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Transforming a Technology Management Master's Degree into an Innovative High Growth Inter-Disciplinary Program

Gad J. Selig and Tarek Sobh
University of Bridgeport, Bridgeport, USA

Abstract: As organizations develop their hiring plans in the areas of business, engineering, technology and management, they are seeking a greater number of individuals with multi-disciplinary skills, competencies and backgrounds to provide them with maximum flexibility for employer assignments, greater diversity in the work force and more effective employees with business, people and technology skills. Most Schools of Engineering or Business today have not yet come to terms with the inter-disciplinary needs and requirements and have not developed programs focused on developing the types of skills and competencies that prepares graduates adequately for the challenging leadership and professional positions demanded by 21st century organizations. Based on extensive industry research and confirmed by the Center for Inter-disciplinary Business, Engineering and Technology Leadership, consisting of senior executives from over 20 small, medium and large companies and organizations such as GE, IBM, UBS, Sikorsky Aircraft, Unilever, Bayer, Gartner, Infosys, Tata and others, the University of Bridgeport has transformed its MS in Technology Management Program into the largest program of its kind in the Northeast with a remarkable three year enrollment growth of over 1100%. This study describes, the transition of the MS in Technology Management Degree Program from a traditionally oriented, narrowly focused engineering management program to a dynamic, flexible and innovative Technology Management program relevant for preparing students for the 21st century global workforce. It outlines the program components, how it is synergized and leveraged with programs in business, engineering and other disciplines and how it prepares students to learn the skills, competencies and technologies required by organizations on a global basis.

Key words: Transformation, technology management, education, inter-disciplinary graduate program

INTRODUCTION

In the fall 2005, 32 graduate students were enrolled in the MS in Technology Management degree program, out of a total of 360 graduates in the entire School of Engineering at the University of Bridgeport. The Technology Management program was the smallest program in the School of Engineering, which also awarded graduate degrees in Electrical Engineering, Mechanical Engineering and Computer Science and Engineering.

At that time, we conducted a review of the TM program and made recommendations to transform the degree into an innovating, dynamic and growth oriented program with the following goals:

- Attract new career oriented graduate students and develop future industry and technology leaders adept at managing technology dependent organizations, technological change and skilled in establishing and maintaining superior competitive advantages for their respective enterprises
- Provide students with a variety of career enhancement options responsive to growing employer and employee needs for multiple competencies and skills in today's and tomorrow's demanding global work place
- Obtain the commitment and sponsorship of business and government organizations and institutions for our programs, provide internship and job opportunities for our graduates, sponsor more research and help to raise funds and support grant opportunities
- Create an innovative inter-disciplinary education environment for our students to seamlessly and easily integrate courses and concentrations offered by the Schools of Business, Engineering and/or Education and Human Resources

The results of the TM program transition have been nothing short of remarkable. In the fall 2008, the TM program has grown to 390 graduate students for a 3 years growth rate of over 1100+%. The TM program at UB is

Corresponding Author: Gad J. Selig, University of Bridgeport, Bridgeport, USA

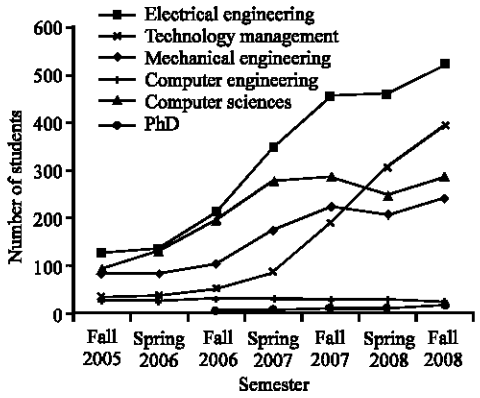

Fig. 1: Enrollment growth for MS in TM and graduate engineering students fall 2005-fall 2008

now the largest in the State of Connecticut and New England and may well be one of the largest in the United States. The growth of the entire School of Engineering in the same period to over 1,476+ graduate students (a growth of over 235%), is also, outstanding. Figure 1 shown the enrollment growth of the TM program and the School of Engineering over the last 3 years.

