An International Industrial Outreach Program in Engineering Education: The Cultural Impact

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ABSTRACT

There is more to engineering education than science and technology; there is more that is beyond the textbooks, the classrooms and the laboratories; there is more that relates to the cultures of the professional worlds in which graduates aim to work. It relates to the gap between the competitive professional world and the protective world of academia, something that has to do with the human dimension, the cultural baggage and with the need for lifelong learning skills required to maintain competitiveness in all fronts.

For the past six years, a program developed by West Virginia University in collaboration with universities and industry from Queretaro, Mexico has been addressing many of issues cited above in the context of an experiential exercise. Each year, the program takes place during six weeks of the summer session, in which students and faculty from West Virginia travel to Mexico to join a similar team of Mexican students, faculty plus industrial liaisons to work as a team, despite language and cultural differences. A challenging industrial project (or problem) is posed to each team with a tight schedule and under budgetary constraints.

The pressure of reaching the objectives on time, the biicultural environment and the team-mentality philosophy of the program bring the cultural differences and personalities of the participants to the forefront. The experience is as much an engineering educational experience, as it is a cultural immersion as well as a "self-discovery" journey for all involved. A fundamental premise for this program is that all involved draw a benefit from this activity. This experience has brought forward not only the practical engineering dimension (from industry), but also the human dimension that comes with the individual participants.

The educational implications of this Program are indeed far reaching. The West Virginia/Queretaro experience is a "customer-supplier" model between academia and industry, which can be expanded and replicated in other areas of professional endeavor in a shrinking global and competitive professional context.

INTRODUCTION

It has been acknowledged that academia and industry in general possess very different cultures. Academia is by nature conservative, traditionalist and individualistic, while industry is progressive,

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adaptive and emphasizes "team work". Another difference is the way success is measured in academia in contrast with that in industry. In academia for example, most measures of success are individual, for example, GPA (grade point average), publications, awards, research funding and teaching evaluations are all examples of measures of individual achievement. In contrast, industry has other measures such as leadership, salesmanship, the ability to contribute to a team effort and ultimately, the ability to get the right things done at the right time and within budget.

Leaders from Industry have expressed concerns about the deficiencies of engineering graduates, citing specifically the following traits [1]:

- Communication skills,
- Ability to work in teams,
- Ability to accept ambiguity comfortably,
- Ability to work with people form diverse backgrounds,
- Appreciation of globalization and its implications, and
- Adequate ethics training

It is no accident that these issues, among others, are also addressed by the ABET Engineering Criteria [2]. What is not so obvious, is that both academia and industry share the responsibility, the challenge and the opportunity of producing top quality in one of the most important "agents of change" in today's world; the engineering graduate. And the key incentive is competitiveness with social conscience.

On the other hand, to bring the international and multicultural dimension to engineering education is easier said than done. One reason is the fact that most engineering curricula are quite intense and there seems to be little time left to address globalization issues, trans-cultural communication or leadership traits in engineering education. All this while industry is fully engaged in a global economy, facing very tough competition throughout the world. Yet, the "School-Industry" relationship, despite its acknowledged importance, continues to be weak.

The challenge comes at a time in which globalization trends demand innovative approaches to new and traditional technological needs as discussed by Jones [3]. One such challenge is producing graduates that can perform effectively and comfortably in international engineering scenarios; being able to communicate, to understand, and most important, to anticipate situations to make a difference in their professional environment [4]. Problems of technology development, trade, technology transfer and technology adaptation in North America and the world, are very closely related to the above-mentioned challenges of Engineering Education.

Being aware of the aforementioned issues, West Virginia University (WVU) and Queretaro's Council for Science and Technology (CONCyTEQ) in Mexico have developed a program, which is the object of this document. The program seeks to bring the international and industrial dimension to upper undergraduate engineering levels in a multidisciplinary and multicultural environment. Specifically this program seeks the following:

- A pilot program at the upper undergraduate and graduate engineering levels, to provide industrial exposure to students in an international and multicultural professional setting.
- This program seeks to bring the technology development research experience into the

classroom, with the added techno-cultural element of "intermixed" groups of students and "team teaching" of engineering and cluster courses.

- The program being proposed involves student/faculty reciprocal visits between participating institutions to conduct academic and industrial exercises.
- This program seeks to bring, students, faculty and industrial practitioners together in meaningful engineering exercises, in which the common link is the professional discipline.
- The initiative seeks to bring the international and industrial dimension to engineering education in a multidisciplinary and multicultural environment.
- This initiative seeks to provide students a closer look at international industrial corporate dynamics, and simultaneously, to provide multinational corporations with prospective employees with a better understanding of international engineering operations.
- This initiative seeks the complementary participation of Industry, of Universities and International funding agencies to support the activities herein described.

