AC 2009-57: IMPLEMENTATION OF AN INTERNATIONAL MULTIDISCIPLINARY ENGINEERING EDUCATION CONSORTIUM

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Abstract:

In recent years, the growing integration of economies and societies around the world has required that graduates of all institutions and disciplines be prepared to work in an economy that is now best seen as essentially international. Global markets are dictating the way that national economies around the world design, distribute, and consume goods and services. Engineers are in the midst of this dynamic development. Most large engineering projects currently require multi-national teams of multi-disciplinary professionals to work together and, therefore, a better understanding of the global economy, communication skills, cultural awareness, and interpersonal skills are critical to engineers. In this context, universities around the world are increasingly moving to establish international partnerships in their education and research programs. This growing trend is fuelled by many factors, including the need to give students the education they require to work in an increasingly globalized world.

In this paper, the authors discuss the key concepts of an engineering educational consortium between the United States and Brazil, formed with the objective to establish a sustainable exchange of undergraduate students in engineering between the U.S. and Brazil. The consortium is identifying the main barriers that currently prevent the existence of exchange of engineering students between the U.S. and Brazil that is consistent with the geographic location and the geopolitical importance of these two countries, so that these barriers can be addressed during the program. The consortium is focusing engineering education in the disciplines of electrical engineering, mechanical engineering, and electrical engineering technology, with emphasis in the area of renewable and alternative sources of energy. The authors describe the preliminary stages of this multidisciplinary project, and the goals and progress made in first year of the four-year project (October'07 to September'11). The consortium is under the auspices of the U.S. Department of Education's Fund for the Improvement of Postsecondary Education (FIPSE) on the U.S. side, and under the auspices of the Coordenação de Aperfeiçoamento de Pessoal de Nivel Superior (CAPES) of the Brazilian Ministry of Education, on the Brazilian side.

One of the main purposes of international programs is to provide students value-added technical and cultural experiences. Engineering students typically do not have the same variety of International Program offerings as students of other disciplines have, such as humanities or social science students. Our consortium partnering institutions focus on use the exchange of engineering students and faculty to study questions of credit equivalents, shared curriculum, distance education and professional practice. Our program also focus on actively pursue sustainable partnerships with the regional industry to provide internship opportunities to complement the education and the cultural exchange of the students in order to illustrate how two different cultures approach a common problem. Specific activities in the program include language preparation, Web based teleconferencing using voice over Internet, pre- and post-departure team building and distance education to allow students rapid emergence into the host country's culture.

1. Introduction

Globalization has strongly influenced economies and communities, and consequently, has entail changes in the role of engineers. As a result, engineering education has to be tailored to the needs of the current globalized world. Industry has begun to respond to the transformation by redefining business strategies and with new expectations for the new set of skills of engineers. According to the literature[1-12] engineering students who have international study experience are more likely to be hired and prepared for the global market place. Engineering graduates will be integrally involved with the globalization of engineering during their course of their careers by working at multinational companies, often having foreign-born coworkers, working with international suppliers, providing services to international product markets, or developing products that have an international market[13].

This changing nature of the world economy makes it essential to provide our students with the cross-cultural tools to become successful professionals in the global workplace; the need to prepare students to contribute to the global workplace is unquestionable. In this context, the new profile of an engineer requires new set of skills; the list of competences for the "global engineer" might include more attributes besides the technical knowledge required for each major[1, 7, 13]. This list of attributes includes: an engineer must understand and accept diversity; be creative in the solution of problems impacting a wider and more diverse population; be able to communicate and socialize with people from different cultures; be knowledgeable of other languages; be able to use the technology to exchange ideas, solve problems and present solutions; be a leader; a team member; and an ambassador[1, 7, 13]. However, preparing engineering students with all the previous mentioned attributes is no small task given that engineering programs are already overloaded with credits, content, and other demands.

Eight international prestigious universities, chaired by TU Darmstadt, started in October 2005 an initiative to conduct the first worldwide scientific study on "Global Engineering"[2]. The results of this study lead to four recommendations:

1. Global competence needs to become a key qualification of engineering graduates;
2. Transnational mobility for engineering students, researchers, and professionals needs to become a priority;
3. Global engineering excellence depends critically on a mutual commitment to partnerships, especially those that link engineering education to professional practice;
4. Research on engineering in a global context is urgently needed.

