AGENDA 2001: Making International Engineering Education Work for Bi-National Economic Development

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Abstract

Present day communication and other technologies have enable us to build a variety of successful partnerships for international development. We have learned that institutions of higher learning both in the U.S. and Mexico do have more common issues and similarities in interests and goals than previously known. To make engineering education more global we must take advantage of new approaches and engineer ways to engage students and faculties in both countries in other than traditional forms of cooperation. And make government and industry part of these new models of cooperation.

There are organizations that are capable of energizing and promoting the development of new partnerships for international engineering education however some of these lack flexibility necessary for particular needs of individual institutions. Sponsors should recognize that the engineering education has particular needs and requirements and it is necessary to continue to shape and define new models for engineering schools.

As technology-driven world economies mature their own abilities to make engineering and technology work for the betterment of their health, environment, education and economy, the U.S. also benefits. Universities developing the next generation of international workforce can take center place to increase the potential of local markets.

Developing potentially new markets brings an influx of new capitals and sparks other innovative approaches to human resource development. Therefore it is possible to create opportunities in which students/faculty can learn processes as: systematic technology deployment, product realization, regional adaptation, environmental integration, business planning, patent and copyright protection and licensing among others that will shape a nation's world-wide competitiveness.

I. Introduction.

The present paper is aimed to promote, stimulate and broaden the dialog among engineering students, engineering faculty and university administrators to develop additional mechanisms through which U.S. universities can develop the next generation of international engineering workforce to increase the bi-national economic development in the American hemisphere.

II. Global vs. Bi-national Economic Development.

The global economic development is characterized by organized regional alliances such as:

a) Asia-Pacific Economic Cooperation - APEC-16 members (approximately 40% of global trade)
b) European Union EU-15 members
c) North American Market - NAFTA-3 members
d) Andean Group - AG-5 members
e) Association. of Southeast Asian Nations - ASEAN-6 members
f) Australia-New Zealand Closer Economic Relations pact - CER-2 members
g) Caribbean Community and Common Market - Caricom-15 members
h) Central American Common Market - CACM-5 members
i) Southern African Development Community - SADC-10 members
j) Southern Common Market - Mercosur-4 members

Among these alliances the first three, APEC, EU, and NAFTA take preeminence in the world economy and while their national, political and internal economic organizations are diverse, these groups are quite successful in managing their differences for the benefit of the group that they belong.

The influence of such alliances in the U.S. economy is easily demonstrated by the trade deficit between the U.S and APEC, the loss of almost half of the U.S. commercial satellite business to the Arianespace launch vehicle and the loss of market share in the Boeing commercial airplane business to AirBus Industries[1,2].

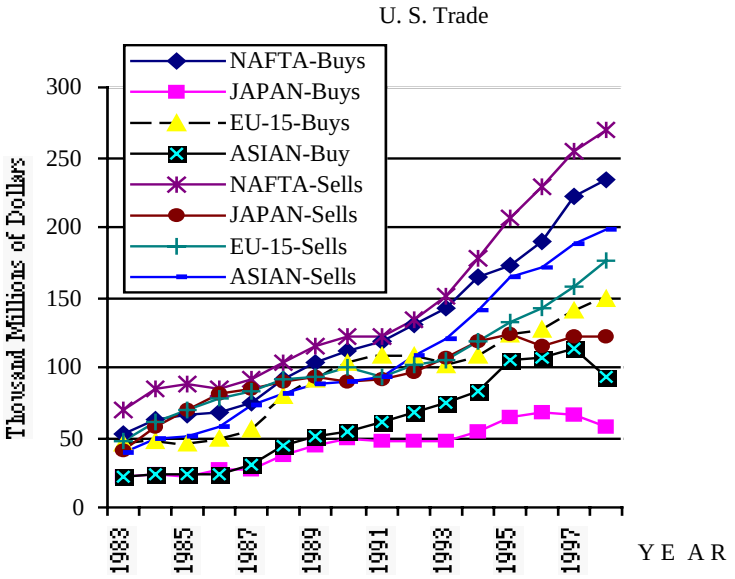

Figure 1. Global trade between the U.S. and major economic groups (O. of Trade & Analysis)

II.1 Bi-national Economic Development.

