Impact of a Successful Technology Graduate Degree Program- Report on program and its graduates

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Abstract

This paper describes the challenges and advantages experienced by the authors in starting and running a successful graduate program in Technology. All relevant program issues that needed to be addressed in creating the third largest (nationally) Technology graduate program are discussed in the paper. These issues are: flexible curriculum, faculty resources, prospective students, students' marketability and preparation for employment, and graduate employment opportunities in industry/business/government. Data is presented on student profiles, graduation rate, graduate placement, and application-oriented industry projects. Furthermore, the coming challenges of maintaining program quality with high enrollment, as well as completion rates, are also discussed in this paper.

Introduction

Purdue University Calumet (PUC) started its Master of Science in Technology degree program in 2008. The program has experienced rapid enrollment growth, as well as resource constraints, and by 2011 had the third largest enrollment in the nation. Since the inception, *the program has produced more than a hundred graduates*. The success of this program may be attributed to the large demand for an interdisciplinary program in the region, the interdisciplinary nature of the program, and flexibility of the curriculum. Such success was predicted by the institution and presented in the program proposal to the Indiana Commission for Higher Education (ICHE).

In a paper on Engineering Technology (ET) graduate programs, it was recommended that ET graduate programs explore and utilize emerging sub-disciplines which include technical management[1]. The authors of the paper also indicated that, "recruitment to placement" strategy rather than "recruitment to graduation" makes the graduate program strong. Purdue University Calumet's MS in Technology program emphasizes on management of technology. Due to industry contacts and partnerships, a large number of the students in the M.S. in Technology program are placed in internship before graduation. Many of these students who completed internships have been hired in the respective industry and business. Kaminski[2] provided an assessment plan for the MS in Engineering Technology program at Central Washington University that includes an internal assessment of the program in terms of attrition and also time to degree completion. PUC tracks such data for the overall assessment of the program. A report on the assessment of a cohort-based Master's degree program in technology, the authors of the report had indicated that the required directed project work enhanced students' knowledge and skills at their workplace and also 30% of surveyed students indicated that they had career growth after graduation[3]. At PUC, graduates of the Master's degree program had similar experience.

In this paper, the issues related to implementing and sustaining the Master of Science in Technology program are discussed. These issues and their supporting data include curriculum, faculty resources, enrollment, careers and placement, and impact of program.

Program Objectives, Admission Requirements

The program educational objectives are: 1) Ability to develop research concepts and practical applications of research methodologies in technical environments and analyze, evaluate and synthesize research, 2) ability to communicate effectively and employ constructive professional and interpersonal skills, 3) ability to function effectively in one or more of the technology disciplines, 4) ability to function on multidisciplinary teams, and 4) ability to continue in a PhD program in technology or related field.

The admission requirements for unconditional admission is an earned baccalaureate degree in an accredited (recognized standing) college or university with a B or better average in undergraduate major. Although the program encourages admitting students from Science, Technology, Engineering and Mathematics (STEM) related fields, students with other backgrounds have been admitted to the program as well. These students are industry professionals and have been working in a technical environment for several years and aspire to be in the management role after completion of the degree. During 2012, the program received 52 new applications and admitted 38 students with an acceptance rate of 73%. Of these admitted students, 31 students registered with a matriculation rate of 82%.

Establishment of a Graduate Studies Office

The rapid growth in the Technology graduate program warranted a separate administrative unit within the School to administer the graduate program. In this regard, the Graduate Studies office was established within the School of Technology and two new positions were created, 1) Assistant Dean of Graduate Studies with 0.5 Full Time Equivalent (FTE) and 2) 1 administrative assistant with 1.0 FTE. A separate budget was created to support the operation of the unit, including support for one graduate assistant. In addition, there has been support for 4 graduate assistants at the institutional level, shared between School of Technology (SOT) and the PUC Graduate Studies office.

