the general objectives, rank and content of the course in which the project will be offered, the level of commitment of faculty and students, and the resources available. The project structure selected for the international collaboration among the LACCEI institutions is the parallel design project in which the teams in each country work independently on the same design proposal but they have to share and discuss data and ideas with their

international partners to enrich the final solution. In this particular case, due to the number of institutions and teams participating, the teams worked in pairs, as shown in Figs. 1 and 2. Therefore, each team had an international partner to discuss the project and share ideas through scheduled audio-video conferences and e-mail exchange.

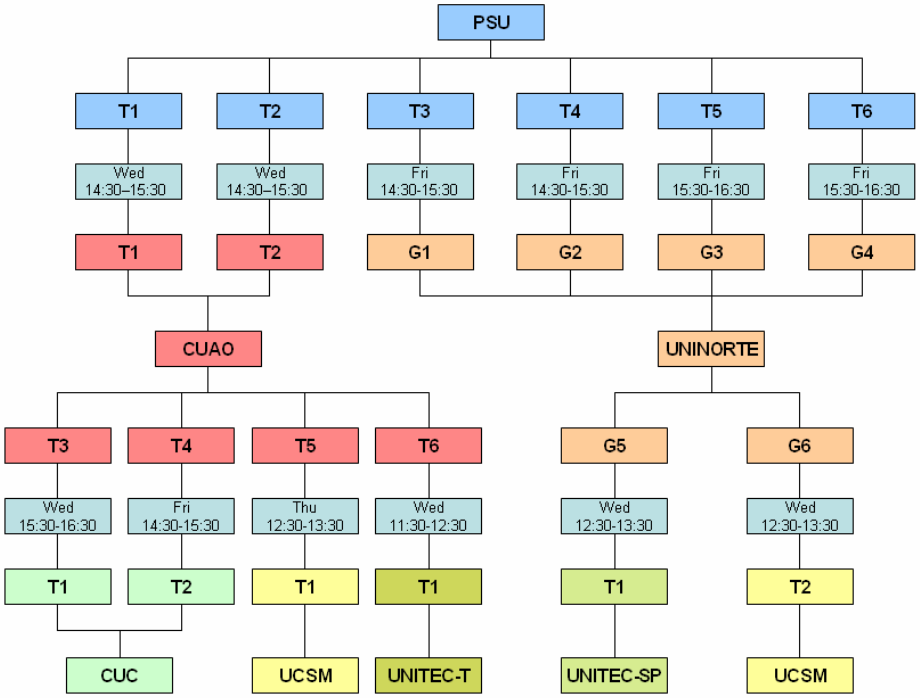

Fig. 2 International collaboration network during Fall 2005.

The global design projects were structured to last seven to eight weeks where the mandatory international interaction was required to last four to five weeks, even though teams were allowed to interact beyond the minimum required period. The chronogram of activities for the projects is shown in Fig. 3.

The design project for all the teams during Spring 2005 was the design of the mounting (support) system for a portable electronic warning sign for road emergencies which is easy to carry in the trunk of a car. This project was suggested by Penn State University Park and adopted by all the participants. During Fall 2005, it was requested that all participating institutions suggested design problems and the list of proposed problems was voted to select the design project. The winning and selected project was the design of a portable and folding bicycle that can be stored in a backpack and carried by a person without any inconvenience.

4. Implementing the Collaboration

There are many activities that have to be planned and coordinated in the development of this type of international collaboration. During the planning process all the tasks must be scheduled and the necessary resources determined. During the project execution it is important to coordinate and facilitate the interaction between the teams and establish contingency plans in the case of inevitable events mainly when technology problems arise.

The most significant tasks in the project planning are:

- **Faculty communication:** The initial and permanent communication among the professors involved in the project is extremely important.

