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Technological Innovation: An Option in the MS in Technology Program

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ABSTRACT

The Technological Innovation (TI) option of the Masters of Science in Technology program emphasizes the research, development and technical management of the technological innovation process within the technology-based organization. It is structured to aid the industrial and engineering professional that is responsible for the design and development of technical processes and products. This option includes the technical management of innovation processes, research and development, information technologies, and process technologies. Participants in this option come from a wide range of technological disciplines and draw on an extensive array of theoretical and applied knowledge.

This paper presents the development and implementation of the TI option. It discusses the content foundation to the option and how the option is structured in order to promote industrial and engineering professional involvement in the enterprises organization

Introduction

Technological advancement has been the single most influential factor in the creation of our quality of life, as we know it today. Economic growth and productivity improvement in the United States over the past fifty years has been driven by technological progress.

The following are just a few examples of how technology has impacted our way of life:

- **U.S. durable goods manufacturers averaged 27 percent of new product revenues, while the global average was 19 percent and new product firms averaged 49 percent.[1]**

- **U.S. manufacturing firms modernizing facilities averaged a 32 percent reduction in scrap/rework; 54 percent through-put time reduction, and 59 percent reduction in service and warranty costs using new flexible automation.[2]**

- **Successful business process reengineering (BPR) projects can achieve 75 percent or even 300 percent to 1000 percent improvements, but the "failure" rate is also high, at about 70 percent.[3]**

- **Information system technology contributes 21 percent of the output of companies, and the average employee is six times more productive than the non-IS coworker.[4]**

As we now move forward into the 21st century, technological innovation will accelerate. With this acceleration will come the challenge to industry and business to better manage the technological innovation process. The challenge to education will be to prepare the engineering and technological workforce that organizations will need to meet this challenge. New educational programs that emphasize technological innovation are needed.

Program Narrative

The Masters of Science in Technology (MST) was implemented in the Department of Technology at Northern Kentucky University during the fall of 1996. Since that time there has been 29 majors graduate from the program. Currently there are 62 individuals majoring in the program: 42 males, 20 females, representing 68 different employers, holding 69 distinct job titles, from 44 different undergraduate schools, and 32 undergraduate majors (see Appendix A).

The MST program is composed of a Core of five classes and three optional areas with five courses in each (see Appendix B). The original optional areas are: Technology Management, Quality Assurance, and Industrial/Engineering Systems. The student takes either a Comprehensive Examination or MST 683 Project to complete the degree. The optional area of Industrial/Engineering (I/E) Systems is the focus of this grant application.

The original I/E Systems option was composed of MST 620 Computer Aided Design, MST 622 Computer Integration, MST 624 Quality System Appraisal, MST 660 Seminar in I/E Systems, and MST 670 Topics in I/E Systems. This MST option was designed for the Industrial Technologist, Engineering Technologist, or Engineer who wanted to continue their education at the graduate level by maintaining a technical focus in their professional development/career. The I/E System has been meet with a moderate interest by these professional individuals. In the spring of 2002 a curriculum review was undertaken to determine if this option was a viable option area for the MST degree. A survey of past graduates, current majors, and potential students was conducted to determine their perception of the option.

Another survey of current and potential employers was also conducted to measure their interest in the I/E System. The results of these efforts indicated that the I/E Systems option did represent a good potential optional area, but that the content focus and structure of the option needed revising. A revision of the I/E System option was started during the summer of 2002. This curricular effort resulted in a major renovation to the I/E Systems area.

It was found that technical professionals are interested in and needed exposure to the technological innovation processes that modern business and industry are using. These professionals are being asked by their employers to participate in all aspects of product and/or process invention and innovation. As a result, the I/E Systems option has been reformed into Technological Innovation (TI). The TI option is designed to educate technical leaders for the 21st century in which new and emerging technologies will increasingly drive the creation of new products and processes at the same time making others obsolete.

