AC 2007-576: FORMING THE GLOBAL ENGINEER FOR THE AMERICAS: GLOBAL EDUCATIONAL EXPERIENCES AND OPPORTUNITIES INVOLVING LATIN AMERICA AND THE CARIBBEAN

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Forming the Global Engineer for the Americas: Global Educational Experiences and Opportunities Involving Latin America and the Caribbean

Abstract

The Engineering for the Americas Symposium's Final Report urges the academic sector to develop a change in paradigm to educate the Engineer of the 21st Century, and in particular to focus on this Hemisphere. This urgent call is coming from all sectors, and clearly requires defining and facilitating experiences that would result in the Global Engineer. The European Union has defined and facilitated multi-national educational experiences important to capacity development in their area, but this has not been done for the Western Hemisphere. This brings political, economic and cultural challenges that must be explored and resolved. This paper explores efforts by the Latin American and Caribbean Consortium of Engineering Institutions (LACCEI), the Ibero American Science and Technology Education Consortium (ISTEC), the Asociación Ibero-Americana de Instituciones de Enseñanza de la Ingeniería (ASIBEI), and Engineering for the Americas (EftA) to promote the formation of world-class engineers for the Americas; as well as an assortment of resources and opportunities that facilitate the participation of faculty, staff, and students from Latin America and the Caribbean in a variety of engineering education experiences.

Introduction

There has been an urgent call to academia to educate the Global Engineer. This is in response to the rapid changes occurring in the global economy and the role that engineers have to play in this new scenario. Recently, eight prestigious universities around the world were involved in the first scientific global engineering study[1]. Their findings lead to four recommendations[1]:

(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; and
(4) Research on engineering in a global context is urgently needed.

These recommendations suggest that a very strong collaboration should exist among the academia, the industry and the government to facilitate the best practices to educate world-class engineers[2].

The European Union has defined and facilitated multi-national educational experiences important to capacity development in their area, but this has not been done for the Western Hemisphere. This brings political, economic and cultural challenges that must be explored and resolved.

The Engineering for the Americas initiative is an academic, industrial and government grass roots effort that has evolved over the past five years. Its aim is to enhance engineering and technology education in the Western Hemisphere, and to strive for mutual recognition of engineering graduates across national boundaries and cross-border trade agreements, facilitating

the flow of work and human resources throughout the hemisphere to optimal locations for distributed economic development[3]. The IV Summit of the Americas recognized the importance of the initiative, and the Organization of American States (OAS), Engineering for the Americas (EftA)[4], the U.S. Trade and Development Agency (USTDA) and World Federation of Engineering Organizations (WFEO)[5] organized the Engineering for the Americas Symposium[6] at the end of 2006 in Lima, Peru. The Symposium focused on the needs of the productive sector for engineering graduates and capacity building; quality assurance in engineering education; and national planning for financing of upgrades to engineering education. The Final Report[6] calls for educational reforms at the regional level that include the needs of the productive sector and preparing new engineers with attributes certified by transparent accreditation systems, which will further professional mobility, investments levels, and therefore economic development. The Final Report[6] urges the academic sector to boost its collaboration with industry to develop a change in paradigm to educate the engineers of the 21st Century. They define the Engineer of the 21st Century, or global engineer, as a world class engineer, leader, visionary, and entrepreneur, committed to the social environment and with a clear sense of the common good; an engineer who helps to create himself/herself, not look for work but create it.

In 2004 the National Academies published *The Engineer of 2020*[7], followed in 2005 by *Educating the Engineer of 2020*[8]. The National Academies was asked by representatives of the U.S. Senate and House of Representatives to formulate strategies policymakers could propose so the U.S. can successfully compete, prosper, and secure the global community of the 21st century. The resulting report, *Rising above the Gathering Storm*[9], was published in 2006.

In June 2006, the American Society of Engineering Education's International Division[10] met and expressed concern that Educating the Global Engineer was not a strategy presented in the National Academies report *Rising above the Gathering Storm*, and will be organizing sessions at future ASEE annual conferences on this topic.

In 2006, *The Online Journal for Global Engineering Education*[11] was launched by the University of Rhode Island, well known for its International Colloquium on International Engineering Education[12] and has published several articles on this topic[13,14].

This urgent call for a change in paradigm in engineering education to create the Global Engineer, and in particular the Engineer for the Americas, is coming from all sectors, and clearly requires defining and facilitating experiences that would result in the Global Engineer. This paper explores the Latin American and Caribbean Consortium of Engineering Institutions (LACCEI)[15] the Ibero American Science and Technology Education Consortium (ISTEC)[16], the Asociación Ibero-Americana de Instituciones de Enseñanza de la Ingeniería (ASIBEI) [17], and Engineering for the Americas (EftA)[4] efforts to promote the formation of world-class engineers for the Americas, as well as an assortment of resources and opportunities that facilitate the participation of faculty and students from Latin America and the Caribbean in a variety of engineering education experiences.