MATERIALS AND METHODS

Market needs: When we initially reviewed the TM program and factored in the growing market needs for more inter-disciplinary education programs, the development team applied many years of business, management, leadership, engineering and technology industry and education experience to the task and asked some difficult questions such as, Who would we hire today as a future leader in business or engineering or technology or a balance of all for our company? What skills, competencies and attitudes would we look for? What mix of soft skills (people, leadership and team), technology and business process skills would we expect? What about ethics, integrity, communications, diversity and a better understanding and acceptance of global diversity and cultures and being able to tap virtual global brains located anywhere and anytime? What about acceptance of and the proactive sponsorship of innovation, entrepreneurship, intrapreneurship and managing change? In assessing the market needs for the purpose of re-inventing the contents of the degree program, we always kept these questions in sight. In general, we also established the following wish list for the graduates of the TM program to be able to accomplish, once they were in the workforce:

- Identify and evaluate the impact of relevant changing technology and help manage those changes proactively in organizations
- Develop strategies and plans to identify, develop and implement innovative technological based solutions.
- Manage the effective planning and execution of those technology based initiatives and the integration of their impact into the mainstream of an enterprises' strategy, processes and operations
- The application of technology to create wealth as in successful entrepreneurship and/or intrapreneurship or corporate venturing initiatives
- Develop future leader and managers in technology or technology dependent organizations
- Develop, lead and motivate high-performance and diversified global teams
- Champion and sustain innovation initiatives and environments
- Manage accelerating change proactively

In a study of MS programs in TM and/or MOT in over 50 U.S. and international universities by Alyear, Rueda, Hernandz and Kocaoglu in 2006, the study concluded that a majority of the universities have recognized the need for and are developing more inter-disciplinary programs and courses that blend both management and technology topics, principles and practices (Audrey *et al*., 2006).

As part of our market research, we also reviewed over 30 leading edge university programs offering either graduate TM or equivalent degrees such as Engineering Management, Management of Technology, Manufacturing Management, Information Technology as well as MBA or MS degrees offered by leading edge business schools relating to some aspect of technology (e.g., Information Technology, Health Care Management and Technology, Supply Chain Management, New Product and Venture Creation, Entrepreneurship and others). We focused on universities that had both Schools of Business or Management and Engineering. Some of the schools that were reviewed included: Carnegie Mellon, Columbia, Stanford, University of California at Berkley, MIT, Stevens Institute of Technology, Polytechnic University, University of Maryland, University of Connecticut, Syracuse University, Worcester Polytechnic, George Tech, Case Western, Rensselaer, University of Missouri at Rolla and others (Web Site Sources of Universities such as Stevens Institute of Technology, etc., 2008).

The University of Bridgeport formed the Center of Inter-disciplinary Business, Engineering and Technology

Leadership (CIBETL) to identify and validate the need for more effective inter-disciplinary education programs to meet the growing employment needs of industry and government organizations. The CIBETL Executive Board of Advisors consists of senior executive and management professionals from both private and public sector organizations that provide advice and guidance on the direction and content of the CIBETL graduate education programs from an industry perspective. The responsibilities of the CIBETL Executive Board are as follows:

- Help shape the direction of inter-disciplinary education and training by suggesting ideas for new courses, degree and certificate programs to better prepare the current and/or future workforce
- Support important research in the inter-disciplinary business, engineering, education and technology fields through grants, contributions and other services
- Fund raising and in kind services such as equipment/hardware/software donations or time allocated to university events
- Give guest lectures, participate in colloquiums and/or consider becoming an executive-in-residence
- Hire interns, hire graduates, sponsor students to the program, etc.

