AC 2008-947: DEVELOPMENT OF A NEW GRADUATE DEGREE PROGRAM AT A REGIONAL CAMPUS: THE PROCESS, CHALLENGES, AND RESULTS

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Introduction

As technology advances, the need for a highly-educated workforce will continue to grow. An educated workforce is important to the economy at both the national and local levels. Thus, the need to increase the number of scientists and engineers, especially at the graduate level is well recognized.^{1,2}

Overall approaches to increase enrollment in graduate engineering programs can be characterized as making graduate engineering programs more accessible or more attractive, or by increasing the pool of interested, qualified students.^{1,2} Specific examples of these approaches have been documented in the educational literature.³⁻⁹ For example, efforts to make a graduate education accessible through distance learning^{3,4} or to make the path to the engineering graduate degree more direct through combined undergraduate and graduate degree programs⁵⁻⁷ are emerging strategies. In addition, programs to recruit and retain underrepresented minorities into graduate engineering programs have also been reported.^{8,9} Indiana University–Purdue University Fort Wayne’s (IPFW) approach to increase graduate educational opportunities has been to establish an engineering program at our regional campus. This has been motivated by the needs of local industry.

Fort Wayne is the second largest city in Indiana and is home to a number of engineering firms in the defense, aerospace, automotive, wire die and orthopedic industries. Historically, northeast Indiana was a hub for manufacturing with products that support the transportation, electronic and logistics sectors. Fifty years ago, the biggest regional companies included International Harvester, General Electric, Westinghouse, Magnavox and ITT Communications Division. Today, the largest employers of engineers and technologists include ITT Aerospace /Communications Division, Raytheon Net Centric Systems, General Dynamics, Undersea Sensors Systems Inc., Zimmer, Biomet, DePuy, General Motors, Dana Corp, and International Truck & Engine. These companies need educational resources to grow their local talent.

The lack of graduate programs in urban areas such as Fort Wayne is rooted in the legacies of the land grant college system. In the late 1800’s and early 1900’s, the U.S. government gave states allotments of federal land with which to create an endowment to establish state colleges. These colleges were often located on one of these federal parcels. Thus, the land grant program was responsible for locating many of our major public universities far from population centers. Indiana’s main population centers are Indianapolis, Fort Wayne, Evansville and South Bend, while the main IU campus was located in Bloomington and main Purdue campus in West Lafayette. Decisions regarding higher education funding and programs struggle to balance efficiencies inherent in utilizing existing campus infrastructure against the need to make higher education accessible to the majority of the state’s population.

The Master of Science in Engineering (M.S.E.) degree program was created to meet the needs of local industry. During the strategic planning process in 2001, local employers made it clear that the West Lafayette Purdue campus could not meet their employee development needs through distance and weekend degree programs. Additionally, defense industry leaders articulated a need for systems engineering training that was not available anywhere in the Purdue system. This led the IPFW administration and faculty to work with industry to develop a plan for graduate-level program tailored to their business needs.

This paper will detail the creation of the IPFW MSE program. It provides insight into issues that are relevant to other regional campuses. Specifically, this paper discusses the process required to establish the program, challenges that were encountered, and the program characteristics.

Campus Environment

Indiana University–Purdue University Fort Wayne is located in the second largest city in Indiana and it is the sixth largest public university in the state with a total enrollment of approximately 12,000 students. Approximately 60% of the students are classified as full-time, and the average student age is 25. Classes are offered during the day, in the evening, and on the weekends.

The College of Engineering, Technology, and Computer Science enrolls approximately 1400 students in its four departments: Engineering, Manufacturing & Construction Engineering Technology, Electrical & Computer Engineering Technology, and Computer Science. Certificate, associate, bachelor, and master degree programs are offered and awarded by Purdue University.

The Department of Engineering has 300 students, 17 full-time faculty members, and offers bachelor-of-science degrees in civil, mechanical, electrical, and computer engineering.

While traditionally an undergraduate institution, in the last two decades IPFW has created a number of graduate programs to meet specific community needs. The Engineering graduate program joins the graduate program in Applied Computer Science and Technology providing a wide spectrum of programs to address industrial workforce needs.

Creation of the Program

In the fall of 2003, the Department of Engineering formed a committee to investigate the need to establish an engineering graduate program locally. They surveyed both graduating students and employees of local companies to assess potential interest.

The committee conducted a survey of 32 graduating engineering students to assess their interest in a graduate program at IPFW. Sixty-five percent of the students indicated that they would be interested in the program. This level of support was significant because the majority of IPFW's graduates remain in the Northeast Indiana region. This also demonstrated that there was a significant pool of candidates that could initiate the program.

A second survey was distributed to local industry with the assistance of the engineering department's industrial advisory board and posted on the internet. Seventy on-line responses were obtained, along with sixteen paper copies. Employees of companies such as International Truck & Engine, Raytheon, UnderSea Sensors Inc., ITT Aerospace/Communications Division returned most of the surveys. The results are summarized in Table 1.