In the next sections we describe each of the organizations, then we describe the initiatives and activities that can be used to form Global Engineers, in particular focused on Latin American and Caribbean experiences.

LACCEI - the Latin American and Caribbean Consortium of Engineering Institutions

In 2002, a group of presidents and deans from twelve universities from Latin America, the Caribbean, the U.S. and Spain, met to explore strategies to advance engineering education, research and practice in Latin America and the Caribbean. As a result of several meetings, it became clear that it was important to create an organization of institutions that could be used as a vehicle for advancement of engineering disciplines, and for collaboration with engineering institutions in this region. Thus, the group decided to form the *Latin American and Caribbean Consortium of Engineering Institutions* (LACCEI). LACCEI, Inc. is a not-for-profit organization headquartered in Miami, Florida, now comprised of 64 institutional members.

The mission of LACCEI is to be the leading organization of Latin American and Caribbean Engineering Institutions that will bring innovations in engineering education and research, and emerge as a major force in this hemisphere to foster partnerships among academia, industry, government and private organizations for the benefit of the society and the nations.

The goals and objectives of LACCEI include the following:
Cooperation and partnerships among member institutions in the areas of engineering education, research, and technology advancement with emphasis on:

- Faculty and student exchange
- New and/or higher level academic programs
- Dual/joint degree and certificate programs
- Distance, continuing and e-education
- Laboratory development and sharing of resources
- Curriculum development, course equivalency and accreditation support
- Faculty development, including higher degrees
- Industry internship, cooperative programs and career development
- Joint training and research programs, and solicitation of funds
- Development, commercialization and transfer of technology
- Dissemination of scholarly achievements and other accomplishments by member institutions.

This organization has served as the meeting place where institutions can work together to join and align efforts to promote best practices to develop well qualified engineers for the Americas with global competencies. In October 2006, LACCEI organized the signing of the *Engineering Collaboration for the Americas,* a memorandum of understanding signed by seven multi-national organizations representing more than 1200 engineering institutions of the Americas at the celebration of the fifth ASEE Global Colloquium on Engineering Education in Rio de Janerio, Brazil. This accord will facilitate the integration of goals and strategies to improve the quality of the engineering programs responding to the challenges of the global market. The signers of the accord are: Asociación Ibero-Americana de Instituciones de Enseñanza de la Ingeniería (ASIBEI), American Society of Engineering Education (ASEE), Engineering for the Americas (EftA), Ibero American Science and Technology Education Consortium (ISTEC), International Federation of Engineering Education Societies (IFEES), Latin American and Caribbean Consortium of Engineering Institutions (LACCEI), and the Organization of American States (OAS).

ISTEC – the Ibero American Science and Technology Education Consortium

Since its inception in December 1990, ISTEC is a non-profit organization comprised of educational, research, industrial, and multilateral organizations throughout the Americas and the Iberian Peninsula. The Consortium has been established to foster scientific, engineering, and technology education, joint international research and development efforts among its members, and to provide a cost-effective vehicle for the application and transfer of technology.

Vision: "ISTEC will be a vehicle to advance socio-economic and educational change for the creation of new wealth and improvement of the quality of life in Iberoamerica".

Mission: ISTEC's members and stakeholders will:

- Advance the state of higher education
- Promote integration between local and international accreditation and certification initiatives in academia and industry
- Create a forum to encourage joint international research and development
- Provide tools, knowledge and environment for entrepreneurship
- Provide a cost-effective vehicle for technology transfer.

To accomplish this, ISTEC has created an organization that is flexible, self-sustaining, transparent and effective, and will be responsible for carrying out the mission.

Background: In an effort to improve international collaborations in Science and Technology, in mid 1990 personnel from the University of New Mexico funded by Motorola visited countries in Latin America to identify and evaluate opportunities for successful collaboration in science, technology and education. Meetings were held with officials from various governments, educational institutions, research facilities, and industrial firms to gage interest in establishing efforts for international cooperation in technical fields. The meetings resulted in the identification of areas of common interest for employing hands-on education, research, and technology transfer in state-of-the-art technology and science. As a result of these visits, an organizational meeting was held in December of 1990, at the University of New Mexico, involving personnel from universities, industries, governments, and foundations throughout Ibero-America. These discussions, which resulted in the creation of the Ibero-American Science and Technology Education Consortium (ISTEC), identified a number of obstacles that need to be addressed:

- Lack of current information for planning and developing technology
- Lack of expertise in the use of information
- Lack of international cooperation in developing the critical mass needed for projects and joint efforts
- Lack of interaction (lack of confidence) among universities, industries, governments, and international agencies.
- Lack of availability of technology and entrepreneurship.