In the pre-global economic age, trade took place mainly among neighboring countries which frequently had border disputes and in some cases because of lack of trust and poor communications these problems often escalated into wars. The victor will then define the "rules" of economic exchange. Fortunately the emergence of new technologies, an explosion of the ways and quality of communications and renewed appreciation for political stability, has permanently change the "old ways" of bi-national economic development.

Nowadays it is recognized the powerful potential of regional world economic alliances. Therefore, it is required that swift and prompt re-alignments take place among nations for their own survival.

In the case of NAFTA, even though there are three countries involved, bi-national trade takes place between the U.S. and Mexico, the U.S. and Canada and between Canada and Mexico.

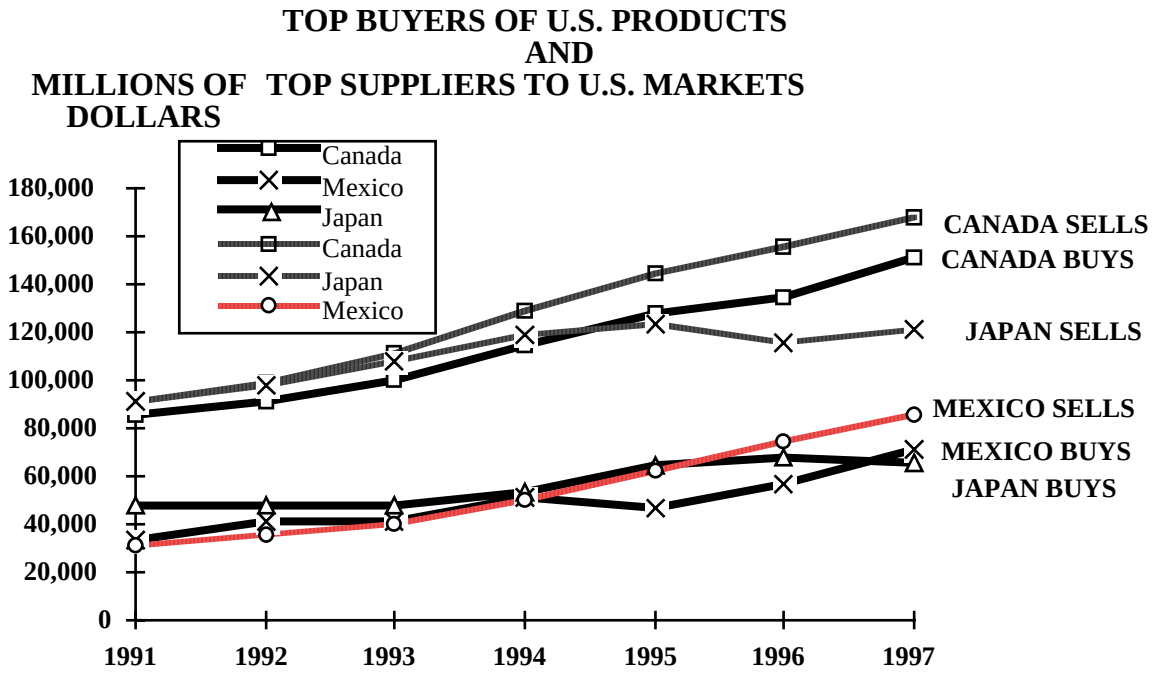

Fig. 2. Trade balances between Canada, Mexico and Japan with the U.S.

Figure 2 shows that there exists a "healthy" trade between Canada and Mexico with the U.S but in comparison there is a significant U. S. trade deficit with Japan.

The **re-alignment** among nations must occur simultaneously in more than one aspect. And international engineering education is one of those aspects that needs to be resolved. International engineering education must evolve and mature in the near term as part of a systemic plan for bi-national economic development. International engineering education

can not be placed out of the radar screen without risking increasing gaps on competencies in international communication, international teamwork and international manufacturing in the next generation of engineering graduates.

While before the 1990's international education has grown substantially in areas of business, culture, tourism, health and agricultural aspects among others; however that has not been the case for international engineering undergraduate education. The Commission on International Education of the American Council on Education[3] states: "Unless today's students develop the competence to function effectively in a global environment, they are unlikely to succeed in the 21st century".

