Engineering Education for the Rio Grand Valley Engineers

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Abstract

With the North American Free Trade Agreement (NAFTA) fully embraced and additional proposals to ease trade obstacles between North American countries, the border area neighboring Mexico has evolved as the center of economic activity or what is known as a "Boom." As the border areas with Mexico grows and more monies and resources are poured into these regions, the demand for a more professional labor population, technicians, engineers, and manager's increases. Most professionals are usually required to have technical or engineering experience and degree. A graduate program for educating the engineers employed at Rio Grand Valley (South Texas Border Region) manufacturing companies, so called Maquiladora twin plants was designed and has served the Rio Grande Valley companies for over a decade. The program was to be as flexible to the needs of the Maquiladora companies as possible, keeping abreast of new and developing technologies demanded by evolving processes that are mostly providing goods to the US and overseas automobile manufacturers. Program curriculum and teaching methods have also evolved over the years as originally expected. The structured curriculum presented originally provides two integrated portions (Industrial & Electrical) based on design, test, and manufacturing with respect to the knowledge base and needs of the Maquiladora Engineers. This paper describes the program development and the long distance teaching techniques used in the graduate engineering degree program offered by the Texas A&M University-Kingsville for educating the Rio Grand Valley Engineers. The innovative features introduced to the program, teaching challenges, student research projects, and the criteria used in advising engineering students are presented. A comparison between our program and the traditional graduate engineering programs, the advantages and disadvantages and how it is tailor made to meet the needs of the Rio Grande valley students is also presented.

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Introduction

A graduate program geared specifically toward the needs of the engineers and managers employed at Rio Grand Valley (South Texas Border Region) companies, so called Maquiladora twin plants[1], was designed by collaboration between the Industrial, Electrical, Mechanical, Computer Science Engineering at Texas A&M University-Kingsville. The curriculum provided two integrated portions (Industrial & Electrical Engineering) based on design, testing, and manufacturing with respect to the knowledge base and application requirements of the Maquiladora Engineers.

As part of curriculum development, the administration and faculty met with the Maquiladora plant managers and leaders several times over a span of several months. The primary objective was to assess the technical, educational, and administrative support required to keep up with the forecasted growth of the twin plants and to establish a long term goal based on the future of manufacturing in the area. This collaboration continues to date to ensure open communication and understanding between the university and company leaders. The first challenge was to establish a curriculum that would be broad and multi-disciplinary, while satisfying the individual plant's requirements, the faculty requirements, and the university resources available for a long distance educational program. Lack of resources as far as facilities, classrooms and even the faculty members to support the proposed curriculum were some of the challenges that the college of engineering was facing.

The Program and the Curriculum

The program has evolved over the years. Instruction delivery mode has changed from face-to-face instructions to video conferencing and even internet courses via the World Wide Web utilizing Black Board and WebCT. The program started with faculty traveling over the weekend to one of the plants centrally located and lecturing Fridays and Saturdays. To meet the goals set by the assessment committee, a set of features were set forth for the curriculum development[2,3]. The main objective was to have a program that provides a sound technical knowledge and solid background in the following areas:

1. Mathematics
2. Computer information systems
3. Computer Aided Design in Industrial Engineering
4. Computer Aided Design in Electrical Engineering
5. Manufacturing process, quality control, and safety
6. Economic awareness and management science
7. Research project in a major area

Keeping these features in mind, two independent and yet integrated curriculums were developed. Table 1 illustrates the curriculum model for Industrial and Electrical Engineering degrees. The curriculum is made of two main segments: masters of science in Industrial Engineering and masters of engineering in Electrical Engineering. The Electrical Engineering branch consists of seven specific courses in two major areas, Electronic and Control. The Industrial Engineering branch consists of seven specific courses with emphasis in Manufacturing, Design, Operation Research, Ergonomics and Safety. The engineering economics, computer science, and manufacturing components were shared in both curriculums.

Besides the general pre-requisites, essential courses for a specific discipline and research project are also required. For a student to graduate from the program, he or she must follow the steps outlined in Figure 1.