The objectives of this initiative and program are consistent with the mission of the institutions involved and with the international outreach strategies of the Consortium members. Specifically, the objectives can be put forward as follows.

OBJECTIVES

The overall objective of this program is to bring the international dimension to engineering education, in order to respond to the demands in industry, at a time in which globalization issues are more than a trend. It is felt that engineers can provide a better service to society and their profession, by understanding their role in the context of a global economy and trade partnership. Specifically the objectives are as followed:

- To add value to the education of engineering graduates (above and beyond the good quality education they obtain in their respective programs). This can be achieved by providing meaningful exposure to industrial practices and techno-cultural idiosyncrasies in an international context.
- To improve employment opportunities for engineering graduates. Students that participate in this program will have international technical experience and the opportunity to establish a relationship with Multinational Corporations.\
- To expand WVU and UG horizons at both, national and the international levels by attracting students to this program and by providing meaningful, innovative and exciting opportunities in the professional field.
- To get academia (faculty, research associates and students) closer to industry, and to explore technology development opportunities in collaboration with international institutions.
- To attract opportunities for funded research and funded technology development programs in collaboration with industry from the USA and Abroad.
- To provide industry and other potential employers an opportunity to recruit students with international and industrial experience.
- To provide Industry and its practitioners with an opportunity of bringing meaningful and practical elements to the engineering curricula in academe. Also to provide them with a

mechanism to further expand their professional development.
- To join strengths and talents (academia and industry) to seek opportunities for technology development, technology transfer and technology adaptation.

PROJECT DESCRIPTION

This program is directed at students, faculty and industrial practitioners in the USA, and Mexico, to collaborate in engineering education curricula program and in technology development and technology transfer exercises, through intermixed (inter-institutional) student teaming for curriculum course work and industrial practicum projects.

The Program brings together students, faculty and industrial practitioners from two countries, to team up and conduct intermixed course work, via reciprocal term-long visits. In these visits students are teamed up in small intermixed groups, and taken to industrial sites, in the region of the host institution with the main purpose of conducting industrial projects under the guidance of faculty (from the visiting and host institutions) and industrial liaisons as monitors.

Industry representatives present to each student team, a project outlining technical issues of a problem to solve. The host institution and industry provide the means for the student/faculty teams to formulate and develop a work plan leading to conclusive results and recommendations. Students and faculty are required to work together (thereby getting exposed to each other's cultural work idiosyncrasies) in order to submit a report and make a professional presentation to the industrial sponsors on the findings for each project.

Students will pay tuition fees and get credit at their home institution. The home institution instructor is responsible for grading. The courses offered to students are developed and shared by faculty of the two institutions. Industrial participants have access to data and material produced in the industrial projects, and also to some of the facilities (labs and computers) of the universities involved, through the project teams.

COURSES OFFERED

For WVU students, the main course offered in this program is a Senior Design course, which can be take as a technical elective by students who have fulfilled that requirement. For Mexican students, the course activity is taken as the requirements to fulfill the Practicum Experience requirements of their academic programs.

In addition to the main course offered in this program, students are eligible to take other courses offered at the host institution during the stay, using the standard procedures for credit transfer between institutions. This would be the case for courses in languages, arts and social sciences. Reciprocal visits of Mexican students to WVU are planned, in which a similar exercise is conducted by intermixed teams, working with industries of the region.

Fig. 1 below illustrates how the industrial projects can be conducted in parallel, while

students have the opportunity of taking cluster courses in the host institution, during the 6 weeks of the stay abroad. In general, the WVU delegation travels to Queretaro to join the local delegation comprised of students and at least a faculty member from one of the participating institutions. The student teams are formed and designated to the various projects set forth fopr the program. After introductory industrial visits, student teams work in parallel. Once a week (on Fridays), each team shares a brief progress report with the other teams as a rehearsal preparation for the final presentation. Students are encouraged to use the "other language" as much as possible in the presentations.