These recommendations suggest that educational institutions, government agencies, and the private industry around the world should collaborate among them to provide mobility, transnational internships, projects, and research initiatives to the faculty and students in a global context. Also, according to the Global Engineering Study[2], strong inter-institutional international partnerships involving student exchanges, dual, double, and joint degrees, and transfer credits are proven means to enhance student participation.

In 2004 and 2005, the U.S. National Academy of Engineering published two reports *The Engineer of 2020* [3], and *Educating the Engineer of 2020* [4]. Both reports stress the impact of globalization on the practice of engineering and the need for U.S. engineers to focus on

innovation and creative aspects of the profession to be globally competitive. The need to create the "global engineer" coming from government, industry, and academia clearly requires academic programs to offer the engineering students the opportunity for international experiences where the students can obtain the global competences as they learn their major skills, and in such way be prepared for the global market place[2, 8, 14, 15].

The challenges and opportunities in forming global engineers for the Americas were discussed in a recent workshop sponsored by the National Science Foundation (NSF) and the Latin American and Caribbean Consortium of Engineering Institutions (LACCEI). The outcomes and recommendations based on this workshop were reported by Esparragoza et al.[8]. Brito et al.[6] make a comparative analysis based upon recent international conferences on engineering education held in Brazil to demonstrate the role of international cooperation in the dissemination of new approaches in engineering education worldwide. This series of conferences reflects the effort of the Brazilian's educators, educational organizations, and government agencies in attracting recognized international organizations and institutions for mutually beneficial cooperation. In October 2006, representatives of 31 organizations in 10 countries gathered in Brazil to launch the International Federation of Engineering Education Societies (IFEES), recognizing that the need for well trained and culturally sensitive engineers[12, 16]. IFEES mission is to establish effective and high quality engineering education processes to assure a global supply of well prepared engineering graduates[16]. Meetings such the ones reported in references [6, 8, 16], are the venues where industry professionals, scholars, researches, and students met to exchange ideas and experiences, explore research opportunities, and develop international collaborations, all in the same context of educating engineers with global competencies.

2. Project Background

In recent years, two areas have been of particular importance to the future perspectives of countries around the world: 1) globalization; and 2) sustainability. A key technology which impacts both of these areas is energy production. The educational consortium discussed in this paper, focusing on the education of professionals prepared to address energy questions from a unique perspective. The outcome of such a program will ultimately lead to the preparation of engineers and technologists that have the understanding and appreciation for the customs, culture, language, technical standards, and business environments of both U.S. and Brazil in a fashion that will enable those professionals to contribute to the technological development in both countries. In references[7, 17], the authors point out that sustainable development is an especially important aspect of international engineering education because it is a critical element in improving the quality of life of people worldwide, especially allowing students to understand the cost and benefits of sustainable development and globalization to communities.

The primary engineering technology focus of the educational consortium presented in this paper is renewable energy sources such as wind, solar, biomass, and water power. New technologies for these energy sources are of increasing interest and investment in both countries, in addition to the enormous interest for biofuel[18, 19].

Because the globalization that we are experiencing today is unprecedented in its magnitude and reach[3, 4] most worldwide higher education systems have not adapted their curriculum to enable engineering and technology graduates to fulfill their full potential as professionals[2,11]. The lack of qualified professionals with the technical, cultural, and linguistic skills to work in multi-national enterprises is one of the factors that have limited the economic development in many regions of the world and in many industrial sectors of the global economy. The development of global standards is one of the major challenges in the efforts to internationalize engineering education[7]. Multi-national approaches by faculty to upgrade curricula worldwide, in additional to active participation of the industry in engineering education are important components of standard development[15, 20]. Traditional student exchange programs have not successfully addressed this problem because of the rarity of the combination of interest in an exchange with foreign cultures, skills in foreign languages, and credit equivalence among universities. Moreover, purely academic exchanges do not enable the students to experience the business and the industrial environments of the host country[11].