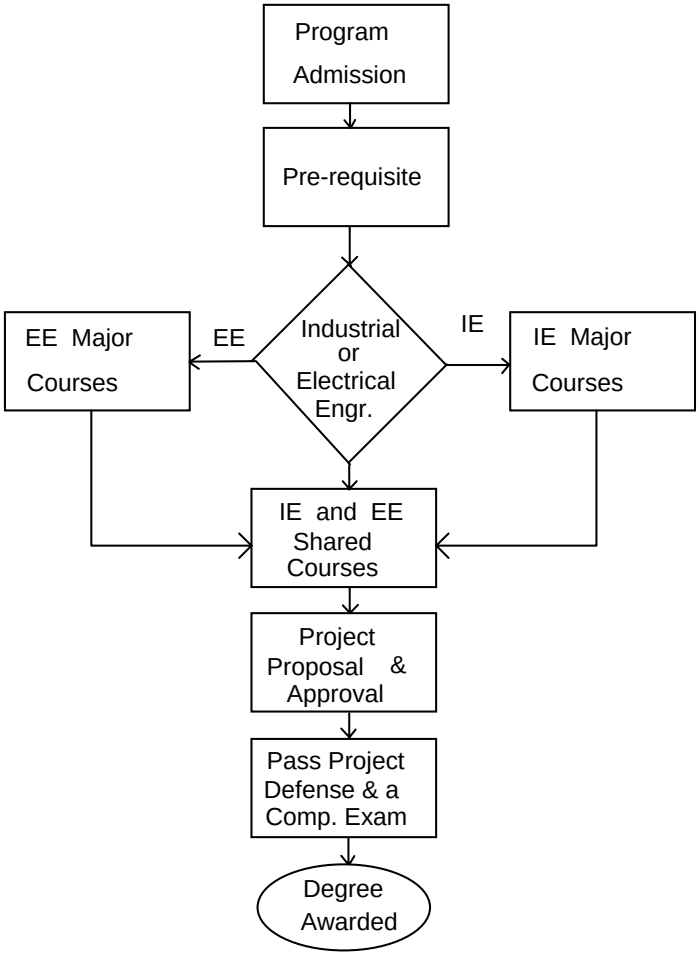

Figure 1. Program Procedure for Industrial and Electrical Engineering

With a B.S. degree in engineering, grade point average above 2.5, Graduate Record Exam (GRE) scores of 1000, and an English proficiency exam such as Test of English as a Foreign Language (TOEFL) of 525, a student were admitted to the program. Students started the two-year program upon full admission at any semester along the two years scheduled program, assuming that they have the necessary background or experience to begin without taking any pre-requisites.

Over the years the demand for industrial and manufacturing expertise surpassed the demand for electrical engineering. This was directly as a result of the core manufacturing work performed at the border plants and the fact the design elements were addressed usually at the US headquarters' of these companies.

Table 1. Course Schedule for the Maquiladora program

INDUSTRIAL ENGINEERING	ELECTRICAL ENGINEERING
Advance Engineering Economic Analysis (6)	Engineering Economic Analysis (6)
Advance Numerical Methods (1,2)	Advance Numerical Methods (1,2)
Computer Appl. Statistical Methods (1,4)	Dynamic Systems I (1,3)
Principles of Optimization (1,3)	Digital Computer design (2,3)
Ergonomics (4)	Control Systems Synthesis (1,3)
Computer Simulation Industrial Systems (4)	Electronic Systems Design (3)
Database Systems (2)	Database Systems (2)
Manufacturing Systems Design (4,5)	Manuf Systems Design(4,5)
Activity Scheduling (4,5)	Electronic Circuit Design (3,5)
Computer Integrated Manufacturing (4,5)	Computer Networks (2,3)
Systems Safety (4,5)	Systems Safety (4,5)
Research Project (4,7)	Research Project (3,7)

(1) Mathematics
(2) Computer Information System
(3) Computer Aided Design/Electrical Engineering
(4) Computer Aided Design/Industrial Engineering
(5) Manufacturing Process, Quality Control and Safety
(6) Economics and Management Science
(7) Research in Major Area

Program Coordination

During the first year of this program, classes were held at the twin plants located in Reynosa, Mexico. They were later relocated to Hidalgo Texas, a small town by the border immediately north of Reynosa. Exploring the challenges involved in distant learning reentered by the brevity of resources, and yet planning to maintain a quality and successful program was the issue to be addressed in the near future.

The most logical and economically feasible solution to the distant learning was the use of Trans-Texas videoconference network (TTVN), with 15 sites within various Texas A&M University system facilities all across Texas. This Technology provided the state of the art digital interaction videoconference and distant education capabilities. Two-way visual/verbal communications links to all A&M system university campuses and facilities in Texas.

