

AC 2009-2468: THE PROFESSIONAL SCIENCE MASTER'S (PSM) DEGREE IN ENGINEERING TECHNOLOGY

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The Professional Science Master's (PSM) Degree in Engineering Technology

Abstract

The Professional Science Master's (PSM) Degree in Engineering Technology (ET) is a new degree option created to meet growing industry needs for technologists with broad background and experience to provide rewarding career and academic opportunities for undergraduates in science, technology, business and health majors. According to the Council of Graduate Schools (CGS), this program involves not only advanced disciplinary study in engineering and technology, but also an appropriate array of professional skill-development activities to produce graduates highly valued by employers and fully prepared to progress toward leadership roles. These additional interdisciplinary professional skills include legal, communication, marketing, finance, and business training which are in demand by industry to complement the students' engineering technology expertise. The nontechnical courses are often developed in collaboration with appropriate academic departments outside engineering technologies and are often taught by qualified adjunct faculty from the appropriate areas of industry.

The main objective of this proposed program is to graduate high caliber technologists with multiple talents who can effectively participate and directly contribute to the improvement of the U.S. industrial competitiveness in the current global economy. This paper portrays an actual program model that describes the method of tailoring this new master's degree program to respond to current industrial needs, both locally and nationally.

Introduction

As the global economy continues to develop and evolve into a competitive world with new requirements for workforce talent and knowledge has resulted in considerable challenge to the U.S. technological leadership in the current world economy and the nation needs to respond to these global changes¹. Today's national and regional high-tech based industries need post graduates who are highly trained and well educated to advance the current state-of-the-art technology, while simultaneously possessing advanced business, communication, and legal negotiation skills. Traditional post graduate education produced scientists, engineers and technologists who are only familiar with their own field of study and focused on their own discipline. Industrial competitiveness is critical to the region's economic growth that has resulted in a crucial demand for postgraduates who have cross-disciplinary scientific expertise in advanced technology, business, communication and social skills to effectively manage high tech projects^{2,3}.

This has kindled the need for the development of a Professional Science Master (PSM) Degree program in Advanced Engineering Technologies-Plus⁴. This new PSM program will represent an effective answer to the problem and provide postgraduates with a chance to work productively

and efficiently in new and emerging industries. The PSM program is designed to serve a great and constantly growing need in industry to produce students who are technically savvy and have a high level of knowledge in the applied sciences, as well as a fundamental understanding of business and effective communication. Industry needs employees who not only comprehend the technical nature of their products, but the business and legal aspects as well, and are able to communicate their mission to broad audiences⁵.

The PSM degree program model presented in this paper is developed by the faculty of the School of Engineering Technologies (SET) at Farmingdale State College to offer bachelor's degree holders in science, engineering, business and technology a direct path to industry. This program is attractive to students because it prepares them for work in a variety of cutting-edge fields and yields a highly marketable degree after just two years of postgraduate study. The faculty and students at Farmingdale State College of the State University of New York are excited about their newly proposed PSM program that is strongly supported by the College's administration and intend its implementation as soon as funding is allocated. The College also is planning to rigorously evaluate and constantly improve its PSM program and disseminates the findings of its strength and weakness regionally and nationally to eventually work collaboratively as a mentor to other institutions interested in initiating their new PSM programs.

These PSM programs do not mean to displace traditional master's programs. Rather, faculty develop them to serve the needs of students who require a different graduate experience for the workplace that necessitates employees with depth of knowledge in science and technology as well as breadth in business, communication and entrepreneurship¹

A brief description of the problem needs to be addressed on both local and national contexts and how it is affecting postsecondary education

Traditional post graduate education is producing scientists, engineers and technologists who are only familiar with their field of study and focused on their own discipline. This has created a growing mismatch between the skills of these graduates that universities and colleges are producing and the needs of newly emerging industry in the current global economy³. These postgraduates of the traditional programs are unable to fit in the constantly evolving needs of new industries in the current intensely competitive global economy. This has imposed serious constraints on companies' growth and necessitates innovative approaches to rectify this problem in postsecondary education.