This project is an attempt to address these problems with a bi-national U.S.-Brazil exchange that fosters collaboration among institutions of higher education to educate professionals in a shared upper-level undergraduate technical curriculum in both countries to enable credit equivalence, which will lead to degree equivalence and a sustainable academic and professional exchange among them. The project aims to enhance the education of the students while they make progress toward graduation. Students from the home and from the partner institution abroad take courses taught in the foreign language in the host foreign institutions. A parity of exchange is maintained so there are no net expenses to either institution. The engagement of the technological industry, which will support the program through the offering of internships and cooperative educational programs, can substantially contribute to the sustainability and, as a consequence, to the success of this U.S.-Brazil exchange program in engineering and technology. Students may work abroad at a Brazilian company or at a multinational company if the Brazilian government can grant temporary work visas for the American students.

The partner institutions of the consortium in the U.S. are North Dakota State University in Fargo, North Dakota, and Michigan Technological University in Houghton, Michigan, and the partner Institutions in Brazil are Universidade Federal do Pará in Belém, State of Pará, and Universidade Estadual de Campinas (Unicamp) in Campinas, State of São Paulo.

3. Project Objectives

The main objective of this project is to overcome curriculum, linguistic and cultural differences between students and faculty members in engineering and technology programs in U.S. and Brazil to promote a self-sustainable academic exchange between the two countries with emphasis in the area of renewable energy sources. To do so, the faculty members perform curriculum study with the goal of achieving credit equivalence for the exchange students. The staff provides adequate support to the students, and the regional industry facilitates student internships. This process will ultimately lead to the education of engineers and technologists that have an understanding of the technical norms and the business environment in both countries. The detailed main project objectives are:

- Achieve equivalence in a majority of junior and senior level courses to enable the exchange students to use those credits towards a degree;
- Establish a process for the selection and preparation of the students for the exchange through a language and cultural training program, including both on-line and regular classes with an immersion session in the host country before the start of classes;
- Identify and correct potential difficulties with the adaptation of the students while they are in the host country through an active mentoring program;
- Assist the exchange students in their pursuit of internships or participation in cooperative programs through cooperation with the regional industry, including multi-national and national companies, leading to sustainability of the program;
- Disseminate the knowledge acquired during the exchange to facilitate the establishment of other U.S. - Brazil University consortia of higher education.

4. Project Planned Phases

The project has several phases in its development, execution and long-term support. The preparation phase occurred in the first year of the project, Oct.2007- Sept. 2008. The execution phase is the phase the actual exchanges occur, Oct.2008-Sep.2011.

a. Preparation phase:

The goals of the preparation phase that started in October of 2007 and it is still in place, include:

- Address curriculum and credit equivalence issues, so that the students can obtain their graduation in a timely fashion. This was accomplished during short faculty visits to partner campuses in U.S. and Brazil to familiarize faculty with the class syllabi, educational process, and resources employed in both countries;
- Develop a language and cultural preparation program that is necessary to enable students to actively and effectively participate in the educational activities during the exchange. Classes in Brazil will be taught in Portuguese, similarly classes in U.S. will be taught in English;
- Develop an infrastructure to support exchange students in the disciplines of electrical engineering, mechanical engineering, and electrical engineering technology during the academic and professional exchange;
- Share information on project management, project evaluation, recruitment, industrial internship opportunities, and criteria for yearly program assessment.
- Create a website containing a comprehensive set of information including, project description, student selection criteria, student funding, credit transfer, how to apply for the project, and partner institutions description. The website also provides guidelines for institutions that are planning to develop similar programs. The website was developed in the Summer of 2008 [21].

b. Execution phase:

- Assess the language skills of the exchange students and make adjustments to the language preparation;
- Provide mentoring to the exchange students to facilitate their adaptation to the foreign environment;
- Cooperate with the industrial partners to pursue the offering of internship and cooperative education opportunities for the exchange students.

c. Evaluation phase:

The program evaluation determines the extent to which program outcomes are being achieved, and the effectiveness of the modifications implemented during the execution phase to improve the program. Internal and external evaluations will be conducted at least once a year, and will include students and instructor interviews, grade examinations, and feedback from the companies employing student interns. Performance indicators have been collaboratively established between the partners and are summarized in the assessment section of this paper.

d. Sustainability Phase:

The assessment of the performance obtained in the evaluation phase will allow the participating institutions to better prepare and advise future exchange students. The participation of the industrial sector through the offering of internships and cooperative educational opportunities, will substantially contribute to the sustainability of the program. An integral component of the project sustainability is the development of an effective language and cultural preparation for the exchange students.