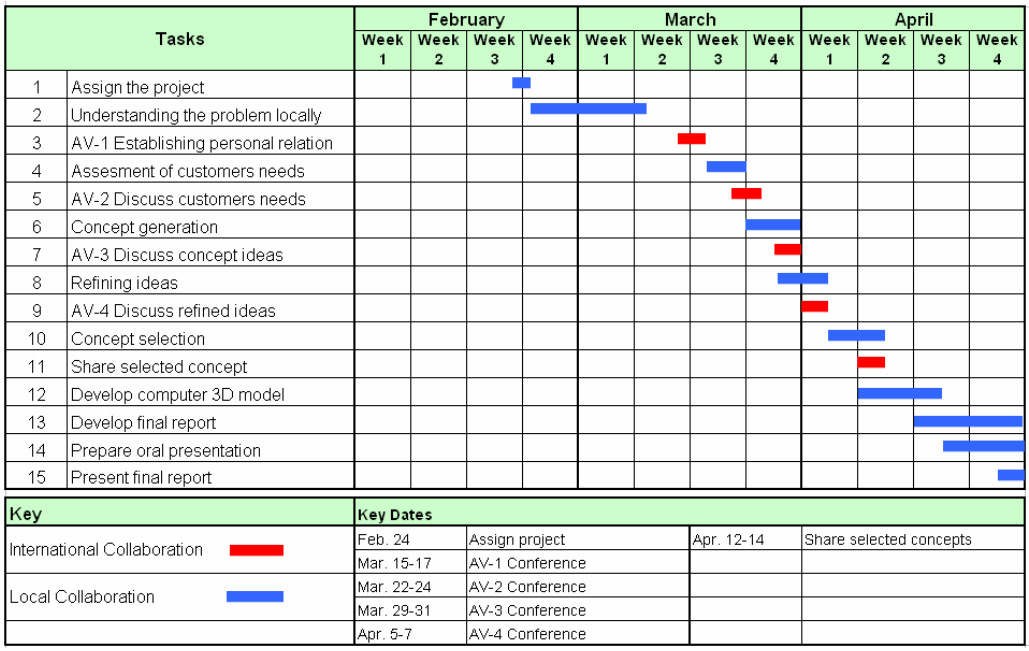

Fig. 3 Chronogram of activities for the global design project.

- **Academic calendar:** It is evident that not all the institutions in the Americas have the same calendar. Therefore it is important to share this information to find the proper time to schedule the design project.
- **Time zone:** This has to be taken into account to schedule the audio-video conferences. Besides that, the daylight saving time that occurs during the project has to be considered from the very beginning. During the Spring 2005, at the beginning of the project US and Colombia had the same time and Brazil was two hours ahead. By the second week, the time changed in the US moving the clock one hour forward and then the difference with the other two countries changed accordingly. During Fall 2005, at the beginning of the project US was one hour ahead of Colombia and Peru, and two hours ahead of Honduras. By the third week, the time changed moving the clock one hour backward and then the difference with the other countries changed accordingly.
- **Selection of course:** Each institution participating determines in which course this international collaboration is incorporated. However, it is important to try attaching this experience to a course or to an independent study activity with a grade associated. Penn State uses this project in a freshman introductory level engineering design course.
- **Selecting students:** Similar to the selection of the course, students participating should be in a similar academic level (freshmen working with freshmen). For parallel projects, like the one reported here, this is fundamental to ensure the participation of all the team members. However, the academic system in the US and Latin America are different. In the US the typical engineering program is four years in length while in Latin America is five years. Therefore, it is possible to have introductory design courses in Latin America during the second year. Consequently, to establish the relationship between international teams, the course content as well as the students' background were considered.
- **Language requirement:** English has been extensively used as a common language for international collaborations and it was used as the official language for this initiative; however, students in the US were encouraged to practice the foreign language (Spanish or Portuguese) at any level they can. Students were instructed to use on-line translators as needed.
- **Collaborative tools:** MSN messenger and Skype were used for the audio-video conferences and chatting. The access to computers and connections to the internet were responsibility of each institution.