The major objectives of the Technological Innovation option are to:

- **Apply a technological process to create or modify products, processes, systems or environments to meet human needs and expand opportunities.**
- **Select and use materials that are appropriate to achieving solutions to technological challenges.**
- **Design, adept, use and present information that is appropriate to achieving solutions to technological challenges.**
- **Design, adept and use systems that are appropriate to achieving solutions to technological challenges.**
- **Pursue and realize opportunities through the development of innovative strategies designed to meet human needs.**
- **Apply organizational, operational and manipulative skills appropriate to using, developing, and adapting technologies.**
- **Understand how cultural beliefs, values, abilities, and ethical positions are interconnected in the development and use of technology and enterprise.**

The TI option is composed of five courses: MST 621 Technological Innovation, MST 623 Advanced Project Management for Technological Innovation, MST 625 Product and Process Development, MST 604 Quality Planning & Design, and MST 693 Topics (see Appendix C for syllabi). The TI option provides a field base experience for professionals engaged in engineering, engineering technology, or industrial

technology related careers. This option provides focused, work-related experiences that emphasize design and development of products and processes, operations and process planning, and quality management. This option may be taken on a work experience or cooperative work basis.

Major topics include in the TI option are: the study of the strategic management of technology; technical innovation processes; technical innovation diffusion and the development, implementation and use of technologies; technological development trajectories; intellectual capital; organizations process by which technically oriented activities are integrated into organizations; product development strategies; technical project management; behaviors and characteristics of technical professionals; technological forecasting and policies; technical information technology management; impacts of new technologies on organizational forms and electronic commerce.

The TI option implementation is scheduled for the fall 2003 semester with the offering of MST 621 Technological Innovation. Each remaining TI course will be scheduled every semester and summer thereafter until all courses have been implemented (i.e., MST 623 spring 2004, MST 625 summer 2004, etc).

E-Teams via Problem Solving

The implementation of the TI option will be based upon the formation of one E-team. This team will involve the efforts of no less then one employer selected from the List of Employers (see Appendix A), a university graduate faculty member, and graduate students enrolled in MST 621 Technological Innovation. This initial E-team will act as the pilot group for the implementation period. One additional E-team will be created each fall thereafter for a period of three years to further establish the IT option. Additional E-teams will be formed during or after this period as opportunities and resources arise. Each E-team will more through the TI option, progressing from MST 621 Technological Innovation through MST 693 Topics. MST 693 Topics will be utilized as the capstone course for the E-team efforts.

The major instructional methodology to be used in the E-teams will be based upon problem solving skills. Each E-team will be required through their project management plans to utilize the most appropriate problem solving approach. Innovative models of diffusion and translation will be introduced to further guide and develop student problem solving efforts.

A graduate faculty advisor will be assign to each E-team. One employee at the minimum level of supervisor from the participating company will be required for each E-team. These individuals will mentor the E-team, representing their respective organizations. The mentors will be responsible for insuring that the E-team adheres to the policies & procedures of their respective organizations. The

mentors will also support the E-team in it's efforts to secure all necessary resources for the project.

NKU Resources

The E-team will have access to a fully operational "smart lab" located in room 111 of the Applied Science & Technology build on NKU's campus. This lab is equipped with modern computer capabilities that will allow for high rate Internet access, Audio/visual features that support virtual meeting and closed circuit meetings, and workshop or training program presentations.

Evaluation

Each course will be evaluated according to the NKU Student Evaluation process. This process measures 20 distinct aspects of teaching effectiveness and course appropriateness. This process is conducted every time a course is offered and is independent of faculty influence. The faculty utilizes these results to improve teaching and content.

The TI option will be reviewed for instructional effectiveness at the completion of its first cycle. A survey will be conducted of the participants, both academic and nonacademic, to measure their attitudes and opinions concerning the IT option. This information will also be used to improve the delivery of the program.

Results of both the NKU Student Evaluation and the participant survey evaluation will be used for quality improvement of the program effort.

Conclusion

The TI courses have been designed and proposed for implementation. Their instructional development still remains. That is, instructional resources and materials, teaching methods and students activities, and company partnerships must be developed and made ready for the initial offering of each TI course. This work is under way. Much of this work will be accomplished during the summer of 2004.