5. Institutional Partners

North Dakota State University (NDSU) is a land grant university. In fall 2008, the institution had a total enrollment of approximately 13,229 students, including 1,818 graduate students. The College of Engineering and Architecture (CEA) currently has an enrollment of 2,811 students, and offers accredited baccalaureate programs in civil, computer, construction, electrical, industrial and manufacturing, mechanical, and agricultural and biosystems engineering, in addition to masters and doctoral degrees. The Departments of Electrical and Computer Engineering, and Mechanical Engineering at NDSU have a long history of cooperation with regional power industry. Both departments offer courses and programs in renewable energy sources and power option.

The region surrounding NDSU is rich in conventional and alternative energy opportunities, including coal, biomass, ethanol, and wind farms, with the State wind potential estimated to be the largest in the U.S. Moreover the Fargo region is home to turbine component manufacturers and local utilities in the area with wind generation in their portfolio, all providing opportunities for the students to tour their facilities and to learn practical aspects of energy conversion, transport, and energy management. NDSU has a history of attracting international students; many of them are from Latin America. From 2001 to 2004, NDSU was the lead partner

institution in the FIPSE supported Alliance for North American Mobility in Engineering (ANAME) program, which initiated a successful exchange program with Mexicans and Canadian universities. In fall 2004, NDSU partnered with the Ansal Institute of Technology, India, in offering a twinning program of study in several areas, including electrical, computer, and mechanical engineering. The CEA has strong ties with multi-national companies based in the region and with facilities in Brazil.

Michigan Technological University (MTU) is a public university committed to providing a quality education in engineering, science, business, technology, communication, and forestry. The Fall 2008 enrollment showed a total of 7,018 students, including 984 (14.0%) graduate students. Over 64% of Michigan Tech students are enrolled in engineering and technology programs. The College of Engineering is ranked among the top twenty schools in the nation in engineering bachelor's degrees awarded, offering programs in Biomedical, Chemical, Civil & Environmental, Electrical & Computer, Geological & Mining Engineering & Sciences, Materials Science & Engineering, Mechanical Engineering – Engineering Mechanics, and Mining Engineering. Although small, the college of engineering has a strong graduate programs and offer both masters and doctoral degrees. The School of Technology offers programs covering the entire spectrum of technology, awarding bachelor degree in Computer Network & System Administration, Construction Management, Electrical Engineering Technology, Mechanical Engineering Technology, and Surveying Engineering. The Michigan Tech's Power & Energy Research Center (PERC)[22] was recently created to focus on alternative and renewable energy, development of new energy technologies, restructuring and deregulation of the utility industry. The center is run by faculty members of the MTU's ECE department, whose current partners includes, American Electric Power, Consumers Energy, International Transmission, Lawrence Livermore National Laboratory, and Schweitzer Engineering Laboratories.

MTU has a history of exchange programs with international institutes in Latin America and is part of EHaz (Earth Hazard) and ExCit (Expanding Cities), both are consortium program of six research-based universities in Canada, Mexico, and the U.S. The EHaz focus area is mitigation of geological natural hazards in North America, while ExCit focus area is decision making for meeting the growing demands on urban water resources systems. Both EHaz and ExCit programs are funded by U.S. Department of Education and equivalent agencies in Canada and Mexico as part of NAFTA agreement. MTU is also expanding its connections with Colleges and Universities in Norway. Many possibilities exist for student exchanges, research programs, and Masters or PhD study[23].