Description of the proposed solution

The main proposed solution of this problem is to develop a postgraduate program to provide working professionals and new graduates in the areas of science, engineering technology and management of technology with an opportunity to join an innovative Professional Science Master's (PSM) Degree program in "Advanced Engineering Technologies-Plus" designed to address current industrial needs. This high quality application oriented program will require a total of 30 credit hours divided into four categories: 1) Core courses, 2) Major required courses, 3) General elective courses and (4) Thesis or a project. The core courses are tailored to broaden the students' technical entrepreneurialship prospective and require a minimum of nine credit hours in the areas of total quality management, financial engineering and technical/ legal communication with Technology Transfer applications. New and innovative technologies recently developed in research and development laboratories across the country and around the globe should have effective and efficient mechanisms for transferring these modern technologies to industry. The major required courses are developed to promote students' advanced academic knowledge and experience in two main tracks namely, Engineering Technology and Management/Entrepreneurialship that are recognized for their considerable demand by the regional industrial community. The Engineering Technology Track will include the following areas of study: Alternative Energy, Electromechanical Systems, Computers and Electrical Engineering Technology, Mechanical and Manufacturing Engineering Technology, Electronics and Embedded Systems. The Technology Entrepreneurialship Track will include the following areas: Construction Management, Airline Management, Business Management and Automotive Management. A minimum of nine credit hours are required for each track in addition to a six credits practice oriented project conducted in collaboration with industry. The main objective of this component is to develop competencies in the student's chosen field of study and related research methodologies. This will enhance students' expertise with teamwork and potential for involvement in modern scientific research at the cutting edge of technology to be able to solve real world industrial problems. The general elective courses are interdisciplinary in nature and are intended to offer flexibility coupled with broad choices for students to balance the technical skills with Management/Entrepreneurialship competencies from the industry perspective.

Goal and objectives of the PSM Program

Goal

The main goal of the program is to train a new class of professionals with strong engineering technology and entrepreneurialship qualifications, including managerial and business skills. Its graduates will occupy leadership positions in corporations that run extensive technologically and scientifically advanced operations or whose activities are affected by modern industrial systems. These future leaders will require technology and entrepreneurialship skills beyond what is offered by traditional curricula at the bachelor's or master's level⁶. Graduates should be qualified to fill jobs that demand a thorough understanding of applied problem solving techniques and analytical methods of finance and risk management as well as deep knowledge of new developments in modeling and simulation and how best to apply them.

Objectives

Serve both industry and academia through achieving the following objectives:

- Deepening a student's knowledge beyond what can be learned in a four-year course of study, but staying within a disciplinary domain;
- Integrating study in the natural sciences and technologies with knowledge and training in business finance, management, law, or other professional domains such as technology transfer and communication;
- Providing well trained and highly educated postgraduates capable of supporting newly emerging industries and advancing the regional and national economy in the current global competitive market.
- Increasing student enrollment in Advanced Engineering Technologies Education and satisfying industry demand for this profession.

Institutional Mission and Planned Program Outcomes

Farmingdale State is the only public college of technology on Long Island to offer a comprehensive base of programs in the Applied Sciences and Technology. The College prepares students to be real-life problem solvers in traditional as well as emerging fields so that, upon graduation, their contributions to the economic vitality of the region, state, and nation are demonstrated. The educational experience at the College is centered on building a foundation of knowledge along with an appreciation of culture, ethics, esthetics, and diversity that empowers the graduate for continuous intellectual and personal development throughout life. The dedicated faculty and staff create a supportive environment in which teaching and learning take place through research and service.

The proposed PSM degree program greatly complements the Board of Trustees approved mission of the College and is expected to significantly enhance the overall campus enrollment by providing students in a number of undergraduate programs with an opportunity to complete their post graduate studies and achieve their academic goals. The program will also expand faculty involvement in research and professional development and increase students' participation in industrial applied research and product development projects that will positively impact their marketability and satisfy the Middle States reaccreditation and review process. This will prepare students for successful futures by providing real life applications of knowledge, critical thinking and a sound liberal arts education to help them pursue rewarding and successful careers.

According to the College's mission review, the implementation of this proposed program is given a top priority in the ongoing institutional planning process as it will foster teaching, learning, scholarship and research in a supportive environment. The program will provide students with an advanced academic foundation which includes an appreciation of the interrelationships among the applied sciences, technologies and current industrial needs. New

York State economy is based on small and medium size companies that approximately represent 95% of the total state business.

In addition to meeting the high-end workforce needs of regional companies, our proposed PSM graduates offer unique advantages to the small and early stage companies that are the engines of job creation. Technical staff in such businesses is often at a particular disadvantage in gaining access to technical information because small companies, that typically represent the backbone of our national economy, do not have the same information-gathering resources as larger firms. For these emerging companies, technology transfer is literal, as in sharing R&D or manufacturing facilities, access to technical expertise, and membership in social networks. For them, technology transfer is not only about patents and formulae but also it is know-how developed through hands-on experience or learning-by-doing. Know-how often is best transmitted through interpersonal contact, which may be difficult to arrange for reasons of distance, expense, or schedule. Because the students in this program bridge academic departments and focus on applied research, PSM graduates can be effective in helping small companies gain access to the College resources including the Institute for Research and Technology Transfer's (IRTT) advanced research and modern manufacturing facility.