Reference

1 **M.F. Wolf, "Meet Your Competition," *Research Technology Management* (Jan/Feb 1994), p. 18.**

2 **J.E. Ettlie and E.M. Reza, "Organizational Integration and Process Innovation," *Academy of Management Journal,* 35, no. 4 (1992), pp. 795-827.**

3 **M. Hammer, "Reengineering Work: Don't Automate Obliterate," *Harvard Business Review,* (July-August 1990), pp. 104-112.**

4 **G. Rovetz, "Computers May Really Be Paying Off," *Business Week,* (Feb 14, 1994), p.20.**

Author

Dr. James R. Gray received his doctorate from West Virginia University and his Masters from Western Kentucky University. His undergraduate work was completed at Western Kentucky University. Dr. Gray is the Director of the Masters of Science in Technology graduate program. He is a Certified Manufacturing Engineer, through the Society of Manufacturing Engineers, and is certified as a Quality Auditor by the American Society for Quality. He is a qualified Lead Auditor for ISO 9000 and is a Senior Examiner for the Kentucky Quality Council. Dr. Gray has over 30 years of experience in education and training in industrial manufacturing subjects. He has specialized in the field of quality management & assurance and automated manufacturing processes. He has designed and developed training programs in the field of quality and workforce development for a variety of companies in the Greater Cincinnati. Dr. Gray has consulted with numerous companies such as Mazak Machine Tools, Clarion Manufacturing Corporation of America, and Sachs Auto of America.

Appendix A

MST Active Student Profile Summary

List of Employers	List of Job Titles	List of Undergraduate Schools
ACS	Account Manager-Technical	Beijing Polytechnic University
Addecco	Administrator	Berry College
Advanced Information Technology Corp.	Analyst	Bradley University
American Computer	Asst. Call Center Manager	Campbellsville University
American Modern Insurance	Builder	Centre College
Apex	Business Analyst/Technical Writer	Charter Oak State College
Attachmate	Business Manager	Cincinnati Bible College
Balluff, Inc.	CAD Instructor	College of Mount Saint Joseph
Bayer Becker Engineers	Claims Adjuster	DeVry Institute of Technology
Blueprint Automation	Consultant	Eastern Kentucky University
BMA Fasteners	Cooperative Education Coordinator	Embry-Riddle Aero. University
Burke, Inc.	Coordinator	Fontbonne College
Children's Hospital	Design Development Engineer	Howard University
Cincinnati Bell	Design Engineer	Indiana University
Cincinnati Public Schools	Designer/Project Manager	Kenya Polytechnic
Cincinnati State TCC	Detailer	Miami University
Cinergy Corporation	Development Technician	Middle Tennessee State University
City of Cincinnati & City of Covington	Director of Human Resources	Morehead State University
Compact Mold Midwest	Director-Project Management	National University of Science & Tech.
Copper Canon Camp	Education Coordinator	NED University of Eng & Tech
Covington Catholic High School	Engineer	Northern Kentucky University
Design Synergy	Environmental Lab Technician III	Ohio Institute of Technology
DHL	Equipment Service	Ohio State University
Electrodyne	Estimator	Ohio University
Emerson Power Transmission	Fire Fighter/EMT	Prince of Songkla University
Entex Information Technology	General Manager	Purdue University
F.N. Sheppard & Company	Graduate Assistant	Regional Institute of Technology
FEMP-Gryphon	Horticulturist	Southeast University/China
Gannett Media Technology	Information Technology Analyst/Mgr.	Thomas More College
Great American Financial	Instructor	Union Institute

Internal Revenue Service
International Paper
International Thomson Publishing
ITT Technical Institute
KDI Precision Products
King Wrecking Company

Krupp Hoesch Suspensions
Mastech System Corp.
Matrixx Marketing
Meridian Diagnostics
Ministry of fAgriculture and Cooperatives- Thailand

Mitsubishi
Northern Kentucky University
Northwest Airlines
Ohio River Company
Ohio State University

Origin Technology in Business
Plexus Corporation
PNC Bank
Procter and Gamble
Rapidigm, Inc.
ResouceNet International
Rohm and Haas
Ross Local Schools

SDRC
Seton High School
Square D Company
Staples Direct
St. Elizabeth Medical Center