The above difficulties are aggravated by another problem, which is the lack of awareness of the simultaneous existence and interaction of the above obstacles. It is imperative that efforts be made to address these issues concurrently in order to further the scientific and technological

development of Ibero-America. It was a consensus among the participants in the meeting that traditional mechanisms for cooperation are not sufficient, and new, more effective mechanisms are needed. As a result of the meeting, ISTEC was created, and universities, industries, and other organizations become members by signing a Memorandum of Understanding (MOU). In 1999, the Consortium officially became a U.S. 501 (c) (3) non-profit institution, comprised of a General Assembly to which all members belong that sets policy and direction, a Board of Directors, which is made up of fifteen academic and industrial members of the General Assembly that carries out the policies and promotes the Consortium, and an Executive Office that handles the day-to-day operations.

Mode of Operation: The objectives of the Consortium are to conceive, plan, and carry out activities of higher education, research and development, technology transfer, entrepreneurship and business development for the purpose of facilitating scientific and technical progress of the Ibero-American countries. ISTEC participants encourage the free flow and access of information in the pursuit of technical excellence. By coordinating eminent personnel and resources from diverse geographical locations, ISTEC has developed a mechanism called the Initiative, which is an organized effort to create activities to address a specific area of concern. The Initiatives are member-driven, flexible, and run concurrently. Within initiatives, projects are identified, planned, and implemented. The distributed structure from which the projects stem avoids duplication of efforts and inherently responds to the needs of the ISTEC membership. Projects are designed with both short- and long-term goals, with consideration of social impact. They are dynamic and expandable, and coordination is encouraged in order to maximize the utilization of available resources. Currently, there are four Initiatives underway:

- *Digital Libraries*: One of the basic tenets of science and technology, engineering and competitiveness is access to up-to-date information. The Initiative aims to modernize document delivery as a complement to education, research, manufacturing, entrepreneurship and policy design, to broaden electronic availability of research materials, to upgrade the information skills of library staff, and to sharpen the savvy and independence of the electronic user.
- *Advanced Continuing Education*: The key to the development of any nation is the availability of highly qualified human resources. This initiative seeks to upgrade the available skills and increase the number of qualified individuals in applicable areas. Projects conducted within this initiative involve curriculum adaptation, design and enhancement, professional development, accreditation, certification, evaluation, on-site training, web based distance learning, as well as non-traditional faculty, staff, and student exchanges, including "sandwich" and/or dual degree graduate programs. Of particular interest is the development of materials that incorporate the latest technology in the education process, both in the way of state-of-the-art textbooks and laboratory materials, and also in the way of development systems.
- *Research and Development*: The R&D mission is to encourage the development of inter-institutional projects and research. R&D promotes the development of research projects that have local impact and can be replicated. Joint collaboration between members is encouraged through the development of thematic areas. The knowledge, information, and applications generated from these thematic areas are shared to support the development and design of "off-the-shelf" solutions. The R&D Initiative has been created to provide a vehicle for performing research and development in a variety of

disciplines. The laboratory facilities not only are utilized for teaching, but also are used to enhance interaction between industries and universities to foster innovation and creativity. Thus, this initiative improves the ability of technology to be applied to the solution of problems using a multidisciplinary approach in a variety of areas. In addition, the R&D initiative makes training and education affordable and available through its Professional Development Series (PDS), which provides support for coordinating and delivering training in the use of new concepts and tools to enhance teaching and research.

- *Los Libertadores*: This initiative is a "common thread" effort that links together all of ISTEC's goals and objectives. It seeks to create a flexible network of electronic services (a hemispheric backbone for education, R&D, entrepreneurship and business development purposes), access, connectivity, computing facilities, and teaching stations, and the creation of "Centers of Excellence". It pretends to share worldwide expertise and distributed problem solving as well as creating the critical mass needed for regional projects.

In addition four interdisciplinary programs:

- *ICT for Social Development*: The objective is to spur an international strategy for generating and supporting collaborative activities among academia, industry, government, and marginalized communities in the Ibero-American region to promote development in Indigenous communities through the use of Information Communication Technologies (ICTs). Additionally, an overarching goal is to challenge communities to develop new organizing tools that can contribute to a bottom-up approach to cultural and socio-economic development that is created by rather than for community members. This proactive and action-oriented approach is aimed at creating the synergy needed to empower indigenous communities to develop innovate ways to use technology applications that improve economic development and the quality of life within their communities.
- *GRANA*: is an international Evaluation, Accreditation and Certification effort for Educational Programs under the Advanced Continuing Education Initiative of ISTEC.
- *SEED –Science and Technology Entrepreneurship for Economic Development*: the objective of this program is to create new companies in the USA, Iberia and Latin America with technology expertise, business knowledge and market from all of the participating countries.
- *ISTEC-Salud – Telemedicine*: the objectives are not only medical in nature; rather, the program aims at developing a new interdisciplinary space that integrates biomedicine, engineering, computer science, and other disciplines. The Project seeks sustainable technological solutions to improve medical/health care access for underserved communities in the region, and to provide innovative ways to facilitate access to knowledge and services in these fields.