Universidade Federal do Pará (UFPA) is one of the largest and most influential universities in the Amazon region and in the equatorial region of South America. It has an enrollment of 22,000 undergraduate students and 2,406 graduate students. The Centro Tecnológico (Technological Center) of the university currently has an enrollment of 3,304 undergraduate students in the areas of civil, computer, electrical, mechanical, chemical, environmental engineering, and architecture. The Technological Center at the UFPA awards bachelors, masters and doctoral degrees in engineering that are accredited by the Ministry of Education in Brazil. UFPA recently created the Group of Studies and Development of Energy Alternatives (GEDAE), whose main research

focus is on renewable energy, such as Wind and Solar generation of electricity[24]. UFPA is committed to education and research cooperation with other institutions of higher education in Brazil and abroad to promote the enhancement of the higher education in the Brazilian State of Pará. In 2005, the Assessoria de Relações Nacionais e Internacionais, the department responsible for articulating agreements with national and foreign institutions, established a student and faculty exchange agreement with universities in North American and throughout the world. In the same year, the same department initiated the Programa de Intercâmbio e Apoio ao Estudante Estrangeiro PROEG (Exchange and Support Program for Foreign students). PROEG was created in response to the need for supporting an increasing number of foreign students enrolling in undergraduate programs at UFPA. Its task is to aid the foreign student population through: coordinating the credit equivalence process, assisting in the location of adequate housing, and provide language and cultural preparation.

Universidade Estadual de Campinas (Unicamp) is one of the most prestigious institutions of higher education in South America and is responsible for 15% of the scientific production in Brazil and 10% of the masters and doctoral degrees awarded in the country. Unicamp has an enrollment of 31,646 degree seeking students, including 15,393 graduate students. Unicamp admits less than 5% of the applicants to its undergraduate programs based on a selective process that consists of an annual common entrance examination. Unicamp's annual operating budget (~535 million U.S. dollars) is entirely appropriated from the State of São Paulo. Engineering areas are organized in separate schools: School of Electrical & Computer Engineering, School of Mechanical Engineering, School of Civil Engineering & Architecture, School of Chemical Engineering, School of Agricultural Engineering, and School of Food Engineering. The Technological Center of Higher Education at Unicamp awards technology degrees. Unicamp recently created a group of energy planning referred as Núcleo Interdisciplinar de Planejamento Energético (NIPE). Unicamp greatly values the presence of foreign students and professors in its academic community as a welcome sign of vitality and as symbol of the extensions in scientific knowledge beyond borders. Unicamp currently has active exchange programs in thirty-two countries around the world.

6. Student participation

The students participating in the program are junior (third-year) or later in their engineering or technology major. The disciplines included in the exchange are electrical engineering, mechanical engineering, and electrical engineering technology. Preference is given to students with interest in the area of renewable sources of energy. Each project director in the consortia is responsible in his or her institution for recruiting, providing language training, and advising their students and the guest students in the exchange at their institution. For that purpose, all the partners will follow similar procedures. The project directors advise both outgoing and incoming students in the exchange at their institution. The American students selected for awards receive a total of US$4,500 stipend to pay for expenses (Airline ticket, housing, etc), $1,000 of which is applied towards Portuguese language training. The project is aimed at enhancing the education of the exchange students while they make progress toward graduation. Classes taken during the international exchange will be transfer to the home institution and will be used towards

graduation.

The first cohort of seven Brazilian students from UFPA and Unicamp that participated in the student exchange at NDSU and at MTU in Fall 2008 were selected during Spring 2008. The first cohort of students from NDSU and MTU to Brazil are participating in the program in Brazil in the Spring 2009. There will be an equal number of students from Brazil and from U.S. in exchange during the program. Brazilian students have enough proficiency in English to start their classes; on the other hand, American students will face an initial language barrier during the exchange in Brazil, given that Portuguese is not an international language. For that reason, American students will receive intensive Portuguese classes 6 to 8 weeks prior to the start of regular classes in Brazil. Students will also start to receive Portuguese training at MTU and NDSU campuses as soon as they are accepted in the program and prior to their departure to Brazil.

An exchange program is beneficial not only to the students going abroad but also to the students of the host institutions. Home students benefit from an international perspective by having international visiting students in their classes and laboratories. In addition, the home campus also benefit from the return of the student to the home campus, since they share their international experience with home university peers.

