Educating International Engineers….
A Midwestern US University Experience

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Abstract

Since its inauguration in 1991, Milwaukee School of Engineering has annually offered a summer "short course" on engineering and engineering management practices to selected European and Asian engineering students. This program is sponsored by Rockwell Automation, a major business unit of Rockwell, International and is conducted in collaboration Czech Technical University, in Prague, Czech Republic. The 1998 program included 47 participants from sixteen universities located in eight different countries.

This paper describes the curricular content of the program and its development from the initial 1991 offering limited to Czech and Slovak students. Special note is made of the unique "live" industry sponsored multinational team engineering project which has become the cornerstone of the program and which presents some interesting challenges not unlike those encountered in similar situations in industry.

The paper concludes with some comparisons of this industry sponsored "short course" to the more conventional international exchange programs also offered by Milwaukee School of Engineering

Background…initial program

In 1991, representatives of Rockwell Automation (then better known as Allen-Bradley) approached MSOE with a challenge: develop a summer engineering program which would be attractive to graduate level Eastern European engineering students; specifically for engineering students in what was then Czechoslovakia The program was to be used as a way to bring "the best and brightest" engineering students to the US and to Rockwell, anticipating a kind of "internship" relationship in which the students learn about the host company while the company has an opportunity to observe the participants. Participants were to be selected on the basis of their command of the English language and being enrolled in a field of study relevant to the work of Allen-Bradley (Rockwell)….this generally meant the students were majoring in computer or electrical engineering.

Rockwell was not the only participant interested in internationalization, however. At that same time, Milwaukee School of Engineering was recognizing that the successful engineering graduate needed an awareness of the global community in which he or she would inevitably practice the profession of engineering. The approximately 90 year history of active collaboration between MSOE and Allen-Bradley was to take an international turn.

A program was designed based upon the following basic principles:

> the visiting engineering students were already quite technically sound
>
> these eastern bloc students were not well versed in topics such as engineering economic evaluation, financial analysis, product costing, marketing, finance
>
> coming from analytically oriented institutions, the students would benefit from some exposure to key manufacturing technologies and techniques
>
> an integral part of the program would be familiarization of the students with Allen-Bradley products, services, and manufacturing processes
>
> in addition to technical and business subjects, the students should be exposed to American cultural activities
>
> in order to pull these multiple "soft" engineering topics together, some sort of "capstone" project should be incorporated into the program

Based upon these principles, a program was proposed and ultimately approved by Rockwell (Allen-Bradley). In summer of 1991, 24 visitors (including three faculty from Czech Technical University) participated in the first program, fully funded by Rockwell. Various MSOE faculty, typically selected from the electrical engineering and school of business graduate program , conducted the four week program. Some lectures and facility tours were conducted at local Rockwell facilities by their personnel. Students were housed in the MSOE dorms. Topics were offered in two or three hour blocks, some requiring two or three blocks; the project was the development of a business/manufacturing plan for a hypothetical product. For the project, students were divided into small teams of five or six, with the faculty dispersed amongst the teams. Team leaders were invariably selected on the basis of their command of the English language as the teams were required to make an oral presentation to MSOE faculty as well as submit a written report.

Modifications….Program Evolution

In a review of the first year's program, including written evaluations by all participants, the following conclusions were reached:

> participants found the technical presentations challenging, worthwhile and complementary to their courses of study
>
> students were challenged by the "soft" engineering topic and eager to learn more
>
> students were not very comfortable in working in teams, much preferring individual work
>
> students were especially uncomfortable with the open-ended nature of the project…they much preferred to work on specific, well-defined assignments; in some cases complaining that information was deliberately withheld

the sponsor was quite pleased with the initial offering, especially in light of the fact that almost all student participants were expected to be employed by Rockwell-affiliated organizations (subsequent investigation confirmed this expectation)

MSOE was also quite pleased as participating faculty found the visiting students and faculty quite stimulating and the sharing of their respective cultures and teaching methods enriching

MSOE students that were involved as program aides expressed deep interest in learning more about European culture

faculty, both MSOE and CTU, felt that the project was not sufficiently challenging, that the students perceived it as artificial and unrealistic and therefore did not expend maximum effort