The world we live in today is one of technology-driven world economies, and engineering has evolved to support multidisciplinary and multi-national production teams. Better characterization of environmental and global climate phenomena brings together scientist and engineers to develop solutions along bordering countries to improve the quality of air and water resources that they must share. Engineers and scientists from neighboring nations need to mature their own abilities to make engineering and technology work for the betterment of their coastal regions, their marine-life resources, their food production, transportation systems and increase the health of their population. As well as safeguarding the environment, and providing means to develop self-sustainable economies. As Canada and Mexico become stronger players in these areas, the U.S-Canada-Mexico partnership also benefits.

II. 2 Undergraduate Engineering Enrollment and the Economy.

It is quite instructive to reflect on the period from 1990 to 1995. During this time engineering undergraduate enrollment hit an impressive low nation wide. In this period U.S. exports had already experience a steady decline that began in 1988. (see chart below).

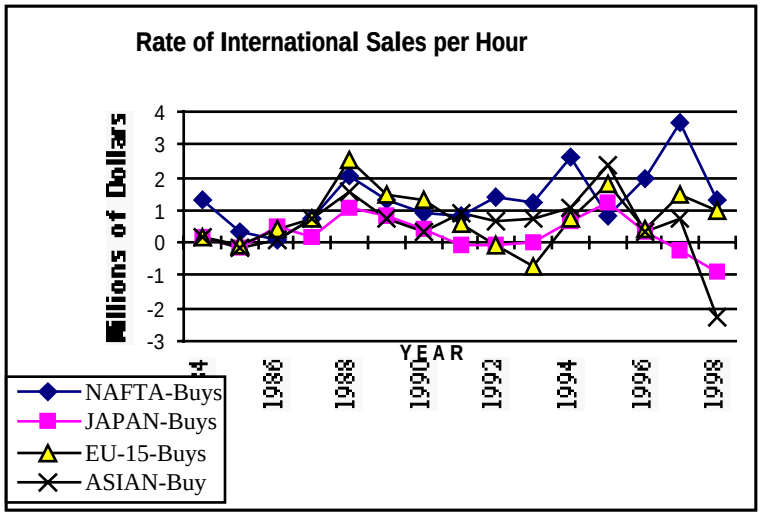

Figure 3. Rate of change in U.S. international sales per hour (Adapted from the Office of Trade & Analysis)

As a result of this period of decline, the U.S. government accelerated the comprehensive reduction on military programs and military base closings. U.S. industry also adjusted by merging, re-focusing on recovering international and national market share. As an example it can be noted that Martin Marietta acquired General Dynamics and later on merged with Lockheed. It was recently that the government opposed the merger of Lockheed Martin and Northrop Grumman.

Companies went pretty much into a hiring freeze until 1995 and some engineering schools started to build up their enrollment a little afterwards. However enrollment levels today are still below the 1987 – 1989 averages for a large number of schools except for selective engineering fields.

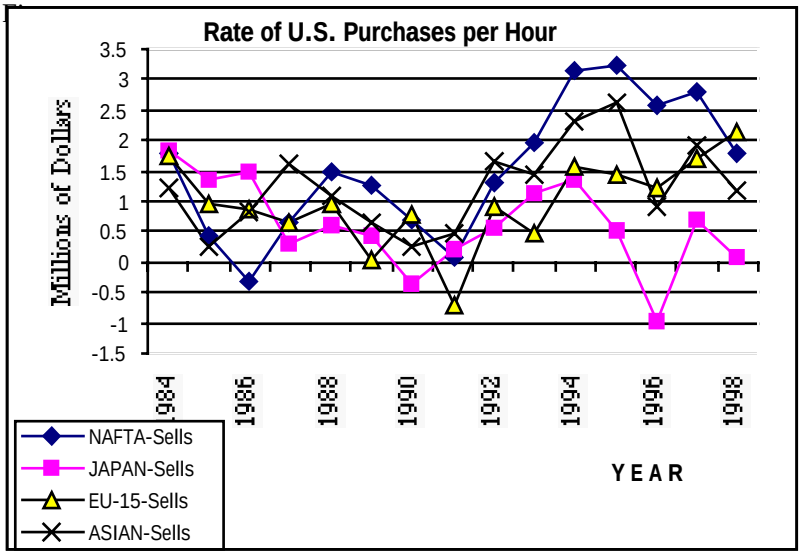

Figure 4. Rate of change in U.S. imports per hour. (Adapted from data of the Office of Trade and Analysis)

What represents a serious change in pace of the global economy should not be trivialized by just saying " It is a typical cycle. " It appears from fig. 3 that a new downturn has just began.