Hemispheric Initiative: EftA – Engineering for the Americas

An outcome of a Motorola-ISTEC IT Challenge co-sponsored conference: "Ibero-American Summit on Engineering Education" March 24-27, 2003, was the creation of a Hemispheric Initiative *Engineering for the Americas* (EftA) which has become a priority of all Heads of State of the Latin and Caribbean Region.

ASIBEI - Asociación Ibero-Americana de Instituciones de Enseñanza de la Ingeniería

ASIBEI can be considered an association of associations of Engineering Education in Iberoamerica because its members are the associations of engineering education of each country in which it exists. It was created in November 7th, 1997 and the founder members were CONFEDI (Argentina), ABENGE (Brazil), ACOFI (Colombia), CONDEFI (Chile), ANFEI (Mexico), CONAFIP (Peru) and Núcleo de Decanos de Venezuela. Other institutions, not associations, became members from countries in which there isn't an association in Engineering Education, such as Universidad Politécnica de Madrid, Universidad de la Coruña (Spain), Universidad Nacional de Asunción (Paraguay), Universidad de la República (Uruguay) Universidad de Aveiro (Portugal) and Universidad Mayor de San Andrés (Bolivia). Since its creation, ASIBEI has continued receiving more members from the different countries of Iberoamerica.

Its institutional mission includes the following points:

- Promote and channel interchange and cooperation between engineering higher educational institutions.
- Encourage teaching engineering related knowledge search and generation.
- Promote engineering teaching and research excellence as well as the links to the productive and social environments.
- Strengthen the engineering curricula development.
- Sponsor and manage international degree recognition based on established minimum curricular standards.
- Promote analysis of engineering teaching evaluation systems to encourage self evaluations and accreditation processes in Ibero-America.

Given its Hispanic-American spirit, ASIBEI extends its influence over North America, South America and Europe, mainly Spain and Portugal, pursuing its purposes and objectives and encouraging the constitution of Engineering Education Associations in those countries where it does not exist at present.

Every two years ASIBEI organizes Ibero-American "encounters", in which topics of common interest in the formation, quality, research and other fundamental matters in the formation and education of the Ibero-American engineer are presented and discussed.

At present, ASIBEI is working in three strategic projects: Curricular guidelines, students and instructors mobility and defining the Ibero-American engineer. The latter one will be presented with the rest of initiatives in the section that follows.

ASIBEI Initiatives

Interested in promoting global engineering education in the Americas and understanding the importance of adopting and adapting successful practices in educating global engineers that have worked in other parts of the world, the consortium established a task force to identify specific areas in need of immediate attention in Latin America and the Caribbean to foster international collaboration and enhance the engineering education on this hemisphere. The first discovery and

recommendation of this working group was the necessity of establishing an accreditation system which provides quality assurance for the engineering programs. This accreditation process will guarantee the excellence in education, promoting the mutual recognition among the different engineering programs in the region and facilitating the student mobility. The next recommendation was to promote and facilitate international experiences, and education for the students to foster cultural awareness, promote diversity, and prepare the future engineers for the global economy. Another important program which is under consideration is the internships abroad so the students have the opportunity to work in a foreign country with a different language and cultural settings. This has been a very successful practice between institutions in the US and Europe[18-20] that can be duplicated on this hemisphere. The professional development of the faculty is another initiative identified by the group as a key factor to improve the engineering education and to develop a significant research agenda in the Latin American institutions. Being consistent with this proposal, the consortium started encouraging scholarship programs for professional development among their members.

Finally, it is also important to mention the Ibero-American engineer initiative. This engineer is defined as a professional of engineering with a solid technical and general cultural formation that without loosing the characteristics of their nationality and preserving their cultural and historical bases of their Iberian inheritance contributes to the solution of the problems of his or her local communities; however, these new engineers are also endowed with global competencies that allows them to work in multinational settings. They are also committed to act with social responsibility, sensibility and solidarity preserving the environment, and respecting ethical principles for the social development and economic growth of the nations.

The competencies that should characterize the Ibero-American Engineer, among others, are:

- Master the English Language, that is to say the language of science and technology, or a second language.
- Capacity to adapt in other countries.
- Communication abilities; Team work; creativity; entrepreneurship and innovation.
- Global, regional and national vision.
- Vocation service and social conscience

These areas identified by the task force have brought challenges but also many opportunities for the engineering institutions in the Americas. A big step has been taken to cooperate with other organizations to align efforts to reach the common goal of educating world-class engineers for the Americas.

In the next sections, key areas that need the collaboration of these associations are discussed.