There are multiple tasks that have to be carried out in the process of developing international collaboration. Some of them require the coordination among all the institutions participating such as establishing the contact between the instructors, coordinating schedules, selecting the project, managing multi-national teams interaction and testing the technology for communication; others depend entirely on each individual institution such as making available all the technical resources, forming the local teams, delivering the project, and providing time for audio-video conferences. It is important to get, with due anticipation, the necessary clearance of firewall protection at each institution. Similarly, testing the technology for communication should be done with the same equipment and rooms where the AV interactions are to occur.

5. Students Feedback

It is critical to determine the effectiveness and impact of this international collaboration in reaching the learning objectives set for this process. Additionally, the student assessment and feedback are very important for future collaborations. For this purpose, the students were asked to evaluate the global design experience by means of an anonymous survey at the end of the project.

Generally speaking, most of the students participating evaluated positively the collaborative experience. They highlighted the richness of the experience and its innovative character. Most of them coincided in placing this first experience as a starting point for other collaborative experiences. Students feel that when international collaborations in global design experiences occur, they are very interesting and pleasurable; they foster learning about other cultures, and other universities; Besides that, they provide a first hand experience about design practice in disperse teams, and the opportunity to think in a different language, and to establish a wider field of acquaintances and friendship. A great majority reported they would like to do more projects like this, and considered this experience will help them to work in distributed teams in the future.

However, there were some issues that constitute a series of challenges and open questions. The first of them is the difficulty of reconciling the work in different languages. A number of teams in Latin America had some difficulty, because, although the students work with English in an educational or technical level, the spoken language presents difficulties for them due to the lack of living the language. Overcoming this kind of difficulty can be not a short term goal. However, these limitations were overcome in some sense by using translation tools and interpretation support. In this specific experience, they were very useful and made this collaboration become viable. The definition of the project was pointed as another drawback for the teams from Brazil, since they were not involved in defining the problem, key aspect for them

Students also reported that the positive learning outcomes and feelings might be threatened with frustration by technical failures in communication, in the production of materials for AV interchange, lack of confidence for interchange, lack of compromise and punctuality of team members, too short time for previous activities and different approaches on conceptual design.

6. Conclusions and Final Remarks

In general this global collaboration project provided an excellent opportunity to involve the students in a different and challenging experience that gave them a taste of how the requirements and approaches may change from country to country. The use of webcams, headsets and the internet exposed them to the future of communication technology and introduced them to a new way of sharing ideas and doing business. The students enjoyed the experience and the instructors developed new contacts with other professors and universities given them opportunities to share ideas and enrich in this way the classroom and the research in which they are involved.

As every experience in non established activities, the initiation of intercultural or international collaboration in global design requires**:** cultural changes in the participant institution own culture, lots of

work by the professor or professors supporting such changes, adequate technological infra-structure and technical support by its administrators for the essential communication processes. The confluence of value, principles, and resource changes affect a wide section of our universities and should correspond to institutional politics clearly defined.

A key element for the success of collaboration among work teams is the definition of an interaction model for team working, more important than technology itself. Although there is consensus over the importance of the English language in the present world, one of the pillars of the collaboration is the partnership climate, where the involved cultures build its own interaction space and meet in the language, without a priori conditions. An important condition for the success of this work is to incorporate this type of initiatives in the curriculum. This provides the level of responsibility and commitment in the development of the projects. On the other hand, the differences among academic calendars hinder the accomplishment of projects, which demands the study of alternative approaches.

The ideas discussed in this paper are the clear reflection of a diverse group working on the same topic. The perceptions change from country to country, and from institution to institution. However, among all the difficulties and constraints, there is a general consensus that these international projects are a valuable tool for the engineering students. The benefits of this initiative, which are significant to the students and instructors, surpass the difficulties that might appear in the implementation process. Students participating have the opportunity of teaming with students abroad gaining not only new friends but also a valuable international experience. Instructors will have a broader view of the engineering education worldwide and how the engineers are educated in other cultures. Besides that, they can create links for future exchange programs and collaboration in research projects.

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