Figure 4 can be interpreted as the change in availability of U.S. purchasing power tied to the available supply of manufactured goods or services from major economic groups.

III. Opportunities for International Engineering Education. - A process of discovery -.

Universities developing the next generation of international workforce can take center place to increase the potential of local markets[4], especially if the faculty and administration maintains an open mind to identify non-obvious opportunities. Opportunities in international engineering education can be built-in as part of the overall re-alignment.

At the core of engineering education is the Product Realization Process, and learning it can

take place in various learning modes. The author favors "hands-on" project development. This mode is widely represented both in Canadian and Mexican institutions of higher learning. And therefore presents itself as a common ground through which engineering students from either Canada, Mexico and the U.S. can learn in teams. But some issues must be resolved beforehand.

First, a joint learning project must be a win-win for all. Students and faculty members from participating institutions must receive corresponding academic credit. To this effect, project development must be integral part of the undergraduate engineering program. Faculty members in consultation with, or sponsored by industry should determine if the nature of the project has the potential for economic development. If the nature of the project development is such that serves to build student's competencies and meets the learning objectives of an engineering subject.
Second, there is the need for the international connectivity, a match needs to be found. And this is where partnerships for development can be of utility for this search. It is important to understand a few things about the dynamics of international partnerships to make better use of them.

The present decade can be characterized as one of reconstruction and renewal regarding international education and partnerships for development. The Institute of International Education in 1993 published an inventory of academic linkages among institutions in Canada, Mexico and the U.S. [5] The report indicates that the linkages were programs of short duration and mainly driven by faculty members. While without institutional support and long term strategic goals these efforts helped to identify obstacles and potential approaches to re-structuring the linkages.

As the world economies had to re-structure to face the challenges of this decade, in the U.S. funding agencies for international development like US-AID also modified their policies to support programs via partnerships in which funding would be "matched" by the partnering organization. At the same time American Colleges and Universities have learned the hard way that there is no place for "business as usual" practices. In an effort to maintain quality programs with reduced budgets, universities have become more aggressive in harvesting support from private industry, centers and institutes have been created to attract research dollars, and some schools have cut programs, consolidated academic departments/divisions and/or merging programs. This situation has created a great deal of discomfort among the Academic Community who is being ask to re-define their University's mission and core competencies for the next millennium if they are to remain competitive.

To no-one's surprise international programs have received a very low priority in most instances. These internal reorganizations provide "re-allocation" of funds to high priority areas. Only a few U.S. universities have explored new ways to increase their revenues through international projects of cooperation/collaboration. And this situation has not been exclusive to U.S. institutions only; Mexican universities have followed a similar path.

Paradoxically while U.S. State funding for higher education, in general, has been reduced

for several years; the U.S. economy has never been better and the main source of revenue has come from expanded international trade, international joint-ventures and partnerships.

In February of 1995, the Association Liaison Office for University Cooperation (ALO) in collaboration with the Asociacion Nacional de Universidades e Institutos de Educacion Superior (ANUIES) organized a conference in Mexico City to evaluate and revise linking activities between higher education-private sector linkages in the USA and Mexico. Through this re-discovery process it proved that our institutions of higher learning both in the U.S. and Mexico do have more common issues, interest and goals than previously known.[6] The meeting provided a forum to showcase a total of 118 cases of collaboration from which 88 cases were presented by Mexican institutions and 30 were presented by U.S. institutions.

It became apparent that to make engineering education (undergraduate and graduate) more global we must take advantage of new approaches and engineer ways to engage students and faculties in both countries in other than traditional forms of cooperation. And make government and industry be part of these new models of cooperation.

III.2 Resources and Strategic Efforts to Revitalize International Collaboration; ALO-ANUIES, WICHE/AMPEI - ELNet, and the US – Mexico Gulf Accord.