Accreditation: A Key Factor

National engineering program accreditation agencies are not available in most of the Latin America and the Caribbean countries. This mechanism of quality assurance of the engineering programs is a key factor for improving the overall engineering education. As mentioned before, the Engineering for the Americas Symposium final report[6] calls for educational reforms at the regional level that include preparing the next generation of engineers with attributes certified by

transparent accreditation systems, which will further professional mobility, investments levels, and therefore economic development. Additionally, the recognition of accreditation systems in the region will create equivalence among the engineering programs which will allow students in the Americas to complete part of their degree, or the complete degree in another country and that degree will be recognized in the whole region facilitating the mobility of the students, professionals and researchers in the Americas. An excellent example of an effective program for mobility of students is the Socrates-Erasmus Program in Europe. This is the European Commission exchange program that allows students from 31 countries to complete part of their degree in another country of the community[21].

A well-structured accreditation system could allow the agencies from the different countries to sign the Washington Accord. As a signatory of the Washington Accord the engineering programs the system accredits would be attain international recognition and be deemed equivalent to the engineering programs of the institutions accredited by other Washington Accord signatories: ABET (US), CEAB (Canada), ECSA (South Africa), EC (UK), Engineers Australia (Australia), Engineers New Zealand (New Zealand), HKIE (Hong Kong), IES (Singapore), and JABEE (Japan)[22].

Due to the importance of the quality of engineering education and the mobility of students, researchers and professionals, accreditation has been a very important topic for discussion on different forums in the Engineering for the Americas, ASIBEI, and LACCEI and ISTEC. In the next sections, accreditation and program recognition initiatives involving Latin American and the Caribbean are discussed.

ISTEC's GRANA: Evaluation, Accreditation, and Certification

Since 2003, ISTEC has been working in the accreditation and certification area to produce a system that will facilitate its members to engage this process. The culmination of the research in the accreditation and certification is the GRANA Program. GRANA has trained over 60 evaluators in the Americas and assisted in the accreditation process of 4 institutions in Latin America. In addition, ISTEC has continued to enhance and establish capacity in the Region to help its members to improve their facilities with an outcome being accreditation.

The GRANA-ISTEC program is an international Evaluation, Accreditation and Certification effort for Educational Programs under the Advanced Continuing Education Initiative of ISTEC. The project was founded in the XV General Assembly of ISTEC. It has an Advisory Board comprised of Evaluators dedicated to the Quality of Education, comprised of members from the Organization of American States (OAS), Engineering for the Americas Initiative (EftA) and ISTEC.

What GRANA-ISTEC does: GRANA-ISTEC measure the quality of educational programs under academic models (in situ, distance learning or mixed), according to international quality standards and social pertinence, with a clear vision of the present necessities to encounter the complexity of globalization.

Why it is needed: The new global standards demand a greater competitiveness level in all the areas of science and technology.

- Prestige.
- Assurance in the quality of academic curriculum plans.
- Being accredited will allow the educative institution to be supported by international institutions and programs, as well as, potential incentives and awards.

How it does it:

- Forming experts that measure quality based on its indicators.
- Evaluating Educational Programs (EP) through an innovative mechanism.
- Accreditation of EPs that surpasses international quality expectations and facilitating its follow-up.

Vision: By means of international accreditation, it is desired to reduce the educational gap between Latin America and developed countries in terms of quality and technological development. Also, establishing quality standards for educational programs, creating learning communities, generating lines of R&D focused on giving solutions to common problems, and fostering sustainable entrepreneurship.

Mission of GRANA-ISTEC:

- That all institutions members and non-members of ISTEC providing educational programs for undergraduate, post-graduate, continuous education, accredit their programs as a continuous improvement of quality and elevated social pertinence, tied to the world-wide network of knowledge.
- Having a compatible educational model in all Latin America and as a way to strengthen the education-learning process according to current professional and competitive needs. At the same time, forming networks of knowledge, breaking cultural, ideological and geographic barriers.
- To achieve regional technological development allowing Latin America to compete internationally.

LACCEI's Engineering Education Capability Maturity Model, Accreditation Workshop and The Turabo Declaration

LACCEI has two accreditation efforts being undertaken by its Accreditation and Program Recognition Taskforce. One is the creation of a model that can be used to structure engineering program evaluation/accreditation process and assess the capability of the program. The model being developed is a five level model, called *Engineering Education Capability Maturity Model*[23] (EECMM). It maps the activities that need to be undertaken to achieve accreditation to the appropriate level of capability maturity of the engineering program. An engineering program that has reached level 3 could be regarded as producing *competent* engineers. While one that has reached level 5 has documented that it is producing *competitive* engineers.

The second effort LACCEI has undertaken related to accreditation is to provide a forum for the engineering institutions in Latin America and the Caribbean to discuss engineering program

accreditation and combine efforts. In 2006, during the 4th Latin American and Caribbean Conference for Engineering and Technology held in Puerto Rico, LACCEI organized an Organization of American States (OAS) co-sponsored the *Workshop on Accreditation for the Americas*: *Advancing Strategies for Achieving Quality Assurance in Latin America and Caribbean Engineering Education*. Fifty deans and Vice Rectors attended the 2006 workshop. The Director of the Office of Science and Technology of the OAS discussed the importance of Engineering to economic and social development. International and national engineering program accrediting agencies (ABET, CACEI, CEAB, and ECUK) presented their perspectives. A panel of representatives from Deans Councils from Colombia, Mexico, and Peru presented their challenges. The group separated into round tables to discuss strategies to advance the accreditation and quality assurance in this region, and the discussions were captured in a report.