The functions of the Graduate Studies office are as follows: 1) serves as the front-line contact for the Graduate Program, 2) interprets and responds to inquiries relating to graduate admission, student registration, Plan of Study submissions, program/degree completion requirements, and other University policy and procedures, 3) serves as principal functional liaison with University's Graduate School, Enrollment Services, and the International Programs office, 4) supports the SOT Graduate Education Council, and 5) prepares program-related data and financial reports.

The role of the Assistant Dean of Graduate Studies in the School of Technology is to provide leadership to meet the School of Technology's strategic goals pertaining to graduate education. This includes administration of: 1) graduate admissions and records, 2) graduate programs: degree, non-degree, certificates, 3) graduate program budgets, 4) graduate program sponsored aideship and fellowship, 5) graduate degree audit, and plan of study approval, and 6) graduate faculty certification. Furthermore, the Assistant Dean is responsible for, 1) collaboration with department heads and faculty members in the development, approval, and implementation of graduate degree/certificate programs, 2) developing relationships with

constituencies and stakeholders to promote and market the graduate degree/certificate programs at local, regional, national, and international levels, 3) maintaining liaisons with Purdue University Calumet's Director of Graduate Studies pertaining to graduate programs, 4) serving as the Chair the School of Technology Graduate Education Council, 5) implementing established policies pertaining to new programs and new course development and approvals, and 6) reviewing and coordinating the process of all new programs/course proposals for approval at the department and school levels.

Curriculum, Program Delivery, and Program Growth

The Master of Science in Technology program is a 33-credit-hour flexible curriculum that allows a student to focus on one of the areas in which the School of Technology offers degrees. The areas are Electrical Engineering Technology, Mechanical Engineering Technology, Industrial Engineering Technology, Construction Management and Engineering Technologies, Organizational Leadership and Supervision, Computer Information Technology, Computer Graphics Technology, and Mechatronics Engineering Technology. There are three required courses in the program, additional 3 courses in Technology Management areas and 4 courses within the area of interest to be chosen by the student (Table 1).

Table 1. MS in Technology-A typical Plan of Study

The program consists of 33 hours:

- *Three core courses (9 credit hours)*
  - *Measurement and Evaluation in Industry & Technology,*
  - *Quality and Productivity in Industry & Technology, and*
  - *Analysis and Research in Industry and Technology;*
- *Three courses in technical electives (9 credit hours) highly recommended*
  - *Leadership & Ethics*
  - *Project Management*
  - *Technology in a Global Environment*
- *Four courses (12 credit hours) in the students' area of interest**
- *Two options for the final 3 credit hours*
  - *A directed project which is a research-based written report focusing on applied research*
  - *Elective credits with approval of advisor*

**Note: Depending on the focus of the student's plan of study, other courses may be substituted for these, including courses from other graduate programs on campus.*

The enrollment growth potential for the directed-project-based graduate program was limited due to the fixed number of faculty members who could advise students' directed projects. Unless a faculty member is willing to be the advisor, the student could not be admitted. To overcome the limit of enrollment growth, effective spring semester of 2012, the program received approval to offer course-based only Master's degree. This has provided an alternative to students in the program and the program has since experienced enrollment growth and a significant increase in the number of graduates. In fact, many students, particularly international students, switched to the course-based option. Program growth has been excellent-it has grown

from 28 students in 2007 as a pilot program prior to final degree approval, to 192 students in Fall 2013.

There are currently 31 graduate faculty members in the School of Technology who can teach technical core courses, as well as courses in the content areas within their field of expertise. The recent faculty hires in the School have Ph.D degrees in their respective fields. Most graduate faculty members teach at least one graduate course per semester. Many of the graduate courses are offered through distance education technology and therefore provide an option to students to take classes either online or on campus. The faculty members have developed and received approval of 26 graduate courses during 2009-2012 (Table 2).