ALO-ANUIES
As an agreement from the ALO-ANUIES 1995 conference, ALO secured funding from USAID to support innovative partnerships among U.S. and Mexican institutions in a "Partners in Development Program". The awards recipients were: West Virginia University, Montana State University, California Polytechnic State University SLO, Ohio State University , Purdue University, Maricopa Community Colleges , Universidad Autonoma de Baja California , Universidad Autonoma de Baja California Sur, Universidad de Guanajuato, ITESM - Monterrey, Instituto Tecnologico de Culiacan and Colegio de Postgraduados en Ciecias Agricolas. (see details at: http://www.cemr.wvu.edu/~wwwalo/partners.html)

ALO-USAID
In 1998 with the theme: Building International Workforce Development Partnerships; USAID and ALO and the American Association of Community Colleges (AACC) is presently supporting 14 partnerships between U.S. colleges and higher education institutions in America and overseas. With cooperation from their business and industry partners ALO-USAID share the goal of "strengthening the capacities of cooperating country institutions to provide relevant "in-demand" marketable skills to the unemployed or under-employed in USAID-assisted countries". (see details at: http://www.aascu.org/alo)

EL Net
The Western Interstate Commission for Higher Education (WICHE) and the Mexican Association for International education (AMPEI), the Universities of Baja California and Arizona developed in 1995 the Educational Leadership Network (EL Net) with the objective of supporting university administrators, policymakers and corporate sector leaders in tri-national educational initiatives in the western United States, Mexico and Canada.

EL NET is a broadcasting and networking tool for higher education collaboration in North America. EL NET is developed and maintained by the Consortium for North American Higher Education Collaboration (CONAHEC). (details at: http://www.wiche.edu/).

GULF OF MEXICO GOVERNOR'S ACCORD

The Gulf of Mexico Governor's Accord is an agreement between the Presidents of Mexico and the U.S. to develop programs and plans of mutual interest to the states bordering the Gulf of Mexico. As per the previous Gulf Agenda it states that:

The Gulf Governor's Accord has identified six working groups to develop programs and activities in compliance with the agreement signed in May 1995 at Campeche, Mexico. The driving force of this initiative is to increase trade and improve the quality of life of about 50 million people who live in the eleven states located in the Gulf of Mexico Basin.

State governments, private enterprises, educational institutions, and non government agencies involved in this effort have made clear that communities' socio-economic development, modernization of infrastructure, and cultural and scientific enrichment are essential components of a long term cooperation.

The Gulf Governor's Accord recognizes the cultural and economic potential of the region and intends to expand its perspectives by creating enhanced opportunities for joint collaboration in reciprocally beneficial ventures. The six areas identified for cooperation are: Trade, Investment and Finance; Communication, Transport and Infrastructure; Health, Ecology and Environment; Agriculture, Forestry and Fisheries; Tourism; and Education and Culture.

During this period (1995-1998), the Education Committee has met on three occasions. The first time in Campeche, Mexico with representatives from the eleven states. A follow-up meeting of the Conference was held in Daytona Beach, in September 1995. At this session, over 70 representatives from Gulf states. The Second Education Conference was held in Mobile, Alabama (May, 1996), during the Governors' Accord meeting, the four areas of collaboration were approved by the governors, and the InterGulf program was established to promote exchanges of faculty, students and cultural groups.

The Third Education Committee Meeting was held in Cancun, Quintana Roo (September 1997). Over 20 Mexican institutions, 12 US representatives and one Canadian institution participated. Following presentations, four cooperative agreements were signed.

The Gulf of Mexico Governor's Accord although being a presidential agreement it has not received specific funding to operate however its members have created programs of collaboration that provide additional opportunities for international engineering education.

IV. Making International Engineering Education Work.

To make international education a reality in the U.S. a few internal issues have to be resolved as it was pointed in section III. And there are other issues that are consider external or from accrediting bodies.