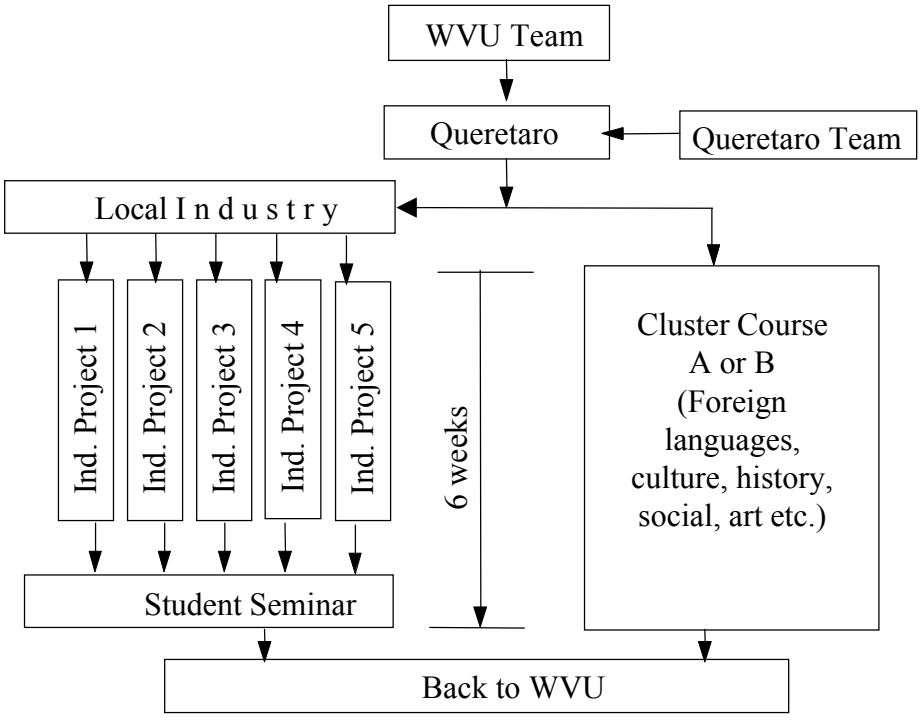

Fig. 1. Program activity during six weeks in the Summer in Queretaro

The number of projects in industry obviously varied depending on the number of participants, but ideally, four students (two from WVU and two from Mexico) participate in each industrial project. Participant students spend an average of 30 hrs/week in industry, working on their projects, which leaves them the opportunity for cultural activities (in most cases in social gatherings with their fellow Mexican team members).

INDUSTRIAL PROJECTS

In this program, it is intended that the industrial projects involve industries that maintain some technical relation (commercial, corporate) with companies in the USA, and the project will deal with some aspects related to technology adaptation, transfer, and development. Engineering projects that involve trade issues and/or language adaptation are ideal in terms of exposing students first hand to globalization in engineering.

The projects being sought currently involve the application of advanced computer aided design technologies for the modeling, analysis and design of mechanical and/or structural systems. The current student advisors (instructors of the course) have had experience in CAD/CAM instruction and actual application of these tools. However, other areas are envisioned in the future. Each project may potentially produce a "case study" that can be used to illustrate engineering issues and their relation with CAD/CAM functions. Figure. 2, below illustrates a typical team comprised of Mexican and American students, engineers from industry always working with the liaisons of with instructors of the course.

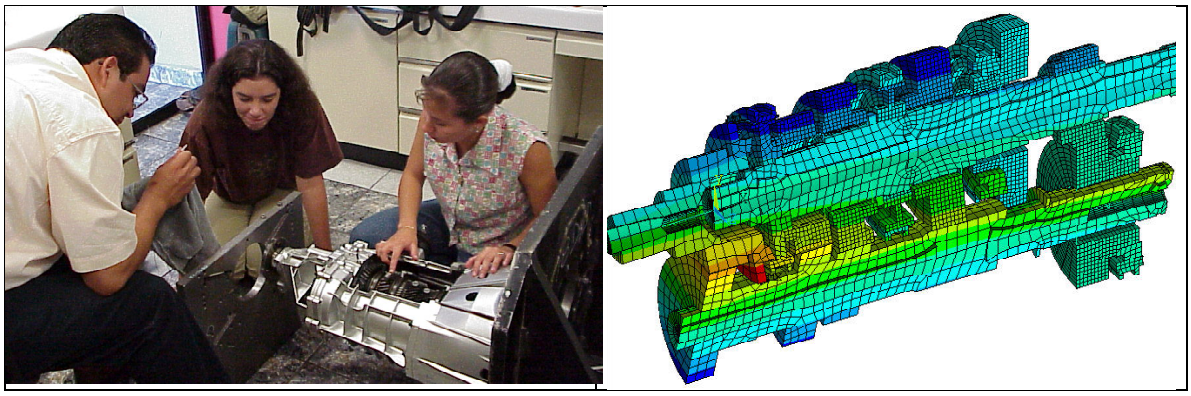

Fig. 2. Students from WVU and Mexico with engineers from industry, conducting vibration experiments and finite element models of vehicle transmissions

There is something to be said about acquiring an appreciation for another culture and discipline by just being "exposed" to it. But nothing compares to having the "need to get the job done", in order to gain a better understanding of the different approaches to similar objectives in two different environments.