Table 1. Results of industry surveys.

Degree obtained	B.S. Computer Engineering	6%
	B.S. Electrical Engineering	27%
	B.S. Mechanical Engineering	29%
	B.A./B.S. Computer Science	20%
	Other (physics, technology, etc.)	18%
Desired area of specialization	Computer Engineering	30%
	Electrical Engineering	32%
	Mechanical Engineering	20%
	Systems Engineering	18%

Due to the nature of the survey, almost all respondents indicated at least some interest in the program. The background of the respondents was diverse. Approximately 38% of the respondents had a degree in a non-engineering field. The results from the survey indicated that there is a strong interest in an engineering graduate program at IPFW, and that all four proposed areas of specialization, computer, electrical, mechanical, and systems engineering, were of interest.

Based on the prevailing campus climate, the current department structure, analysis of the survey data, and discussions with members of the industrial advisory board the committee concluded that:

- The graduate program should serve the needs of computer, electrical, mechanical, and systems engineering students.
- An explicit path would have to be established to allow students without a degree in engineering (but with the appropriate background) to enter the program.
- The program would have to be offered with a minimum of resources.

With these ideas in mind, the committee constructed a proposal to describe the program. The timeline for the proposal approval process is shown in Figure 1. The rest of the paper describes the notable characteristics of the program.

Figure 1. Timeline for the establishment of the program.

Program Overview

The stated objectives of the program are:

- Provide opportunities for qualified individuals to earn a masters degree in engineering.
- Establish a nationally-recognized, graduate engineering program that offers a combination of theoretical and practical educational experiences
- Meet the need for a comprehensive graduate engineering program in northeastern Indiana.

Students in the program can select from one of four areas of specialization: computer engineering, electrical engineering, mechanical engineering, and systems engineering. To earn the MSE degree the student must complete 30 credit hours. The coursework is divided into four categories: engineering core requirements (12 credit hours), engineering electives (6 credit hours), mathematics/statistics/computer science electives (6 credit hours), and general electives (6 credit hours). Both thesis and non-thesis options are available.

Admission Requirements

To be considered for admission into the MSE program, applicants ideally should have graduated from an approved, accredited engineering program with a Bachelor of Science degree in their selected area of specialization. In addition, graduates with Bachelor of Science degrees from programs in the physical sciences, computer science, mathematics

or technology will be considered for admission. Formal admission to the MSE program requires a Bachelor of Science degree as well as:

1. completion of the engineering mathematics sequence which includes integral calculus and analytical geometry, multivariate calculus, linear algebra, and differential equations,
2. at least two semesters of calculus-based physics, and
3. prerequisite engineering courses required to take the required graduate courses.

Curriculum

To earn the Master of Science in Engineering degree, students must complete 30 credit hours. The courses in each area of specialization are divided into four categories: (1) engineering required, (2) mathematics/statistics/computer science elective, (3) engineering elective, and (4) general elective. The specific curriculum for each area of specialization is listed in the Appendix.

The required engineering courses provide students with a solid, yet broad foundation in the fundamentals of their selected area of specialization. These specific courses (see Appendix) were selected to meet the needs of students and local industry, with the strengths and abilities of the IPFW engineering faculty in mind. The plan is to offer each of the required engineering courses at least once a year on campus.

The engineering electives offer the student a chance to develop depth in his/her area of specialization and to explore new technologies of interest. Students will have the option of taking engineering elective courses on campus or via video.

The mathematics/statistics/computer science electives provide the students with the opportunity to sharpen their analytical skills and obtain useful tools to apply to future work within their selected area of specialization.

Finally, the general elective courses give the student flexibility to tailor the program to meet his or her specific needs. For example, a student wishing to eventually move into a management position might opt for courses in Business or Organizational Leadership and Supervision, while another student might decide to perform research in areas such as robotics, controls, signal processing, tribology, or heat transfer and produce a thesis.

Structuring the curriculum in this manner supports all areas of specialization with minimum resources. The required courses in one area of specialization, serve as elective courses in the other areas of specialization. For example, students in computer, electrical, and mechanical engineering are allowed to take courses in systems engineering. Engineers with this type of education are in high demand in northeastern Indiana and nationwide. In addition, students interested in systems engineering can take elective courses in their undergraduate engineering discipline.

Resources

Based on the prevailing climate on campus and the structure of the department, it was clear the program would have to be initiated with limited resources. The challenge is to offer courses to support all of the areas of specialization while not significantly impacting the undergraduate programs. To minimize the impact to the undergraduate program, the concept of replacement time was used. Replacement time allows for the hiring an adjunct faculty member to teach a course formerly taught by a faculty member now teaching a graduate-level course. Once the program achieves sufficient enrollment levels additional faculty lines will be requested.

Table 2. Resources requested for the first two-years of the program.