Table 2. New Graduate courses developed during 2009-2012*

2009	*2010*	*2011*	*2012*
8 courses	*11courses*	*5 courses*	*2 courses*
Optical Networking (EET)	*Advanced Construction Operations (CMET)*	*Product & Process Development (IET)*	*Nanotechnology & Applications (MET)*
Wireless Networking (EET)	*Temporary Structures in Construction (CMET)*	*Global Supply Chain Management (IET)*	*Sustainability Engineering (TECH)*
Coaching & Mentoring in Organizations (OLS)	*Robotic System Design (EET)*	*Enterprise Quality Planning (IET)*	
Highway Construction & Maintenance (CMET)	*Embedded System Design (EET)*	*Database Object-Oriented Modeling and Architecture (ITS)*	
Advanced Issues in HR (OLS)	*System Reliability (IET)*	*Database Application Integration (ITS)*	
Interpersonal Skills for Leaders (OLS)	*Software Project Management (TECH)*		
Workshop in OLS (variable course title	*Internship in Technology (TECH)*		
Managing Diversity (OLS)	*Database Management Security (ITS)*		
	Database Administration (ITS)		
	Data Warehousing and Business Intelligence (ITS)		
	Leadership and Organizational Change (OLS)		

** CGT-Computer Graphics Technology; CMET (Construction Management and Engineering Technologies; EET-Electrical Engineering Technology; IET-Industrial Engineering Technology; TECH- Technology; ITS- Computer Information Technology; MET-Mechanical Engineering Technology; MEC Mechatronics Engineering Technology; OLS-Organizational Leadership and Supervision*

Based on these approved courses the program has developed 3 graduate certificate programs. These are: 1) Six-Sigma for Business and Industry, 2) Database Integration Technology, and 3) Organizational Leadership and Supervision. The students are advised to develop their plan of study in such a way that as they graduate they can also receive a related

graduate certificate. Graduate certification has been promoted actively during 2012 among enrolled MS students. In fall 2012 alone, there was a total of 10 students that received graduate certificates.

The program has been popular because students, particularly industry professionals, can enhance their knowledge and skills in both, technology management as well as in their field of expertise. Table 3 shows the number of admitted students who have declared interest in different content areas and took 3 or more courses in these areas. While EET, IET, and MET enrollment has increased considerably, CIT and CMET enrollments have declined during the 2010-2012 period. The reason for the decline in CIT is that two full-time CIT faculty members left the institution during that period. The program could not determine the cause of declining enrollment in the CMET focus area. Table 4 shows the actual number of students enrolled in the program. The trend shows little increase in full-time students and little decrease in part-time students. This could be due to an increase in international students.

Table 3. Number of admitted students who have indicated areas of interest

Area of Interest	*Number of students admitted (Fall data)*				
	2008	*2009*	*2010*	*2011*	*2012*
Computer Information Technology	*20*	*43*	*50*	*31*	*28*
Computer Graphics Technology	*2*	*5*	*9*	*14*	*13*
Construction Mgmt. & Engineering Technology	*7*	*13*	*16*	*11*	*8*
Electrical Engineering Technology	*7*	*19*	*22*	*32*	*41*
Industrial Engineering Technology	*4*	*14*	*15*	*29*	*26*
Mechanical Engineering Technology	*7*	*13*	*21*	*25*	*37*
Organizational Leadership and Supervision	*11*	*26*	*26*	*33*	*30*
Mechatronics Engineering Technology	-	-	*0*		*9*
Undeclared	*17*	-	-	-	-
TOTAL	*75*	*133*	*159*	*175*	*192*

Table 4. Number of students who have enrolled in the program

	2008	2009	2010	2011	2012
Part-Time	50	71	92	82	77
Full-Time	19	45	33	35	37
Total	69	116	125	117	114

One of the strengths of the program is that a student can complete an internship during the program (Table 5). These internships are the result of mutually-beneficial partnerships between faculty members and key industry partners. In many cases, students were hired by the companies after completion of the program.