Select CIBETL member companies, include Applied Engineering Products, ATMI, Avon, Columbia University Graduate School of Business, Connecticut Center for Advanced Technology (CCAT), Connecticut Innovations, EMCOR, Fuji Film, Infosys, USA, GE, GE Real Estate, Halbrecht Lieberman, IBM, IPC Corp., Purdue Pharma, Pitney Bowes, Oracle, Sikorsky Aircraft, TATA Consulting, TNT Expense Management, UBS Financial, Unilever and others. We conducted a survey of these and other companies to better understand what characteristics and skills they look for in business, engineering and technology graduates. The respondents checked the attributes (all that applied) in the following order of importance:

- Seventy percent ability to communicate (oral and written) more effectively
- Fifty nine percent strategic thinking, planning and marketing
- Fifty four percent ability to lead and motivate staff and teams
- Fifty percent understanding business processes, operations and basic financial knowledge

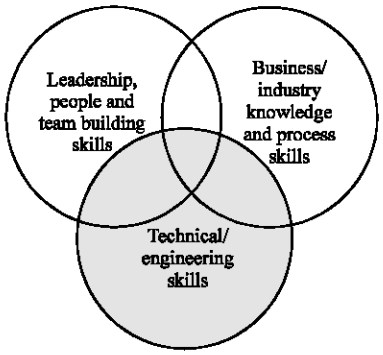

Fig. 2: Inter-disciplinary business, engineering, technology and leadership competencies

- Forty eight percent technical proficiency
- Forty five percent thorough knowledge of technology options
- Twenty two percent understanding industry trends and business strategy
- Twelve percent negotiation skills

During our research, we discovered that many of the engineering universities did not offer courses in many of the above areas. We also conducted, a short survey of select UB engineering school graduate alumni, who were in the work force. They strongly supported and re enforced the findings identified by the CIBETL board organizations.

In our TM program modernization efforts, we wanted to make sure that the Master's Program was well balanced and designed to develop leaders and professionals adept at managing technology dependent organizations, technological change and skilled in establishing and maintaining superior competitive advantage for their respective enterprises. The UB Technology Management Program was specifically designed to develop inter disciplinary skills and competencies in: the management of technology dependent businesses and enterprises, global markets and business development, leadership and people skills, new product or service development and commercialization, managing change and innovation proactively, strategic, tactical and project planning and execution, entrepreneurship and corporate new venture creation and many other skills. The program integrates the following disciplines as shown in Fig. 2.

A study of 69 universities by Nambisan and Wilemon further support the growth of inter-disciplinary graduate education with a balance of technology and management courses (Nambisan and Wileman, 1999).

RESULTS AND DISCUSSION

The transformation of the MS in technology management degree program as part of the newly formed graduate studies division: As with most universities who want to institute major change involving multiple programs and schools, each headed up by a Dean, we formed a committee of high powered and action oriented faculty members, department heads and deans representing the Schools of Business, Engineering and Education to facilitate the development of multi and inter-disciplinary courses and programs that would leverage the offerings of all of the participating schools and facilitate the promotion and delivery of these programs from a marketing and administrative perspective. We also recognized that we could achieve economies of scale by cross-listing courses in several programs and schools within the university.

The Graduate Studies Division at the University of Bridgeport was formed in 2006 and is comprised of the Schools of Business, Engineering and Education and Human Resources. It was established to offer new and tailor-able inter-disciplinary graduate degree concentrations, dual graduate degree options and graduate certificates in a variety of growth oriented professional fields. These innovative inter-disciplinary programs provide students with a variety of flexible career alternatives responsive to growing employer and employee needs for multiple competencies and skills in tomorrow's demanding global professional work force.

The School of Engineering at the University of Bridgeport offers the M.S. in Technology Management. Based on the market research we conducted in 2006, we completely redesigned the core course curriculum and offered 27 new or updated industry and professionally relevant concentrations to UB students. The Technology Management program requires a minimum of 32 credits to earn a graduate degree, consisting of both required core and elective courses selected from one or more concentrations. Many of the core courses were redesigned to cover multiple, but yet inter-related topics as validated by the CIBETL Board. In addition, we developed a number of new courses and concentrations such as environmental and energy management, program and project management, bio-technology sciences and management, service management and engineering and others based on industry and market input. The degree requirements are listed in Fig. 3.