Market: Need and Demand

The degree program and the two track options are designed to provide direct response to the demands of engineering, technology, management, pharmaceutical and health care professionals working in the region. The New York Metropolitan area and surrounding regions encompass some of the major research centers and leading industries that include engineering technology, biosciences, pharmacy, electronics, and instrumentation. These regional firms are heavily involved in high tech electronics, automation, biomedical technology, construction technology and aerospace research and development. In addition, manufacturing, defense, homeland security and other business sectors are also involved in product development, marketing and entrepreneurship. There is growing demand for professionals working in these industries to gain currently needed skills and competencies in alternative energy systems, biomedical technology, airport management, construction management and nanotechnology implementation, computer technology and applications⁷. The proposed degree program's two track options are intended to address these needs and produce highly skilled graduates capable of effective participation in the regional economic growth.

The US Department of Labor (DOL) projects that computer and electrical technologists will be one of the fastest growing occupations during the next 15 years⁸. The expanding integration of internet technologies and the explosive growth in electronic commerce is expected to result in rising demand for computer engineers and technologists who can develop internet and World Wide Web applications. The expanding electronic data-processing systems in business, telecommunications, government, and other settings continue to become more sophisticated and complex. Growing numbers of electronics technologists will be needed to implement, safeguard, and update systems and resolve problems. Consulting opportunities for computer technologists and entrepreneurs are also expected to increase as businesses seek help to manage, upgrade, and customize their increasingly complex computer systems. Employers are expected to seek increased number of software engineering professionals with strong programming skills, and

competencies in computers and electronic systems development and applications. The proposed program track in engineering technology with a computer application concentration is aimed at meeting the needs of newly emerging industry and supporting the regional expanding economy with competent graduates who are familiar with modern technologies and entrepreneurship that includes business, communication, legal negotiations and technology transfer.

A considerable industry demand and the acute shortage of professionals with advanced skills in alternative sources of energy was emphasized by a number of industry and academic prominent leaders, in a recent SUNY Sustainability Conference that was held in November 2007 at Saratoga Springs, NY. A long list of large corporations, locally and nationally, are currently striving to become more environmentally friendly and are making a major commitment to renewable energy and invested millions of dollars to recruit technologists and engineers with advanced knowledge and applied skills in related engineering technologies.

It was recently reported, "The renewable energy gold rush intensified after these large corporations entered the market with a pledge to deliver electricity from renewable energy sources cheaper than that produced from coal." The internet giant disclosed "a new initiative called RE< C (Renewable Energy with low or no carbon pollution) to work towards delivering this target and announced it was hiring engineers, technologists and energy experts to lead its new research and development work." It is expected that industry will invest tens of millions of dollars into renewable energy related areas with a particular focus on advanced hydrogen systems and fuel cells. This will support the economic growth and create about 1500 new jobs on Long Island that will increase the demand for graduates with strong backgrounds in renewable energy and environment management. A degree program track in engineering technology with a concentration in renewable energy and environment is proposed to meet those needs.

As government and industry take measures to educate increased numbers of health care professionals, there has been a continued need to educate and train them with the application of advanced technologies in computers, robots and automated systems. Demands for information management and entrepreneurialship have created the need to educate professionals in the application of advanced technologies. To address these educational needs in the region, an interdisciplinary program involving engineering technologies and entrepreneurialship is proposed.

Although the new housing market has slowed down in recent months, there is a vast market in Long Island for modernization of facilities that include many school districts, public and private commercial and institutional buildings, and infrastructure projects. There is a tremendous need for highly trained construction managers in this industry. To address this need, the Professional Science Master's in Construction Management degree will be designed to provide students with a high level of skill and understanding in the technical and business aspects of construction project administration. Substantial emphasis will be placed on advanced studies in the field of new and emerging techniques for construction project delivery systems, business and administration of the construction firm.