Sweco Inc.
Tetra Tech NUS
Toyota Motor Manufacturing
United Parcel Service

US Army
US Precision Lens
Watson's

Intake Supervisor
Lead Business Analyst
Library Systems Engineer
Maint Technical Editor
Mathematics Teacher
Mechanic Operator II

Nurse Manager
Packaging Engineer
Product Marketing Manager
Production Associate
Production Systems Coordinator

Program Evaluator
Programmer
Product Design Engineer
Project Manager
Project Management Specialist
Prototype Department Manager
Quality Assurance Inspector
Quality Engineer
Quality Manager
Sales Manager
Senior Programmer
Software Consultant
Software Engineer

Sr. Programmer Analyst
Supervisor
Support Analyst
Support Engineer
Support Staff

Systems Engineer
T&D Operations Coordinator
Teacher
Teaching Assistant

Technical Specialist
Technical Support Engineer
Technical Support

Univ of the Sacred Heart/Puerto Rico
Universite' d'Abidjan
University of Cincinnati
University of Garyounis
University of Kentucky
University of Nairobi
University of Science and Technology
University of the Phillipines
University of Toledo
Utah Valley State College

Virginia State University
Western International University
Western Kentucky University
Wright State University

List of Undergraduate Majors

Aeronautics

Animal Science/Chemistry
Anthropology
Architecture
Biology
Business
Business Administration
Communication
Computer Science
Computer Science & Engineering
Criminal Justice
CST/CSIT
Economics
Electrical Engineering
Electronics Engineering Technology
English
Geology
History
Industrial Education & Technology
Industrial Labor Relations
Information Systems

		Representative	
Westerman Print		Technical Writer	Information Technology/Business
Totals		Technology Coordinator	Manufacturing Engineering Technologies
	6		
Total Enrolled in MST	2		Marketing
Number Majoring in Technology Management	3 1		Mathematics
Number Majoring in Industrial & Engineering Systems	1 7		Mechanical Engineering Technology
Number Majoring in Quality Assurance	1 2		Nursing
	3		
Number of Kentucky Residents	4		Office Systems Technology
	2		Organizational
Number of Out of State Residents	8		Studies/Education
	4		
Number of Males	2		Political Science
	2		
Number of Females	0		Science Technologies
	2		
Number of Majors Graduated	7		Statistics

A. The MST Program is a thirty-three (33) hour program composed of a Core and one Track. All students must complete the five Core courses, plus a Master's Project or Comprehensive Final Examination:

Core Courses

- **MST 602 Project Management in Technology …….3**
- **MST 61 0 Research Methods in Technology ……3**
- **MST 612 Technical Management in a Global Economy …….3**
- **MST 614 Computer Applications in Technology ……3**
- **MAT 630 Applied Statistics in Technology ……3**
- **MST 683 Project or Comprehensive Final Examination ……3**

B. Areas of Concentration (Tracks) 12-15 semester hours - Candidates for the MST must complete program requirements by selecting one of the three tracks: lndustrial and Engineering Systems, Technology Management, or Quality Assurance.

1. Industrial and Engineering Systems

The Industrial* and Engineering *Systems track provides a field base expe7ienceforprofessionals engaged in engineering, engineering technology, or industrial technology related careers. This option provides focused, workrelatedexpe7iencesthai emphasize Design and Development of Products and Processes, Operations and Process* Planning, and Quality *Management. This Track may be taken on a Work Experience or Cooperative Work basis.

MST 620 Computer Aided Industrial and Engineering Design .....3 (Design and Development for Production)

MST 622 Computer Integration in Industrial and Engineering Systems 3

MST 624 Quality System Appraisal (Quality Management) 3

MST 660 Seminar in Industrial and Engineering Systems 3

MST 670 Topics in Industrial and Engineering Systems (Related Topics) 3

2. Technology Management

The technology management track provides coursework* in training and *development, technical communication, and other specialized content areas to assist students to manage rapid change in a technical environment.

MST 640 Technical Training and Development 3

MST 642 Human Resources Management in Technology 3

MST 644 Technical Communications in a Global Economy 3

MST 665 Seminar in Technology Management 3

MST 675 Topics in Technology Management 3

***3.* Quality Assurance**

The Quality Assurance track emphasizes the specific technical skills and managerial competencies needed by professional to* analyze an *organization's present quality needs, develop a comprehensive plan to account for that organization's quality goals, facilitate the successful implementation of quality elements, and determine the effectiveness and efficiency of the overall quality program. The track will be delivered via Internet instruction - Web based courses with no scheduled classes on NKU campus.