The workshop report, called *The Turabo Declaration*[23], reveals that wholesale adoption of a foreign accreditation system, e.g., ABET, would not be appropriate for the countries in the region. Instead, best practices should be implemented, and differences rationalized. There is no consensus on what the best practices might be. Therefore, it was recommended to LACCEI to appoint a task force to study the following current practices:

1. There are national systems and nationally external ones.
2. There are optional systems, and mandatory ones.
3. There are systems that accredit institutions and others that accredit programs.
4. Some systems emphasize individual certification; others emphasize institutional improvement.
5. There is both developmental and punitive use of accreditation information; local laws often govern this.
6. There may be conflict between a local/national accrediting agency, and a regional/international one.
7. There is a possibility of resistance to foreign scrutiny.
8. There is consensus that accreditation should allow mobility. There are various mechanisms for this, including signatory status of the Washington Accord.
9. There are two alternatives for achieving global recognition:
    a. Develop a national/regional accreditation system, and then sign an accord,
    b. Adopt an existing accreditation system (e.g. British or American)
10. There is a possibility of incest in national accreditation systems, especially, in small countries.
11. There is a certain degree of difficulty in joining consortia such as the Washington Accord; even more so for individual countries.
12. Various groups need to be educated on these issues.

The report charged the task force to draft a first principles document (constitution) of a Latin American and Caribbean Engineering Accreditation Agency (LACEAA).

A second workshop is planned as part of the 5th International LACCEI Latin American and Caribbean Conference on Engineering and Technology in May 2007 to progress on this initiative, also co-sponsored by the OAS.

The next section describes different types of experiences that can contribute to developing a global engineer.

Global Educational Experiences

Through the consortium, many educational experiences have flourished and more need to be explored. The most significant experiences are:

Global Design Projects

In the 2nd LACCEI conference in 2004 in Miami, Florida, a group of professors from the U.S., Colombia and Brazil started discussing the need of collaboration in the area of teaching design through multinational design projects. In the 3rd LACCEI conference in 2005 Cartagena, Colombia, the effort of the first collaboration[24] emphasized the importance of global design projects in the engineering curriculum in Latin America and the Caribbean institutions. The global design projects collaboration started in Spring 2005 and by the end of 2006 more than 200 students from nine different universities in six countries (U.S., Brazil, Colombia, Peru, Honduras, and Dominican Republic) have participated in this initiative. The number of teams, campuses and countries that have participated are summarized in Table 1.

Table 1 Participation in the global design projects initiative

Period	No. of Teams	No. of Campuses	Countries
Spring 2005	18	4	U.S., Brazil, Colombia
Fall 2005	24	7	U.S., Colombia, Honduras, Peru
Spring 2006	10	4	U.S., Colombia, Dominican Republic
Fall 2006	13	5	U.S., Colombia, Peru, Dominican Republic

The multinational design projects were adopted by these institutions because it has been shown that they are one of the most effective ways to incorporate international experience in the curriculum[25-27]. This type of projects allows the students to work in diverse teams that are geographically dispersed while they are solving a real engineering problem. The multi-team projects are of short duration, running as part of a course that usually lasts for seven weeks. The project is assigned to the students in the different countries simultaneously. Pairs of collaboration are formed among the institutions participating so each team has a corresponding partner in a foreign institution. Participating students discuss the design methodology and the project at a local level first and then they are asked to discuss the problem and share information with their international partners to enrich the final solution of the problem using web conferencing tools and e-mail. Some of the students presented their design in poster sessions at the next LACCEI conference and requested that more of these types of projects be incorporated in the curriculum.

These projects have been introduced at an undergraduate level and mainly for freshman and sophomore students. This has been a very successful experience and more opportunities are under discussion for more advance collaboration at a senior and graduate level.

Dual Degree Programs

The European Commission, under the Erasmus Mundus[28] project, has approved a large number of Dual-Degree Masters in economically and strategically important areas of study. The programs are designed to permit a student to start studying in an institution in one country and conclude their studies in another institution in another country, and receive a degree from both institutions. Some programs permit a third institution to be involved. The degrees organize the program across as many as five institutions. The student is expected to learn more than one language, some require the student take the courses in the foreign language. There are ample scholarships for non-European citizens that offer $25,000 stipends and tuition. Faculty from other institutions can also participate in the program and receive a stipend to lecturer in the program. Non-European institutions can also participate in the program through agreements, and students in the Erasmus Mundus programs can spend part of their studies in those non-European institutions.