The Technology Management degree prepares a student for many career choices and allows students to tailor their education options to prepare them for rewarding careers in business, engineering, consulting and/or management. The exciting and innovative degree concentrations include: Automation and Robotics; Bio Tech Management; CAD/CAM; China/India Trade; Computer Communications and Networking; Corporate, Government and Information Security and Continuity Management; E-Commerce; Entrepreneurship and New Venture Creation; Environment and Energy Management; Global Business and Marketing; Global Program and Project Management; Health Care Management and Administration; Human Resources Management; Information Technology; Intellectual Property Management; Manufacturing Management; Modern Data Base Systems; New Product Development and Commercialization; Service Management and Engineering; Software Engineering; Strategic Sourcing and Vendor Management; Supply Chain Management and Wireless and Mobile Communications over time some of these concentrations have become more popular with the

TM core courses*	Choice of concentrations for electives (27 choices)**
• Marketing, entrepreneurship and innovation • Total quality management and continuous process improvement • Finance and accounting for managers • Leadership, teams and managing change • Global program and project management • Business policy and startegy-capstone and/or project • Introduction to graduate studies (1 credit) • Engineering colloquium (1 credit)	• Bio-technology and/or bio-medical management and technology • Computer, networking, DBMS and software • Data base management systems • Electronic commerce and information technology • Environmental and energy management global • Management • Health care management and administration • New venture creation/entrepreneurship/intrapreneurship • Manufacturing management and technology • New product development and commercialization • Program and project management • Service management and engineering • Strategic sourcing and outsourcing • Supply chain and logistics mgmt. and technology
Required courses: 8 courses for degree	4 Elective courses

*Minimum total credits required = 32 for graduation

Fig. 3: Technology management core courses and elective concentration choices

student then others. In addition, we are continuously scanning and analyzing TM graduate education trends in the market place and are prepared to invest in new programs and concentrations that make market and financial sense.

As an example, a new MS in Bio-Medical Engineering Degree was recently approved by the Department of Higher Education of the State of Connecticut. UB's Technology Management program emphasizes hands-on involvement with business management and technology issues and opportunities through case studies, internships and team and individual research projects. The program has established very strong relationships with industry in the last few years through an active Center for Interdisciplinary Business, Engineering and Technology Leadership Industry Advisory Board and intensive networking and outreach initiatives with local, regional and global companies. Nothing happens in academia without great faculty. In the TM program, we are fortunate to have several faculty members who are top in their field and have helped to grow the program through their excellent teaching, research and service efforts.

To market these programs, we used both traditional and new ways to market our program. We also recruit students heavily from the international arena. Over the past 2 years, the growth in size, reputation, quality, introduction of new and innovative career oriented programs, courses and research outcomes has been extraordinary. Student teams from the TM and MBA programs have won first prize in the State of Connecticut Business Plan competition in the last 4 out of 6 competitions and were awarded a total of over $10,000 in prizes. The competition is open to all Connecticut based universities (e.g., Yale, UCONN, etc.) and is co-sponsored by the Connecticut Venture Group, Connecticut Innovations and the Department of Economic Development of the State of Connecticut (CT Entrepreneurial Foundation, 2008).

In addition, a 2008 National Science Board study, sponsored by the national Science Foundation, further validated the growing need for graduate degrees that focus on new business and venture creation in select science, technology and engineering disciplines and fields (National Science Board, 2008).