LESSONS LEARNED

To share the experience gained in the summer of 2001, some comments and perspectives from participating students are in order. The following are several comments by students upon completion of the program, taken from Ref.[3]

- *"We all had great opportunities to learn a lot about industry, people, culture and also about OURSELVES. For example, we were treated as "family members" by our host families, who really took good care of us. We also made a lot of friends with Mexican students, who were always friendly and helpful. We also learned that Mexican Professors are highly regarded and are to be shown respect by students. I guess we are a little bit more casual here in America. Industry people were quite open and friendly, and at the end, they seemed to be very happy with our work".*

- *"We found that with a little work on our part, we could get around Mexico and we could get across in most situations, despite the language and cultural barriers".*

- *"An important realization, is that we know (because we've done it), that we can*

perform professionally in a different cultural setting and that WE CAN DELIVER !".

- *"We also learned what a great University WVU is. We are grateful to WVU for giving us this opportunity and we highly recommend this type of experience to every student at WVU".*

From the perspective of the faculty, two benefits can be brought forward, one is the "closeness" to students developed through the program, the second one is the "closeness" to industry, which in turn trickles down into better class-room communications and richer illustrative engineering examples. As pointed out by Prof. Ollis et.al. [4], this program addresses several of the important outcomes of the ABET 2000 criteria and has provided the academic units of the participating institutions with valuable insight into practical alternate ways to integrate these issues in the curriculum.

Finally from the industrial perspective, the main benefits are yet to be realized in terms of long-term impact of this program, which include a larger pool of graduates with international bicultural experience in the professional context and excess to expertise from faculty researchers. But the short-term benefits to industry include first and foremost the results of the projects conducted by students, as well as the networking that results naturally from the contact with students and faculty members from other institutions and country.

In a prior paper by the authors about this program [5], various project descriptions were provided, which are too numerous to include here. The table below summarizes the total number of participants, projects and institutions involved in the past 6 years in Guanajuato, Queretaro and West Virginia.

Institutions Involved	Participant students	Faculty from both countries	Industrial Liaisons	Industries/Research Centers	Projects developed
· **West Virginia University** · **University of Guanajuato** · **University of Queretaro** · **Institute of Technology of Queretaro** · **CONCyTEQ**	· **35 (WVU)** · **10 (UG)** · **15 (UAQ)** · **13 (ITQ)**	· **3 (WVU)** · **2 (UG)** · **2 (UAQ)** · **1(ITQ)**	**(2) GM (Gto)** **(4) TREMEC (Qro)** **(2) Transm-TSP (Qro)** **(1) Micro-Troq. (Qro)** **(2) IMT (Qro)** **(2) LAPEM (Gto)** **(2) I. TurboReact. (Qro)** **(1) Terramite (WV)** **(2) KOSA** **(2) New Holland**	· **GM** · **TREMEC** · **Transm-TSP** · **Micro-Troquelados** · **IMT*** · **LAPEM*** · **I. TurboReact.** · **Terramite Corp.**** · **New Holland** · **KOSA** *** Research Centers** **** From West Virginia**	**(1) GM Mexico** **(5) TREMEC** **(3) SPICER-TSP** **(1) Micro-Troq.** **(3) IMT** **(2) LAPEM** **(1) I. TurboReactors** **(1) Terramite Corp.**** **(2) KOSA** **(2) New Holland** **** From West Virginia**
5 Institutions	73 Students	8 Faculty	20 Liaisons	10 Companies	21 Projects

Six-year summary table of people, companies and projects developed in this Program.

CONCLUSIONS

Internationalization of engineering curriculum has become a necessity, and while it is important to identify the reasons why it should be done, to provide answers to the how to do it is at the very heart of the challenge of bringing the international dimension to engineering education.

In this paper, a concept that has been in operation for 6 years is put forward, to provide an example of how the international dimension is being brought to the engineering curricula in various institutions of Mexico and the USA, with a minimum of curricular changes. As a matter of fact, these can be viewed more as curricular adaptations rather than changes.

While this program initially targets mechanical and industrial engineering students, it is quite likely that this program will expand to other areas of interest such as robotics, machine tools, electronics etc. Most importantly, this program may possibly expand to involve other universities in Mexico and later on in Canada as well.

This Program is unique. It pursues the main objective of adding value to engineering education through an industrial exercise in an international setting. The program addresses issues that range from communication skills and cultural differences to human relations in the context of a practical engineering project. This experience has brought forward not only the practical engineering dimension (from industry), but also the human dimension that comes with the territory.

Indeed, cultural differences actually exist. They come forward when people disagree, when people negotiate, when people reach agreements, in the concept of "value" as well as in attitudes toward life. But being able to understand and better yet, anticipate cultural differences may be the difference between failure and success in professional situations in today's industry. Ultimately, the success of the program will depend on the difference that this program will make on the students and the industrial participants, as this program is meant to add value to the professional profile of all of those involved.

In an increasingly globalized professional environment, we are doing our share to meet the challenge. And now the new challenge is to carry on.

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