Table 5. Number of graduate students completed internships

Year	Spring	Summer	Fall	Total
2010	3	8	13	24
2011	6		3	9
2012	2	6	6	14

Furthermore, such faculty-industry partnerships have resulted in industry-sponsored projects for students' directed project work. Internship opportunities for students have been the main reason for enrollment growth of the program without significant marketing and promotion of the program.

Prospective Students, Student Marketability and Employment Opportunities

Part of the program development and implementation has been the review of employment and job opportunities of current students and graduates. Most of the students in the program are working adults, although there are about 30 percent students who are full-time student (Table 4) and are not employed outside the University. Currently employed students are typically looking for advancement opportunities or a career change. In recent economically depressed years, some students expressed a desire for a degree in order to be more knowledgeable and valued as employees, and therefore more likely to be retained in times of layoff and employee cutbacks.

In assessing the impact of the degree, and determining where potential students were and what their master's degree education might prepare them for, the program looked at the growth rate (employment projections) of the various employment opportunities related to the MS in Technology degree. The information below reflects current information on employment trends, and differs from the employment trends as originally evaluated in support of the degree in 2006-2007. According to the Bureau of Labor Statistics (BLS), occupations in the master's degree education category are expected to grow the fastest, about 22% (2010-2020 projected).[4] Standard Occupational Classifications (SOC) 11-3051 reported that for Industrial Production Managers, the job outlook for 2010-2020 is projected to grow at 9 percent.[5] For Architectural and Engineering Managers (SOC 11-9041), the rate of growth is also 9 percent, or slower than average. For Industrial Engineering Technicians (SOC 17-3026), the rate is even slower, a projected 4 percent.[6]

A search of O*Net OnLine (another database on employment outlook) for SOC codes matching 11-3051 yields a family of positions.[7] Of these, industrial production managers and quality control systems managers are most relevant to the MS in Technology degree. Sample reported job titles are: Production Manager, Production Supervisor, Plant Manager, Manufacturing Manager, General Production Manager, Production Control Manager, Production Supervisor, Supervisor, Manufacturing Coordinator, and Area Plant Manager. A similar search can be performed for SOC 11-9041 Architectural and Engineering Managers. Sample reported job titles are Engineering Manager, Project Engineer, Project Engineering Manager, Project Manager, Director of Engineering, Chief Engineer, Civil Engineering Manager, Principal Engineer, Process Engineering Manager, and Supervisory Civil Engineer. Again, only some of these titles are directly relevant to the typical positions held by graduates in the MS in Technology program. Some of these positions may not be filled by graduates from MS in Technology who do not have adequate industry experience, however many of the students in the MS in Technology program are industry professionals with several years of experience in industry who may qualify for these positions.

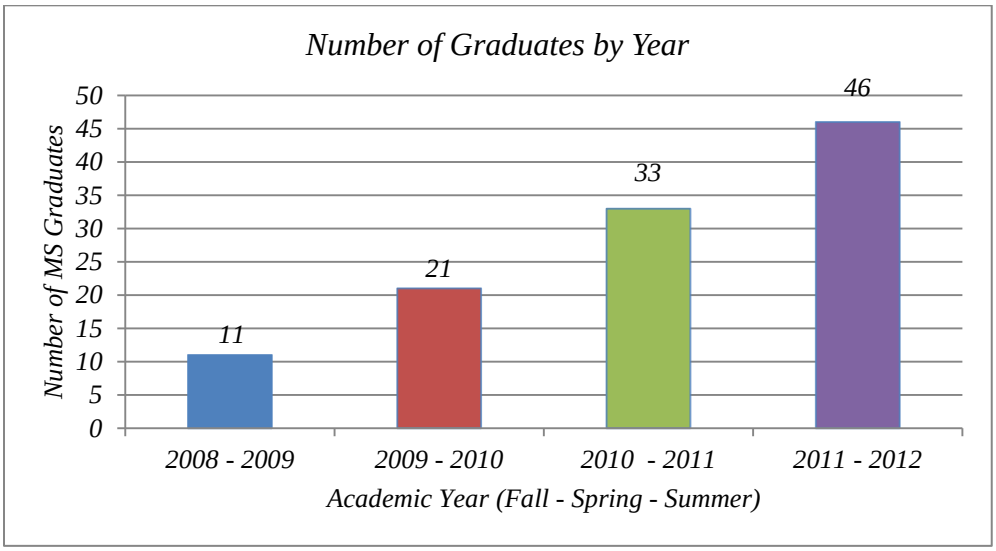
Another source of information about the needs of employers is the Major Employer information for the region which the campus serves. It is possible to locate information on