In light of this review, and influenced by the assignment to the program of a new academic coordinator (the author), a modified program was proposed for the following year. Key modifications to the initial program included:

utilization of a "live" Rockwell project with a dedicated corporate sponsoring group and the requirement that the projects results be presented to the sponsoring technical group and appropriate management personnel

addition of interactive sessions on subjects of creativity and innovation…especially focusing attention on the value of deferred judgement, and both individual and group ideation techniques

increased attention on developing an understanding of group dynamics and team behavior…including the use of group behavior assessment instruments

more effective utilization of visiting faculty

MSOE students involved as full participants, with the opportunity to subsequently study at Czech Technical University the following semester

All recommendations were accepted and, despite some challenges, fully implemented. The major challenge was the identification of an appropriate "live" project. Late in the planning cycle, one technical manager with a strong commitment to engineering education and some previous positive experience in student projects came forward with an interest in evaluating various software packages for automated software testing. He committed to procuring the candidate packages and to provide the necessary support for the project. MSOE committed to providing the necessary laboratory facilities. A stronger classroom component on project management theory and practice was implemented.

As a result of the positive informal faculty interactions, and anxious to mutually expand institutional influence, a faculty exchange program was proposed and, with some initial assistance from Rockwell, immediately implemented. Interested faculty from each institution submitted proposals for lectures/workshops. A selection committee at each school made the final selection

and two professors from Czech Technical university came to MSOE in the Spring of 1992, followed by two MSOE professors lecturing in Prague in early summer.

The second year summer program proved to be even more successful than the first. The project was an overwhelming success, with the students excited about the real project, impressed with the obvious level of hardware and software support from Rockwell, and challenged by the prospect of working with state of the art software, and interacting with Rockwell personnel. The formal final team presentations, while the source of many sleepless nights of worry about presenting to technical and management personnel in other than their native tongue, provided a highly visible and meaningful end to the program. The work was of such quality that the group's recommendations were subsequently implemented in multiple Rockwell facilities. The MSOE students, recommended by MSOE faculty but ultimately selected by Rockwell personnel, distinguished themselves on the project teams. They were not allowed to serve as spokespersons, but were nonetheless used heavily as "language consultants" for the written and oral reports. Visiting faculty were utilized as technical consultants to all teams.

Expanded International Involvement

In 1996, Rockwell expanded the program to include student representatives from a number of countries essentially neighbors of the Czech Republic: Slovakia, Germany, Poland, Slovenia, Austria, Hungary. The largest single group of participants still came from the Czech Republic, and the majority of them from Czech Technical University. Project teams were now formed to be multinational in nature, with three MSOE students dispersed among the teams. As before, they were not allowed to serve as project managers or spokespersons.

The practice of a "live" project continued. The faculty exchange program was organized so that MSOE professors would be present in Prague in May to lecture, in part, to the assembled European students selected to visit Milwaukee the following July. The MSOE program coordinator accompanied the team and used the opportunity of the assembled summer program participants to brief them on the Milwaukee MSOE program, including the project, and to do some initial assessment of participant characteristics in anticipation of their assignment to a team. He was also able to present the initial lecture on one of the summer program topics, in part to give the European students a flavor of the US style of instruction…less formal, much more interactive.

The 1997 program was notable in that it included two participants from Russia, and one from China. The Chinese student was not able to come to Prague to meet his European colleagues so he first met them in Milwaukee. While not a problem this time because of the nature of the specific individuals involved, we noted that this could be a problem in the future. Having a student joining a group that has already been together for an entire week could be problematic. The string of successful team projects continued…this year the audience for the final presentations included some representatives of senior management.

Major Expansion - New Challenges

With a previous maximum size of 27, including visiting faculty, the 1998 program represented a radical departure from the past as we increased the number of participants to 47, including 26 from the Peoples Republic of China. The number of faculty included in the program also

significantly increased, from the previous years' two or three to now number eight. It should be noted that past successes of the program, measured in terms of participant satisfaction, placement of participants in positions affiliated with Rockwell, and the value to the sponsor of the team projects, now prompted the significant increase in the size of the program. An additional consideration was the company's acute interest in developing a working relationship with technical personnel and institutions in China. Of course it was recognized that exposure to engineering colleagues in China would be of benefit to MSOE and CTU as well.

The content of the 1998 Program is shown in Appendix I. Also included is a listing of the participants by country and academic institution. Several measures were taken to ensure success of this now quite different program. While the European participants were again gathered in Prague in late Spring for a briefing on the project, for assignments to project teams, and for introductory lectures, the Chinese participants were not. Instead, they were brought to Milwaukee two days earlier than the European contingent. This was intended to enable the Chinese participants to "catch up" to their European colleagues.