An estimation of student demand at the local level for this program

The student demand for this program is estimated at 5% of the total bachelor degree graduates from Farmingdale State and other colleges and universities in the related fields of technology within a 50 miles radius from the Campus. An additional 5% of the eligible graduates in the southern part of NY State are expected to express interest in this program. The total estimated student demand for this program is 300 students annually. In addition to our own graduates from the Construction Department, a vast pool of engineers and architects on Long Island are interested in a construction management graduate program. A preliminary survey conducted by the department has shown substantial interest from other related programs in the construction management area. Graduates of other disciplines (other than construction management, such as engineering and architecture) will be able to enroll in this proposed program with some undergraduate prerequisite courses. Similarly, graduates with bachelor degrees from related areas of engineering, technology, management and science could join the proposed PSM program in any of the areas presented in both tracks of this new curriculum.

An estimation of local employment opportunities for graduates of the program

Employment opportunities for professionals with advanced technical degrees in Engineering Technologies with additional training in Management/Entrepreneurialship and other business related areas will increase considerably in the next decade. According to recently published projections by the Department of Labor regarding job growth from 2007 to 2017, the overall job growth for professionals with advanced degrees in engineering technology related areas is estimated at 25% on average. The projected job growth in areas that graduates of the proposed program may seek employment opportunities is shown in the following table.

Occupational Group	2007 - (thousands)	2017 - (thousands)	Change (%)
Computer Science	788.2	1,030	30
Engineering	630	709	12.5
Healthcare	1,701.3	2,140.4	25.8
Energy relating	904	1,180	30

Note: This data presented above is for the NY metropolitan area.

Expected program enrollment and fiscal factors

Projected Enrollment

The program enrollment is conservatively estimated over five years since the inception of the program and is based on only 5% of the eligible bachelor degree graduates from the School of Engineering Technologies (SET) and other related programs on the College Campus. An online search of other similar programs across the nation was also conducted to reach the enrollment projection shown below:

	Year1	Year 2	Year 3	Year 4	Year 5
Full-Time	40	50	55	65	75
Part-Time	30	35	40	45	55

The proposed program provides the undergraduate students with a natural academic extension and a pipeline for their educational goal at the Master Degree level. Thus, an estimated 20% overall increase in the students' enrollment in the School of Engineering Technologies and related programs is anticipated.

Estimated Total Cost Requirements

	Year1	Year 2	Year 3	Year 4	Year 5
Operating Budget	\$590,000	\$630,000	\$760,000	\$770,000	\$795,000
Capital Equipment	\$85,000	\$88,000	\$100,000	\$100,000	\$100,000
Total	<u>\$675,000</u>	<u>\$718,000</u>	<u>\$860,000</u>	<u>\$870,000</u>	<u>\$895,000</u>

Evaluation plan, outcome assessment and continuous improvement of the project:

The evaluation of the effectiveness of this project will be predicated on how well the goals and objectives of this project are attained. The evaluation efforts and responsibilities will be shared among the instructors as they are in the best position to assess student performance and progress. However, the project outcomes are measured by graduates capability, effectiveness, and productivity in the industrial community and will be mainly evaluated by the employers. Students' enrollment, graduates placement rate, and these graduates' salary levels will be surveyed by the departmental and institutional offices.

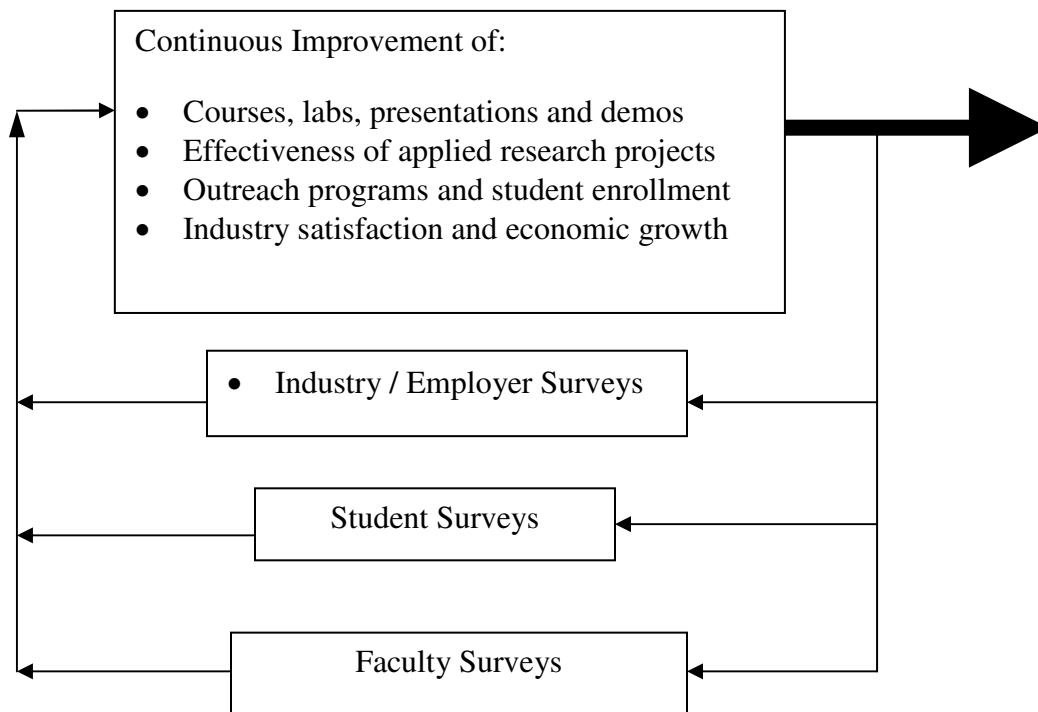
The external evaluation will study implementation of the various program components including how resources are used to develop activities, and how the activities are initiated. In the first phase, the evaluation will consider the experiences of students, faculty, and others associated with this new Professional Science Mater's program. Evaluation methods will include observations and interviews, surveys assessing student involvement and attitudes, focus groups, review of relevant documents, and analysis of numerical data as needed. As the project continues, the evaluation will consider outcomes for students, faculty, and the institution. As far as collecting data and assessing impact, the evaluation will consider resources, project activities, and project outcomes.