Major Employers by county and state for the areas where the campus is located, or where the majority of its graduates are likely to end up. Typically this information is available on a state by state basis, and relies on census and related data. This serves two purposes: it provides ideas for a graduate level industrial advisory committee, and it also gives a direction for employment needs in the area. This also gives an idea of where potential students are currently employed, so that recruitment efforts might be targeted at employers who may wish to send their students for additional education.

Program Success and Challenges

The Master of Science in Technology started in 2008 with no additional faculty resource. Today, the program has grown to have 192 students, 102 of whom are registered in Spring 2013. This program, as shown in the chart below, has graduated a total of 111 students by Summer 2012 (Figure 1). Please note that graduation data is presented for each academic year (Fall-Spring–Summer). Also, it should be noted that 28 students were enrolled in 2007 as a pilot program prior to final program approval by ICHE in Spring of 2008. A total of 11 (8 in Fall 2008; 3 in Spring 2009) students graduated during 2008-2009 academic year.

Figure 1. Number of graduates during 2008-2012



The above enrollment and graduation numbers are more than four times the numbers proposed to the Indiana Commission for Higher Education. The proposed prediction was to have 22 FTE students in the program's fifth year. The total FTE in Fall 2012 was 92. An alumni survey was conducted in Spring and Summer of 2012 to learn about the distribution of graduate employment in different sectors. Responses from 53 alumni showed that most graduates worked for industry and businesses (Table 6). Three graduates went on to pursue PhD degrees.

One of the hallmarks of this program has been its directed-project course, helping regional companies solve their problems. As of summer 2012, of 103 graduates, 66 students (64%) completed directed projects. For instance, one of the directed projects saved over $800,000 per year for a manufacturer of consumer products. Another project related to the

healthcare industry saved over $200,000 per year. However, due to a limited number of faculty members, a directed project-based program limits the program's growth. A sample list of directed projects is presented in Table 7.

Table 6: Employment of graduates in different sectors

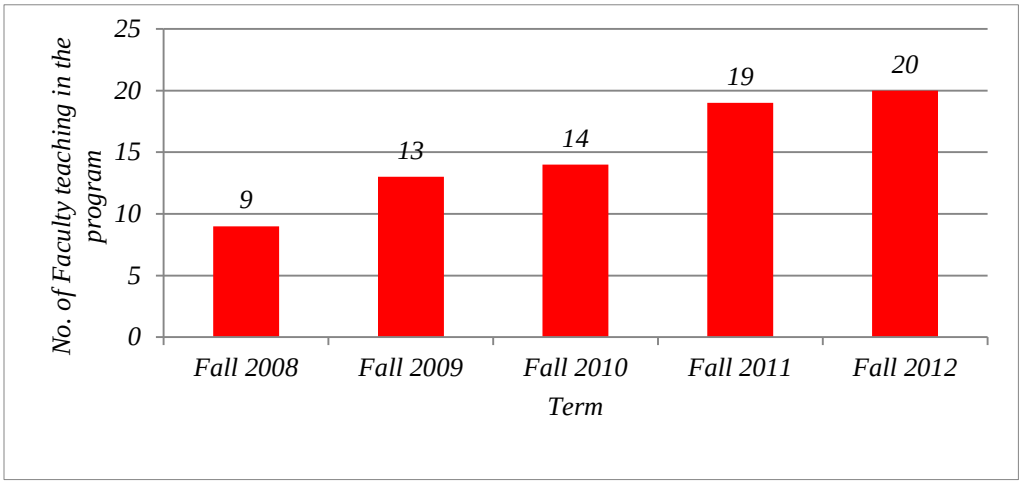
Industry	*21*	*Healthcare, System Integration, Manufacturing, Medical Equipment, Wireless Communication, Automotive, Transportation*
Business	*19*	*E-commerce, Business services, Financial Services, IT Consulting, Graphics Business*
Government	*3*	*County, City, State Governments*
Education	*7*	*K-12, 2-year College, 4-year College*
PhD Program	*3*	*Doctoral program in Technology*