The new dual graduate degree programs linking the schools of business and engineering and education and human resources: Another finding of our research was that companies were also interested in students who earned >1 Master's degree. This further supported the inter-disciplinary nature of and direction of our programs and led us to the development of the dual graduate degree program options. The Graduate Studies Division of the University of Bridgeport offers several dual graduate degree programs, offered jointly by the Schools of Business, Engineering and Education and Human Resources. Current dual degree offerings include the MBA (Masters of Business Administration) and M.S. degrees in: Biomedical Engineering, Computer Science; Computer Engineering; Electrical Engineering; Technology Management; Mechanical Engineering and Instructional Technology. Dual Graduate Degree Programs typically reduce total required credit hours by eliminating redundant course requirements, which significantly accelerates the completion of 2, often complementary, degrees more efficiently and with significant cost and time savings for the students. Candidates for dual graduate degree programs are typically required to complete a minimum of 48 credit hours to satisfy the requirements of 2 masters' degrees. Some dual graduate degrees require a different number of credit hours. Table 1 identifies the available dual graduate degree programs. Where, BME = Biomedical Engineering; C.S. = Computer Science; CpE = Computer Engineering; MSIT = MS in Instructional Technology; M.E. = Mechanical Engineering; E.E. = Electrical Engineering; TM = Technology Management; MBA = Masters of Business Administration.

Table 1: Inter-disciplinary dual graduate degrees offered by the schools of business, engineering and education and human resources

BME/CS or CpE	CS/CpE	CS/MSIT	CpE/MSIT	ME/MBA
BME/EE	CS/EE	CpE/EE	EE/ME	ME/TM
BME/ME	CS/MBA	CpE/ME	EE/MBA	TM/MBA
BME/TM	CS/ME	CpE/MBA	EE/MSIT	TM/MSIT
BME/MBA	CS/TM	CpE/TM	EE/T.M.	Couns. and HR/MBA

The dual degree program prepares a student for many career choices and allows students to tailor their education options to prepare them for rewarding careers in business, engineering, consulting and/or education. A growing number of courses are also cross-listed between several of the above departments (ME and TM; MBA and TM, etc) so that students can easily register for them, without getting the prior permission of the department heads thus, saving time, sharing teaching and facility resources and reducing the overall cost of operations. The dual degree program has also experienced steady growth over the last year and is attractive to both students and corporations.

More career choices and opportunities for inter-disciplinary degree students: Based on the remarkable growth and success of the inter-disciplinary focused TM and Dual Graduate degree programs so far, we are providing greater flexibility and choice for our graduate students. In fact, some students will decide on technical

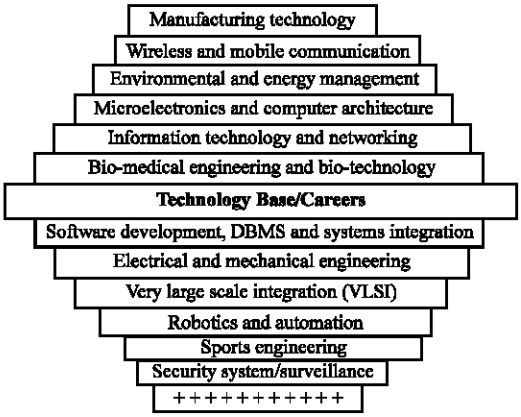

Fig. 4: Select technology careers

Fig. 5: Select professional and managerial careers

careers, while others will decide on management and consulting careers, while still others may choose entrepreneurship and start their own businesses or choose a combination of the above. Figure 4 and 5 shown the various career choices our graduating students are preparing for, in technology, various professions and/or management depending on their objectives, interests, capabilities and motivations.

CONCLUSION

Success is a wonderful thing. We will continue to refine and update the TM program in terms of new and industry relevant courses and concentrations and continue to grow it organically and through alliances with other domestic and international universities. We plan on expanding our cross-listed courses in multiple disciplines.

Based on our remarkable growth and current size, we are developing a Ph.D Program in Technology Management proposal, which will offer an inter-disciplinary Ph.D. program including courses from several graduate schools and represent an appropriate next step for the University of Bridgeport on our journey to become a world class education institution. This will include the Schools of Business, Engineering and Liberal Arts and Sciences at a minimum and perhaps others as well. We are also forming joint ventures and alliances with a growing number of domestic and international universities.

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