LACCEI has facilitated the successfully paired of US institutions with Latin American and Caribbean (LAC) institutions to homologate the courses in their engineering programs and construct Dual Degree programs for students in their institutions. These have been done in the undergraduate and graduate. Since most of the LAC engineering lasts for five years, many of these programs use a 3+2 or 4 +1 model, where the student attends the LAC program for 3 or 4 years and completes their last two or one (two semesters and a summer) year at a US institution and receives a B.S. degree from each. There are some successful cases in Industrial and Mechanical Engineering between universities in the state of Florida and Colombia. Dual degree programs are an example of mutual recognition processes.

ISTEC has been working with its membership to establish dual degree programs at the graduate level, Master's and Ph.D. This program not only benefits the students but helps establish joint R&D efforts among institutions and it brings a different perspective and opportunities for funding. We also encourage exchange programs at the undergraduate level. For instance, there is a successful program between the University of New Mexico Electrical and Computer Engineering Department and its peer at the State University of Campinas (UNICAMP), Campinas, Brazil. Other programs are being established in the Region.

Students Scholarships

LACCEI encourages its institutional members to set aside some scholarships for Latin American and Caribbean engineering students, and to advertise these in the LACCEI web site[15]. Many institutions also sign Memorandum of Understanding (MOU) that permit student exchanges, where the student spends a semester or two at another institution, but pays the tuition rate of their home institution. These exchanges need to achieve a balance of exchange, some allow balance to be achieved with internship experiences.

Faculty Development

Some LACCEI institutions offer special faculty development programs to LAC institutions. The LAC institutions identifies engineering faculty who they want to get their doctorate degrees. The

LAC institution pays their salary so the faculty can maintain their residence in their home countries. The host institution offering the Faculty Development program then pays the faculty an RA or TA stipend and tuition waivers for a year while the faculty completes most of the required courses, the PhD Qualifying Exam, and selects a thesis advisor and topic. The faculty then returns to their home institutions to do their research with a decreased teaching load until they complete their PhD. The home institution also pays for travel for the faculty and their advisor to meet periodically to advance the progress. This model emphasizes the selection of research topics that are important to the home institution, so that the home institutions helps support the faculty research environment. In other cases, the teacher continues in the LAC institutions and return to the country when he or she finishes the doctoral program. There are important experiences in this way with Colombian Universities. These faculty development programs are very important because in the majority of countries of Latin America there are not enough instructors with doctoral degrees and, therefore, not many Doctoral Programs. Obviously, this helps not only to improve teaching processes but also to strength research programs in Latin American universities; this is very important for the economic development and capacity building in these countries.

Opportunities

Most of the experiences discussed before are the foundation for many opportunities working with Latin America and the Caribbean. This is a region with great potential and excellent educational background that needs the attention and support of the developed countries, especially the natural neighbors on this hemisphere. The U.S. and Canada should start looking south and the Americas should be a unified block to be competitive in the new global market. Some of the opportunities are:

Multinational Projects

So far, just the undergraduate global design projects have been considered. There is room for more advance and challenging international projects that can be carried out among institutions in the Americas and they include:

1. *Capstone or senior design projects*: Integrated teams can be formed where a single multinational team solves the problem together. These are usually a semester or two semester long projects and might involve some traveling to meet with your partner in the foreign country. Contrary to the global design projects for freshman and sophomore, these projects demand a higher level of student and faculty commitment and some funding are required for the expenses involved on this. The best alternative is to have these projects supported by private industry. This is an excellent opportunity for the private sector to contribute in the formation of the world-class engineers.
    - *Village Empowerment: Peru Project*[29] is a University of Massachusetts at Lowell based project, part of the Senior Capstone Design course for Mechanical Engineers, that has been ongoing in the Peruvian Andes for many years under the direction of Prof. John Duffy.

2. *Research projects*: This kind of projects is very similar to the one described above except that this one is tailored for graduate level students. It could be funded by the private industry or the funding government agencies in the respective countries. This initiative also demands a very high commitment from the students and faculty involved. Usually there are two advisors, one on each country and the final result should be conducive to a thesis or dissertation for a graduate degree. Normally, theses projects last more than a year depending on the complexity of the problem and travel is required. So far, it has been considered the case of integrated teams where two members in different countries work together in a research project; however, under certain circumstances, it is possible to have an alternative case for this kind of project: a student from one country working a research project with a professor at a foreign institution. In this case, student must travel frequently and should have a co-advisor in his home institution working. Examples of these research experiences opportunities include:
   - National Science Foundation (NSF) Research Experiences for Undergraduates (REU) program. Some of the projects are organized as a dual international site project, e.g. the NSF REU in Automotive Technology[30], where 10 US undergraduates travel to the Technische Universitaet Darmstadt (TUD) in Germany and four students from abroad travel to Virginia Tech in Blacksburg, Virginia to participate in 10 weeks of automotive research during Summer 2007 and receive at least $3,000 plus free room, board, and travel.