In the fall semester of 2012, for the first time, the program hired two limited-term-lecturers. Due to an increase in enrollment, the program had to offer more graduate-level courses and involve more faculty members (Figure 2). It should be noted that the number of full-time faculty members in the School of Technology remained at the same level for the last six years, which is 34. No additional full-time faculty member has been added for the graduate program yet.

Table 7. Sample list of student MS Directed Projects

Directed project title	***Students' area of interest***	***Working in related field (Yes/No)***
Analyzing the Support Need of the Clinical Connect Program and Implementing Technical Change - Saved $200,000 per year for ind ustry	*OLS*	
Servo Driven Inline-Orienter to Deliver the Containers in Proper Orientation to a Filling, Labeling or a Capping Machine During a Packaging Process - Saved $800,000 per year for the industry	*MET*	*Yes*
Inventory Management in a Lumber Manufacturing Facility using RFID technology	*IET*	*Yes*
Assessment in Legal Issue in Cyber War	*ITS*	*Yes*
Identifying and Eliminating Noise & Vibrations from High Speed Conveyors	*MET*	*Yes*
Developing Virtual Laboratory Experiments to Enhance Student Learning Radio Frequency Identification (RFID) Technology	*IET*	*Yes*
Government Regulation and Security of the Web-Based Disaster Management Communication	*ITS*	*Yes*
Increasing Utility Fossil Power Plant Steam Cycle Efficiency as a Result of Colder Condenser Cooling Water Inlet Temperature	*MET*	*Yes*
Cost Effective Way to Providing Robotics Training to Students and Industry Personnel	*EET*	*Currently, a PhD Candidate*

Figure 2: Number of faculty members teaching in the graduate program



With over 100 alumni in four short years, a large number of graduates have been hired by regional companies. This has had a positive impact on the economic development of the region. It should also be noted that a number of students take advantage of internships in this program. Some of these internships have resulted in small grants given to faculty/students by local companies to solve their technical problems. This program has also resulted in students/faculty having joint publications and scholarly work. With the unexpected large growth of the program, more resources need to be allocated to the program to sustain this growth and consequently help the faculty development growth.

Summary

The Master of Science in Technology introduced in 2008 has been one of the successful degree programs of the Purdue University Calumet due to several factors. These factors are:

- a flexible program that could be tailored to the needs of the student's career goals
- the existence of graduate certificates, creating an added credential, targeting employers seeking specialized skills
- establishment of the Graduate Studies office with a new position of an Assistant Dean, a full-time Administrative Assistant, and resources allocation including a recurring budget
- a program that assesses and addresses the needs of the local and regional industries
- requirement of a directed project which produces tangible results, benefiting industry
- partnerships between faculty members and industry professionals that create internship opportunities for students. These opportunities not only provide students with meaningful experiences, but in many cases, resulted in full-time, well-paying jobs.
- increased faculty scholarly output resulted from students' directed projects.

The program has had significant growth and is projected to have an enrollment of about 200 students in the next two years. However, a limited number of faculty members within the School of Technology could hinder such growth.

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