Because of the size of the group, it became necessary to deploy the project teams into two separate, but comparably equipped, laboratories. The project was selected, in part, based upon the ability to organize into eight subprojects of roughly equal complexity

Because of the interactive nature of many of the classroom sessions, it became necessary to now split the group in order to limit class size.

As in the past, project teams were assigned, in part, on the basis of national origin and native language, seeking to create teams as homogeneous as possible. However, because of the large number of participants from a single country, speaking one language, we found that in practice we were unsuccessful. Since each team consisted of approximately 50% from one country, teams seemed to seek out opportunities to organize themselves into two groups - one European, one Asian. For example, a typical team of six might include three Chinese, a Czech, a Russian, and a Hungarian. The three Chinese naturally gravitated towards working together. The teams almost inevitably saw their work as consisting of two major subtasks.

Evaluations by the participants and by the sponsor organization were quite positive and plans are in place for a 1999 program of approximately the same size as 1998.

Lessons Learned

The opportunity to collaborate with academic institutions abroad has had a significant positive impact upon the students, faculty and staff at our institution. Our students are much more aware of the global issues related to engineering practice. Students participating in the Global Development Program have consistently reported that their experiences, both during the summer program and later when studying in the Czech Republic were one of the highlights of the total University educational experience. Several have sought foreign employment opportunities as a result. Friendships have been established, not only amongst students, but faculty and staff as well. Working wit European and Asian colleagues on this summer program has lead to one faculty exchange program (others in the preliminary stages), a full year student exchange with one university, and the start of some collaborative research projects. We expect more to follow. The intense relationship between our institution and the corporate sponsor has resulted in numerous spin-off benefits: donations of both hardware and software, technical support, additional

opportunities for industry-academe collaboration, guest lecturers in the classroom, and invited speakers in the workplace, class projects, etc.

We have learned a great deal about multinational design teams. Throwing individuals together does not, of course, make a team. Forging an effective team takes hard work and careful planning and forethought in any case. Configuring a project team in which the team members have English as a second language and who represent different social and cultural backgrounds is significantly more complex.

While not without its own set of unique challenges, we have found that an extended short course format with a project as its focal point can be especially useful in implementing an international student program. In our particular situation, the critical success factors were found to be the live industry project carefully coordinated with classroom content, demonstrated support and visible authentic interest in the project outcomes on the part of the corporate sponsor, a curriculum that complements that available at the foreign institutions, classroom collaboration between the academic and the industry practitioner whenever possible, and an administration committed to the globalization of the engineer.

Milwaukee School of Engineering also offers its students other international study opportunities in Germany and India. In both cases, the courses are carefully organized so the students in selected academic programs are able to directly apply their credits towards graduation. In effect, the MSOE student replaces classrooms, laboratories, and professors in Milwaukee (in fact, a full academic year's study) with a comparable set in Lubeck, Germany or Manipal, India. Selected participants in a limited number of academic programs are then able to graduate on the same schedule as if enrolled in their home University, but with the considerable additional benefit of having experienced another culture. In contrast, the Global Development program described in this paper provides a much more intense, and clearly more internationally diverse, learning experience during the six weeks of the summer program, followed by a semester long European experience. The price paid by the students is that graduation is delayed. Feedback from MSOE participants has unanimously been that the benefits vastly outweighed the investment

Appendix One

1998 Global Development Program Topics (partial)

Ropes And Challenges Course
individual styles and effects on group performance

technical communications-written, oral

creativity and innovation-group and individual enhancement
implementing change

project management-tools and techniques, applications

estimating costs, economic evaluation of alternatives, business finance

rapid prototyping techniques and applications in design
product development processes
concurrent engineering
business process reengineering
ergonomics/human factors in design
manufacturing systems

ISO9000 principles and practices
TQM concepts
codes and regulations

marketing / advertising / customer relations

Rockwell products, practices, procedures…facilities tours

project exhibits, formal presentations to technical / executive management

Appendix Two

1998 Global Development Program Participation
Country and Institution

Austria

Technical University - Wien

China

Harbin Institute of Technology
Tsinghua University
Chongqing University
Shanghai Jiao Tong University
Shanghai Fudan University
Southeast University
Zhejiang University
Xian Jiao Tong University

Czech Republic

Czech Technical University-Prague
Western Bohemia University-Pilsen
Technical University-Brno

Hungary

Technical University-Budapest

Poland

Technical University-Warsaw
Technical University-Gliwice

Russia

Tyumen State Oil and Gas University

Slovakia

Technical University-Kosice
Technical University-Bratislava

United States

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