7. Project Outcomes

The project is expected to produce multiple long term benefits for participants. At the conclusion of this project, the following outcomes related to the skills, knowledge, and behaviors that participants will acquire as they progress through this project:

1. Provide students with the language, culture, technical, and business skills to work for international companies;
2. Create course articulation agreements that transfer credit between participating institutions;
3. Develop a system for linguistic and cultural preparation for students participating in the foreign exchange;
4. Provide industry with culturally and technically proficient professionals qualified to work in several locations for multi-national companies;
5. Document results of successful relationships between project participants (students, institution administration, participant faculty, industry advisory committee) that lead to educational and disciplinary research;
6. Document results of the progress made toward equivalent professional licensure in both U.S. and Brazil.

In addition, the project seeks to improve the quality of teaching and student learning. The students that are going to participate in this exchanged will have the opportunity to experience a different culture and learn a different language. Language learning is highly correlated to a better understanding of the local culture[2]. Language skill is considered as a key element for the success of this program. Moreover, the engineering students will have access to classrooms and

laboratories in a foreign country, and will have an opportunity to learn about similarities and differences on how engineering is taught elsewhere. The students will also have the opportunity to be involved in one or more research projects that are being carried out in several research laboratories at UFPA and Unicamp on renewable sources of energy and biofuels. This experience is expected to have a positive impact in the professional careers of the students, and will also give them a better understanding, appreciation, and respect for the diversity of values existing in different cultures. These new set of skills are of enormous importance for U.S. engineering graduates as globalization challenges them to work in a multicultural workplace with foreign born engineers.

8. Project Assessment

A number of meetings have been held to discuss course equivalencies, recruiting efforts, and student mobility. Success indicators of the U.S. - Brazil exchange program have been collaboratively established between the partners, as follows:

1. The number of students that participated in the program;
2. The academic performance of the participating students during the academic exchange;
3. The satisfaction of the students that participated in the program;
4. The satisfaction of the faculty that participated and contributed to the program; and
5. The satisfaction of the industries providing internships, and of the student interns.

In addition to these quantitative measures gathered by the in-house advisory Board, an independent external evaluator will conduct formative assessment during the whole duration of the project. In the first two years of the program, the assessment will have particular emphasis on initial direction of the preparation phase. The first assessment session was performed by the external evaluator and was included in the first project annual report. Some of the assessment methods described below were suggested by our external project evaluator.

The assessment methods and tools that will be used for the project include:

Direct Measures

- Formal articulation agreements
- Written performance reviews of student interns (from industry participants)
- Student performance in class (exams, written reports, etc)
- Student overall performance (collective course GPA)
- Student performance on standard tests (Fundamentals of Engineering Exam, Brazilian National Final Exam)
- Student performance on language tests (TOEFL)
- Student numbers (program participants)
- Pretest/post test (student preparedness and performance)
- Student performance in the Capstone class
- Associated project (documented educational and research-related collaborations)

Indirect Measures

- Student surveys (related to instruction)
- Student surveys (related to exchange program performance)

Faculty and advisor surveys (related to student preparedness and performance)
Faculty and advisor surveys (related to exchange program performance)
Employer surveys (related to the performance of interns)
Written reviews and comments from the industry advisory committee
Graduation exit interviews (from students who have completed the program)

For each of the surveys (indirect measures), a consistent numeric scale should be used to provide a means of comparing the collected data between the administered surveys. In addition, student performance (direct measures) must be converted to the same scale for consistency.

8.1 Assessments for first student cohort from Brazil to US in Fall 2008

The assessment methods and tools applied to the first student cohort from Brazil to US include: language proficiency (TOEFL), collective course GPA, student surveys, written final report, and written reviews and comments from students. All the Brazilian student participants in the first cohort had TOEFL scores higher than the required by the two US institutions (minimum 550 PBT, 213 CBT, 79 iBT). The collective course GPA for all the participants were above 3.5 out of 4. The engineering courses taken by the students include: Electric Energy Systems, Power System Analysis, Engineering Electromagnetics, Linear Systems and Control, Microcontroller Applications, and Electronics. The students collectively worked on a written report on Renewable Sources of Energy, which was submitted as a Conference paper already accepted for publication. The students also wrote a final report on the overall program participation, which includes description of the courses taken, language improvement, cultural proficiency, difficulties, and suggestions for project improvement. The summary of the students' comments in different categories follows below:

Facilities: All the students stated that the American Institutions offer excellent structure, with access to the laboratories 24 hours, well equipped classrooms, efficient staff, wireless internet cross campus, and excellent libraries.