Resources include the expertise of individual faculty as well as other collaborative activities including leading industrial personnel that will be involved in the preparation of innovative courses and materials for the newly proposed program, work on the use of technology in teaching and learning, and interdisciplinary applied research projects that will be developed by the participants. Project activities are mainly defined by the deployment of new and innovative technologies and modern systems for students' demonstrations and utilization for applied research projects. Outcomes will be studied and assessed, particularly in the areas of faculty

development, student performance, overall departmental and institutional impact, and contribution to Long Island's and the nation's technical community.

The evaluation will first consider implementation – whether demonstrations are developed and offered as planned, and what barriers are encountered. Surveys, interviews, and discussions will be used to gather data about faculty and scientists' collaboration with industry, and the impact of the new PSM project on students, faculty, and industry. Students will be interviewed to assess changes in their enrollment and careers with industry in the area of engineering technologies. Faculty will also be interviewed and surveyed to assess students' performance and the effectiveness of faculty development programs, sponsored by the Department and the College in this new and exciting field of Professional Science Master's degree.

In the area of outcomes, the evaluation will consider the degree to which the proposed efforts accomplish the stated goals and objectives of the project, as well as faculty and industry acceptance and enthusiasm for this effort. The project's impact on the development of students' competence will be evaluated by their ability to utilize newly learned concepts of technology in the design and fabrication of more efficient systems as well as their ability to effectively utilize the applied research opportunities proposed in this project. The evaluation will be alert to unanticipated outcomes and will suggest midcourse corrections as appropriate. Based on the evaluation process the project continuous improvement method is shown in the following:



Dissemination plan

We feel that this proposal is quite innovative and deserves to be considered as a model to benefit many other institutions. Online communications, educational demonstrations and presentations at

regional and national conferences will serve as the main dissemination vehicle for sharing the results of the project and its evaluation findings with other professionals in the science, technology, business and energy fields. An important goal of our dissemination efforts is providing a working model to other colleges and schools of engineering technologies across the nation to be able to adopt or tailor this model to their program. Our intentions are to continue disseminating the proposed PSM program findings that include online research and educational demonstration materials developed from our proposed project and outreach programs for feeder colleges. Currently, we hold at least one workshop per semester through our Nationally Certified Solar Energy Center and the Fuel Cell Research and Education Center for industry, postgraduate and postsecondary education institutes as well as high and middle school teachers and students. We plan to continue participation and hosting of at least one national conference on the outcomes of our PSM program and our outreach efforts to introduce new applications in areas of national interest such as clean renewable energy and hydrogen fuel cells to graduate and undergraduate engineering technology faculty and students in cooperation with local industries and utilities. Our last national conference on renewable energy was held in October 2007 at our campus. We will continue to maintain the quality of dissemination efforts by publishing our education and research findings in peer reviewed journals. We also intend to continuously improve our dissemination plan based on feedback surveys from students, professionals, and peer review comments. The National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL), is also a part of our dissemination efforts as we plan to submit online courses, laboratory manuals, and applied research projects findings to be indexed and cataloged within the appropriate collections of NSDL.

Acknowledgement:

School of Engineering Technologies participating Faculty

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