Academic Year	Description
Fall 2007	50% Replacement Time for Graduate Director 25% Time for an EE Adjunct Professor 25% Time for a Computer Eng Adjunct Professor 25% Time for a ME Adjunct Professor Half time Secretarial Support Student Office, Computer and Supplies
Spring 2008	25% Replacement Time for Graduate Director 50% Time for an EE Adjunct Professor 50% Time for a Computer Eng Adjunct Professor 50% Time for ME Adjunct Professor Half time Secretarial Support Student Office, Computer and Supplies
Fall 2008	1 Systems Engineering Faculty (1 st faculty) 25% Replacement Time for Graduate Director 50% Time for an EE Adjunct Professor 50% Time for a Computer Eng Adjunct Professor 50% Time for ME Adjunct Professor 1 FTE Graduate Teaching Assistantship Half time Secretarial Support Student Office, Computer and Supplies
Spring 2009	1 Systems Engineering Faculty (1 st faculty) 25% Replacement Time for Graduate Director 50% Time for an EE Adjunct Professor 50% Time for a Computer Eng Adjunct Professor 50% Time for ME Adjunct Professor 1 FTE Graduate Teaching Assistantship Half time Secretarial Support Student Office, Computer and Supplies

Concluding Remarks

The IPFW Department of Engineering has received approval to offer a new Master of Science in Engineering (MSE) degree program. This program has been designed to meet the needs of industry and potential students.

Notable aspects of the program include:

- The program offers four areas of specialization with limited resources. This is accomplished by allowing students in computer, electrical, and mechanical engineering to take courses in systems engineering. Engineers with this type of education are in high demand in northeastern Indiana and nationwide. In addition, students interested in systems engineering can take elective courses in their undergraduate engineering discipline.
- The curriculum is extremely flexible. Students are able to tailor the program to meet their needs by blending courses offered by the IPFW Department of Engineering and the Purdue College of Engineering, as well as approved courses offered by the IPFW Departments of Physics, Chemistry, Biology, Mathematics, Computer Science, School of Business and division of Organizational Leadership and Supervision (OLS).
- A clear path has been established to allow students without a degree in engineering to be admitted. This will serve industry and assist in populating the program.

The graduate committee is currently considering the following issues:

- the development of an assessment plan that might include the degree requirement of a project,
- the assurance of sufficient enrollment in courses on a regular basis,
- the establishment of an equitable reward system for faculty members who advise students or serve on graduate committees, and
- the development of certificate option in systems engineering.

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Appendix

Table A1. Curriculum for MSE-Computer Engineering

Category	Course	IPFW	Video	Cr. Hrs.
Engineering Required	ECE 502 Linear Control Systems	x		3
	ECE 547 Intro. to Computer Communication Networks	x	x	3
	ECE 565 Computer Architecture	x		3
	ACS 560 Software Engineering	x		3
Math/Stat Electives	select two MATH/STAT/CS graduate courses (5xx/6xx)	x	x	6
Engineering Electives	select additional engineering courses or CS courses	x	x	6
General Electives	select engineering, CS, OLS, TECH, MATH/STAT, BUS, PHYS, CHEM, BIOL courses	x	x	6
Total				30

Table A2. Curriculum for MSE-Electrical Engineering.

Category	Course	IPFW	Video	Cr. Hrs.
Engineering Required	ECE 502 Linear Control Systems	x		3
	ECE 538 Digital Signal Processing I	x		3
	ECE 547 Intro. to Computer Communication Networks	x	x	3
	ECE 565 Computer Architecture	x		3
Math/Stat Electives	select two MATH/STAT/CS graduate courses (5xx/6xx)	x	x	6
Engineering Electives	select two additional engineering courses	x	x	6
General Electives	select engineering CS, OLS, TECH, MATH/STAT, BUS, PHYS, CHEM, BIOL courses	x	x	6
Total				30

Table A3. Curriculum for MSE-Mechanical Engineering

Category	Course	IPFW	Video	Cr. Hrs.
Engineering Required	ME 505 Intermediate Heat Transfer	x	x	3
	ME 509 Intermediate Fluid Mechanics	x	x	3
	ME 550 Advanced Strength of Materials	x		3
	ME 562 Intermediate Dynamics with Applications	x	x	3
Math/Stat Electives	select two MATH/STAT/CS graduate courses (5xx/6xx)	x	x	6
Engineering Electives	select two additional engineering courses	x	x	6
General Electives	select engineering, CS, OLS, TECH, MATH/STAT, BUS, PHYS, CHEM, BIOL courses	x	x	6
Total				30

Table A4. Curriculum for MSE-Systems Engineering

Category	Course	IPFW	Video	Cr. Hrs.
Required Engineering	SE 510 Systems Engineering	x		3
	SE 520 Engineering Economics	x		3
	SE 530 Engineering Management	x		3
	SE 540 System Architecture	x		3
Math/Stat Electives	select two MATH/STAT/CS graduate courses (5xx/6xx)	x	x	6
Engineering Electives	select additional engineering courses or CS courses	x	x	6
General Electives	select engineering, CS, OLS, TECH, MATH/STAT, BUS, PHYS, CHEM, BIOL courses	x	x	6
Total				30