Teaching: While in Brazil, the exams usually only have a few difficult problems with enough time for the student to think of a solution. In U.S., the exams have a large number of easy problems, but no time to think. Grading in Brazil is a combination of the grades obtained in exams, while in U.S. a relevant portion of it comes from homework and quizzes. The students also found that the instruction levels in U.S. and Brazil are comparable.

Language Skills: All the students indicated significant improvement in language proficiency.

Cultural experience: The students related that, even though the American students were always polite and willing to help, they were individualist and emotionally distant (with no hugs, no hand shaking, no loan of objects, no or limited study in groups, etc). As a result, the Brazilian students had the tendency to interact socially more with other International students. The students also noticed how clean and safe the cities of Houghton-MI and Fargo-ND were compared to their home towns in Brazil. They also enjoyed the season change from fall to winter, and the opportunity to see snow for the first time in their lives. Students also enjoyed the contact with people from diverse countries, with different perspectives, and the maturity development while dealing with different situations.

Negative points: Long processing time and costly Visas, costly housing arrangements, homesickness, need to adapt to cultural differences.

9. Initial Difficulties

There were a few hurdles in the first year of the project, including:

1. The bureaucracy in the institutions, which delayed the approval of the Memorandums of Understanding (MoU) for the student exchange at undergraduate level in engineering and in engineering technology. Each participating institution in the U.S. had a separate Memorandum of Understanding with each participating institution in Brazil, totalizing four documents. The four MoU were necessary because there was no prior student or faculty exchange collaboration among these four institutions;
2. The difficulty and necessary paperwork needed for Brazilian students to obtain U.S. VISA in American Embassies and to take the English placement tests. In particular, the students from UFPA had to travel from Belém-PA to Campinas-SP (a distance of ~1,800 miles) at their own expenses to take the TOEFL exam. Moreover, the same students had to travel once again, also at their own expense,to another distant city to take part in an interviews for student visas to the U.S. These issues added additional costs not covered by CAPES (Brazilian agency), and therefore reduce the number of students that can participate in the program. Even though, this is a problem faced by the Brazilian students (not supported by FIPSE), these problems negatively impact the project by reducing the number of potential incoming exchange students from Brazil;
3. Mismatch between academic calendars in the U.S. and in the Brazilian Institutions, and the lack of dedicated housing for exchange students, especially in the Brazilian, universities since Brazil doesn't have the culture of on-campus housing;
4. The delay in the processing of an entry VISA to Brazil for one of the U.S. project collaborator. Because of processing delays by the Brazilian Consulate in Chicago, one faculty collaborator from the U.S. had to cancel his visit to partner institutions in Brazil in May 2008;

While participating in this project is a gratifying experience, it is important to mention that working in such a project requires a substantial time investment. Faculty members working on this project need to dedicate a large number of working hours to the project, which may result in time reduction to work on other scholarly activities. Overall, the authors of this paper believe that the benefits of such collaboration outweigh the difficulties.

10. Conclusions

Globalization has transformed the way businesses operate and has changed the character of the engineering profession and the profile of an engineer. The need to create an engineer with the skills to succeed in a globalized society requires academic programs to provide them the opportunity for international experiences, where they can learn at least one foreign language and familiarize with a foreign culture while they complete part of their engineering education. However, very few U.S. engineering students have any international experience. Of those, an even smaller fraction of engineering students have participated in student or professional exchanges in Brazil. In this paper, we presented the key components of an engineering

educational consortium leading to the preparation of engineers and technologists that will have the understanding and the appreciation for the customs, culture, language, technical standards, and business environments of both the U.S. and Brazil. These attributes will enable these professionals to contribute to the technological development in both countries. Assessment guidelines have been developed to provide feedback for program improvement. More detailed discussion on curriculum development, course equivalences, assessment of project outcomes, student internship and undergraduate research, and faculty development will be included in future publications. More information about the Fund for the Improvement of Postsecondary Education (FIPSE) international programs and how to submit proposals can be found at the FIPSE homepage[25].

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