Among the different obstacles cited for implementing a fluid and transparent exchange of engineering students between Canadian, Mexican and U.S institutions is that of equivalencies of courses and the uncertainty of accreditation standards among the three countries. In this regard it is of great help the recent (1997) document entitled "North American Engineering Exchange Guide: The guide describes, probably, as a first attempt to find parallelisms among the three educational systems in regard to accreditation, quality assurance and characteristics of academic programs. It lists more than 100 curricular charts for the programs in the three countries as well as contact persons. The North American guide is a subset of a more comprehensive document entitled: "International Perspectives: Engineering Education in North America, Europe, and The Asia/Pacific Region.[7]

The aforementioned document makes readily available information that has been difficult to obtain in the past and facilitates its understanding since it provides the English translations from Spanish and French languages. The topics discussed can serve for an initial, more rational discussion on engineering course contents, learning objectives and evaluation of educational outcomes.

The efforts listed above provide the tools to make international engineering education work for those universities that can envision the advantages and those institutions that are willing to innovate to build other successful partnerships for international engineering education for bi-national economic development.

V. Engineering is about competent analysis, design, simulation, experimentation, evaluation and use of approximations (computational methods) in the product realization process.

To make international engineering education work we need to try it. As long as international engineering initiatives are misunderstood it will become difficult to sponsor, promote and develop students and faculty to work in international joint projects in applied engineering or applied science.

In comparison with the educational exchanges among the European Union nations and the Asian-Pacific countries for the most part international engineering education is an uncharted domain in the U.S. Government organizations and foundations need to contribute both intellectually and with resources and support North American innovative educational endeavors so that U.S. faculty and students can participate in the solution of multidisciplinary and multinational technical issues derived from joint ventures for new value-added products and processes and increase quality, reliability and safety factors that can help keep North American products competitive in the global market.

It becomes very important to seek and develop local avenues for hands-on education with international relevance. These international skills need to be developed by US graduates so that they do not become the exclusive domain of overseas institutions of higher learning.

V.1 The Cal Poly and Technological Institute of Culiacan Experience. - Case Study on Building of a Partnership -

The author, with the assistance of Dr. Joe Montecalvo (1993-1996), worked on the establishment of an international virtual organization in México aiming to expand opportunities for faculty and students of both institutions to promote engineering international education. The mechanisms proposed involved projects that will result in international technology transfer process for bi-national economic development. From these efforts, the "North American TEAMING" Initiative evolved. The Initiative for Technological and Educational Advancements in México for Innovation and Needed Growth (TEAMING) was a Cal Poly's internal initiative that helped to organize Symposiums, Institutional agreements of Cooperation (Cal Poly - SEP 1994 agreement) through which the American institution can be connected to more than ninety four year polytechnic schools of the National Directorate of Technological Institutes (DGIT).

To facilitate international activities, TEAMING also proposed the design of a Center for Technological Innovation (CTI), as a joint project with ITC, the Sinaloa Sciences Center (SSC), industry associates (CANACINTRA-Culiacán), and the city government of Culiacan, Sinaloa, México,
In July 10, 1996, the Center for Technological Innovation of the Pacific was officially registered and recognized by both the government of Sinaloa and the Mexican Ministry of Foreign Relations (SRE).
This project has demonstrated how U.S. and Mexican Universities can be in the forefront of innovation and world-wide development through cooperation.

Although; CTI can facilitate of U.S. and Mexican associate scholars and industry partners to come together to engage in grant seeking proposals and project development in areas such as:

a) Education and education technology with an international interdisciplinary focus.
b) Applied Technology Transfer Adaptation and Development for: food processing, manufacturing, value-added technologies and enviro-tech self-sustainable projects.
c) Economic development, assessment and research on applied strategies to expand market share of participating industry partners.
d) Supporting, developing, operating in site demonstrating technologies for business.

VI. Conclusion

We have learned that institutions of higher learning both in the U.S. and Mexico do have more common issues, interest and goals than previously known.

To make engineering education more global we must take advantage of new approaches and engineer ways to engage students and faculties in both countries in other than traditional forms of cooperative learning. And learn how to make government and industry part of these new models of cooperation. (review success stories from partnerships described earlier).

While a good number of successful partnerships among US and Mexican universities exists and international projects take shape in the western states, in the central states, and in the Gulf states there is not a consistent and coherent national engineering agenda for international engineering education in the short term. The author recommends working towards articulating an agenda for the year 2001 in which bi-national economic development is an integral part.

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