3. *Service Learning Projects*: Service learning[31,32] by definition is the activity that combines the service objectives with the learning objectives. Therefore, a capstone project or a research project could also be a service learning project if it satisfies the conditions given in the definition. However, service learning projects might stand alone as short term projects, usually one semester long, where students team with partners at a foreign country with the purpose of finding a solution of a problem affecting the community. This is a frequent practice for students from developed countries working in communities in under-developed countries. Latin America has multiple problems that need immediate attention for the welfare of the local community. Therefore, it is a source of great number of opportunities for service learning. Most of these activities required a field trip and the funding usually comes from the authorities of the under-developed country or from the private industry. A common practice is to organize the field trip during the summer break. *The Michigan Journal of Community Service Learning*[33] is an academic journal that focuses on service learning experiences. There are several organizations that approve and help organize meaningful international service learning projects:

   - *Engineers Without Borders*[34] (EWB) or *Engineers without Frontiers* are non-governmental organizations in several countries that promote international development projects done with university students in collaboration with practicing engineers. Most of the projects are generally small scale grass-roots partnerships. Many have joined EWB – International: Australia, Belgium Cameroun, Denmark, Egypt, Germany, India, Kenya, Mexico, Nepal, Québec, Rwanda, Sweden, USA, and Southern Africa. Others have become provisional members: Argentina, Belgium, Chile, Congo, Colombia, Ecuador, Finland, Ghana, Greece, Iran, Ireland, Kosovo, Macedonia, Malawi, Nigeria, Pakistan, Palestine, Philippines, Portugal, Serra Leone, Singapore, South Africa, Sudan, Turkey,

and Uganda. Those that have not joined the EWB International include: Canada, Italy, Spain, and UK.

- *Engineers Without Borders Canada* focuses on marshalling the technical community to help address the developing world's needs, less on integrating international projects into the curriculum.
- *Engineers for a Sustainable World*[35] provides international projects for service-learning through student chapters in universities.
- *Engineering Projects in Community Service*[36,37] (EPICS) is a network of 15 universities that brings together undergraduate teams with local community organization and helps fund the technology transfer of design that can be useful if produced commercially.
- *Campus Compact*[38] is a national organization that promotes service learning in higher education. State compacts provide projects, training, and funding for students and faculty; and sponsor student conferences to share their community work experiences.
- *National Service Learning Clearinghouse*[39] is a National Information Clearinghouse provided by the Corporation for National and Community Service has environmental and educational projects and other resources for service learning.

4. *Internships*: There are several organizations that help plan a work experience abroad:
   - *International Association for the Exchange of Students for Technical Experience* (IAESTE)[40]. The Department of Education has several scholarship and programs to help fund U.S. students to study or work abroad.
   - *International Network of Engineering Education Research*[41] (INEER) has an International Student Internship Committee.
   - *Council of International Education Exchange*[42] (CIEE) have information on internships and international study abroad programs.

Final Remarks and Conclusions

It is evident that there is an urgency to educate the next generation engineers as creative thinkers and innovators capable of working in multi-disciplinary teams in a global context. Rapid changes in the global economy call for a change in the role of engineers in society and, as a result, in the engineering education. A new organization was formed in 2006, called IFEES – International Federation of Engineering Education Societies, and already has 31 member organizations, to try to collaborate and share resources and efforts to meet this need. There is an increasing perception of the need to educate competent engineers for the global market[2]; an engineer who must understand and accept diversity; be able to work in multi-national corporations; be able to work in multi-cultural teams; be creative in the solutions of problems impacting a wider and more diverse population; be able to communicate and socialize with people from different cultures; be knowledgeable in other languages; be able to use technology to exchange ideas, solve problems and present solutions; be a leader, an excellent team member, and an ambassador. Only, a strong commitment and collaboration among academia, government and industry, as suggested by the Engineering for the Americas initiative, may facilitate the formation of the global engineers.

All the organizations, institutions, governments and industries from this hemisphere should join and align efforts to promote and facilitate all the activities necessaries to prepare the engineers

for the worldwide market. There must be a continuous exchange of information and resources to maximize the implementation of the best practice and minimize the use and impact of weak practices. This joint effort implies changes in the foreign policy and the budget allocations of the governments, in the curriculum and teaching methodology, in research and development, and internship policies of industry, and the mental attitude of the students. It is clear that the changes have to be conciliated with the idiosyncrasy and culture of the individual countries.

Latin America and the Caribbean have understood the importance of engineering and technology as a driving force for economic growth. This is a region thirsty for knowledge, development, and peace, and it is also a region of opportunities, human resources, and challenges. Only through their combined network and resources, and a philosophy of action and collaboration, can organizations, such as LACCEI, ISTEC, ASIBEI and EfTA, successfully promote best practices, quality, innovation and research, and facilitate active collaboration among industry, the institutions, faculties and students, for the benefit of the local communities and the nations. This is critical to the economy of the Western Hemisphere

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