Since 1990, TTVN system has been used for one-half of the total teaching time. The faculty and the students must meet at one location at least 1/2 of total class time. To meet the course objectives, when using TTVN as a teaching medium, a strategy must be used to not only cover the coarse content but also create the necessary interaction with the students. From a total of sixteen lectures per semester (see Table 2), four are taught on TAMUK campus and another four are presented at Weslaco Texas, serving the south Texas border areas between Laredo and Brownsville Texas. Weslaco is the home to Texas A&M University Agricultural Research and Extension Center and is located centrally to all major cities in south Texas.

Table 2. Class Schedules and Tasks

Meeting Number	Location/Medium	Number of HRS	Task
Meeting #1	TTVN	3	Phase 1
Meeting #2	TTVN	3	Phase 1, 2
Meeting #3	TAMUK	4	Phase 3
Meeting #4	WESLACO	3	Phase 4
Meeting #5	TTVN	3	Phase 1
Meeting #6	TTVN	3	Phase 1, 2
Meeting #7	TAMUK	4	Phase 3
Meeting #8	WESLACO	3	Phase 4
Meeting #9	TTVN	3	Phase 1
Meeting #10	TTVN	3	Phase 1, 2
Meeting #11	TAMUK	4	Phase 3
Meeting #12	WESLACO	3	Phase 4
Meeting #13	TTVN	3	Phase 1
Meeting #14	TTVN	3	Phase 1, 2
Meeting #15	TAMUK	4	Phase 3
Meeting #16	WESLACO	3	1 HR for Phase 4 (Final Exam)

Seven remaining lectures of the semester are presented via TTVN. The dynamic schedule and the rotation of meeting locations, in combination with changing instructional mode have become a challenge for the faculty and students. Other contributing factors include language differences and multi-cultural personalities between students, faculty, and staff. Time differences and national and local holidays between the two countries include some of the logistic problems that remains discrepant.

Lecture Presentation

The techniques used to present an Electrical Engineering course in Electronic Circuit Design and an Industrial Engineering course in Ergonomics are described in this section. A top down approach was employed as illustrated by Figure 2. The TTVN (long distance) lectures are primarily used for concept introduction. The Weslaco (on-site) lectures consisted of problem solving sessions that would create discussion, questions and answers. On campus meetings were conducted by short lectures followed by a workshop. This would give the students the experience and exposure to computer aided design and engineering tools. For each new concept the loops shown in Figure 2 were repeated. The use of TTVN reduced traveling cost and fatigue significantly.

Each student, after completing all required courses must complete a research project as part of requirements for the masters of engineering degree. The research projects are derived from existing problems or on going projects in the company where the students are employed. Identification of the problem is performed by consulting the manufacturing management. The proposed research project must then be approved by the members of the research project committee. The faculty advisor guides the student in deriving at a state-of-the-art engineering solution. After the completion of the project, a formal report and a presentation and defense for the project is due. Several successful projects have been taken up by the students and their faculty advisor. The procedure is very similar to a normal on campus Masters program. The main difference lies in the selection of the research project. The project are individual, departmental, or company wide projects that the students are currently involved with at various levels and capacity.

Program Comparison

This is a special graduate program geared mostly toward electric, electronics, and other manufacturing companies in south Texas and Mexico border. The integrated Industrial and Electrical engineering masters program was designed to meet the technical requirements of the companies in this region and at the same time meet the curriculum requirements of the college of engineering. One major difference between this program and the traditional masters program is the restriction in the type and the number of classes offered. The 12 courses offered for each discipline are pre-set for this program and only two courses per semester are offered.

Another difference is that a student can enter the program at any point in time if the student's previous academic or work background are sufficient to justify this without having to take any pre-requisites. In a traditional program, foundation courses are required before other courses are taken.

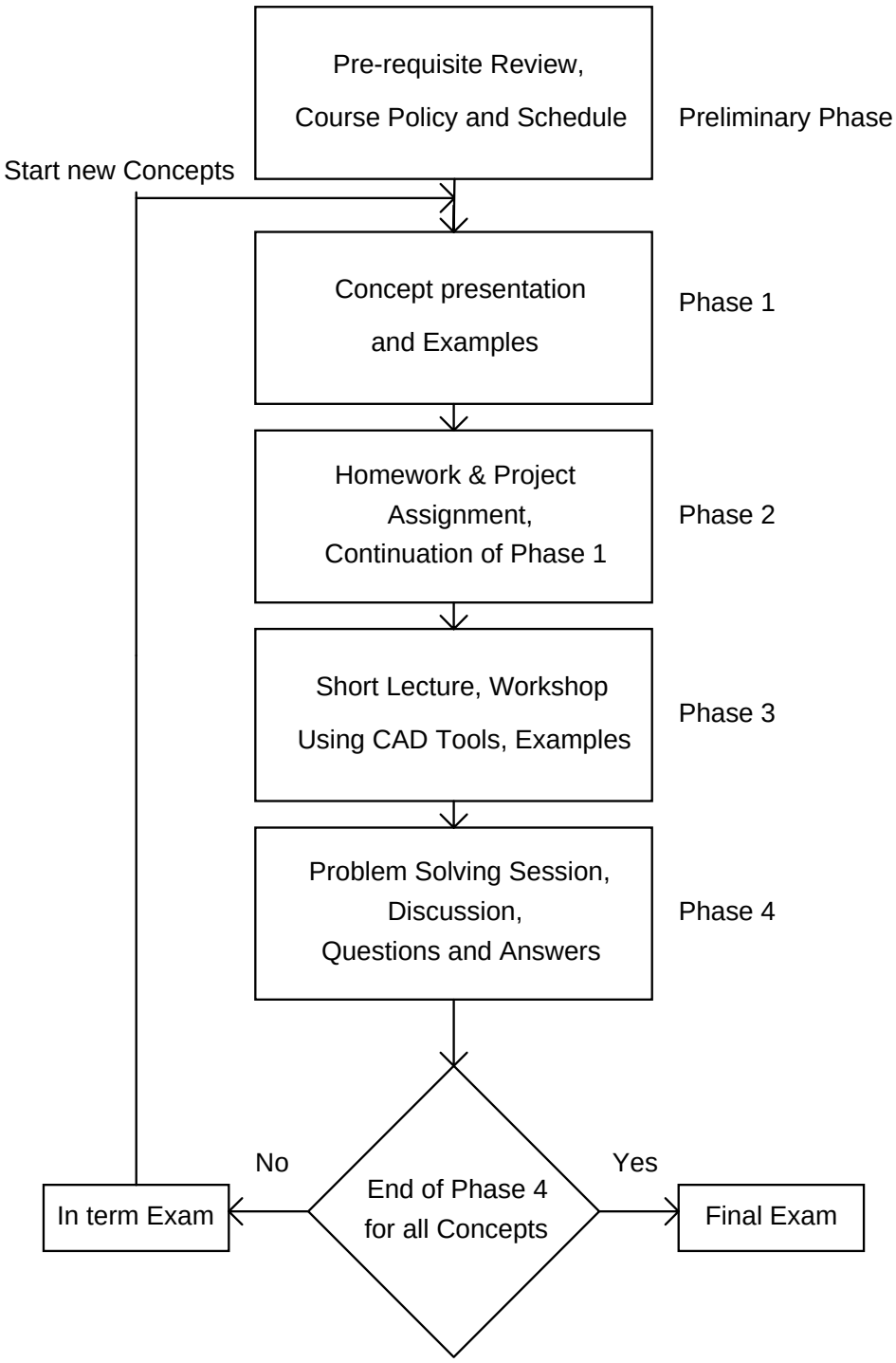

Figure 2. Flow Chart of the Teaching Technique Used

The Rio Grande valley program creates a more technical and hands on type of environment for the students. The students are encouraged to discuss projects that they may be involved with at their company. Regular class tours are arranged in different types of industries that are participating in the program. Real life problems and solutions are addressed in the classrooms. Each class project is selected from on going projects among the companies. The students are allowed to work on a challenging and state of the art project as part of their research project and the results are complied and presented as their thesis.

Using the TTVN system as a teaching media is a challenge of it's own. It requires at least several semesters and a few training courses for the faculty to become familiar and comfortable with the system. The same challenge is bestowed upon the students as well. They must be motivated enough to achieve the level of concentration required, especially in highly technical and advance classes. The dedication and the level of commitment are higher for the students, faculty, and administrators, as it would be for a traditional on campus program.

Conclusion

This program has been in place now for over a decade and has graduated over 60 engineers. Many of the graduates from the program have been moved into higher technical or managerial positions such as chief engineers or plant managers over the years. As the regional demand for education fluctuates but mostly following growth trend, the program reacts and is able to accommodate the demand from both NAFTA and Maquiladora growth in Texas and Mexico border area. As more experienced is gained, a more flexible approach to instruction and even curriculum is utilized. The feed back from the students, graduates, and the participating plant's management has marked the success of this program.

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