MST 604 Quality Planning and Design 3

MST 624 Quality System Appraisal 3

MST 634 Design of Experiments .....I.....3

Appendix C

Replacement for the Industrial/Engineering Systems Option

Technological Innovations

The Technological Innovations track provides a field base experience for professionals engaged in engineering, engineering technology, or industrial technology related careers This option provides focused, work related experiences that emphasize Design and Development of Products and Processes, Operations and Process Planning, and Technological Innovations. This Track may be taken on a Work Experience or Cooperative Work basis.

- **MST 621 Technological Innovations**
- **MST 623 Advanced Project Management for Technological Innovation**
- **MST 604 Quality Planning and Design**
- **MST 625 Product and Process Development**

Course syllabi
TECHNOLOGICAL INNOVATION

MST 621 (3, 0, 3)

CATALOG COURSE DESCRIPTION

This course focuses on the technological-based innovation process. It examines how industries are transformed by new technologies and how organizational action shapes product class evolution. It integrates content from strategy and policy, organizational behavior, engineering operations, marketing and Research & Development.

Prerequisites: MST 621

Text: V.K.Narayanan. Managing Technology and Innovation for Competitive Advantage. Prentice-Hall Longman, 2001.

Course Objectives:

- **Develop a set of tools and methodologies for innovations management**
- **Develop abilities to create an innovation as a management process**
- **Create awareness of the role of all multiple functions in creating an innovative process**
- **Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common process management initiative**
- **To provide a reinforcement of specific knowledge from other prerequisite courses to provide practice and reflection in the management of innovation.**

Course Topics:

- **To Understand the Present, You Have to Study the Past — The Development of Technological Innovation.**
- **The Age of Biology. Innovation and Biology**
- **Determining Your Present Position and Setting Goals.**
- **People — Internal and External Stakeholder Analysis.**
- **Analysis of the NPD and NBD Business Processes.**
- **Determining Non-linear Mechanisms.**
  Modeling the Innovation and NPD and NBD Processes — Dynamic Business Modeling.
- **DBM — Speeding Up Organizational Learning.**
- **Designing and Redesigning Business Models and Strategic Management.**
- **DBM and the Management of NPD and NBD.**

PRODUCT DESIGN AND DEVELOPMENT

MST 625 (3,0,3)

Catalog Description:

Product Design and Development is the integration of the marketing, design, and manufacturing functions of the firm in creating a new product or process. The course is intended to provide students with: (1) Competence with a set of tools and methodologies for product design and development, (2) Confidence in own abilities to create a new product and/or process, (3) Awareness of the role of multiple functions in creating a new product (e.g. marketing, finance, industrial design, engineering, production), (4) Ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective, and (5) Reinforcement of specific knowledge from other courses through practice and reflection in an action oriented setting.

Prerequisites:

MST 621 Technological Innovation

Text:

K. Ulrich and S. Eppinger, Product Design and Development, McGraw-Hill, 1999.

Course Topics:

- **Introduction**
- **Opportunity Identification**
- **Project Proposals**
- **Customer Needs**
- **Specifications**
- **Concept Generation**
- **Prototyping**
- **Concept Selection**
- **Concept Testing**
- **Human Factors**
- **Product Architecture**
- **Design for Manufacturing**
- **Taguchi Methods**
- **Financial Modeling**
- **Intellectual Property**
- **Environmental Issues**

Course Objectives:

- **Develop a set of tools and methodologies for product design and development.**
- **Develop abilities to create a new product and/or process.**
- **Create awareness of the role of multiple functions in creating a new product.**
- **Develop ability to coordinate multiple, interdisciplinary tasks in order to achieve a common objective.**
- **Apply research & development (R&D) skills to product and process design projects.**

Instructional Processes:

Project and Assignment Descriptions

Each of these assignments are intended to pace the development process for a new product or process. Assignments will be due on time, no extensions will be granted. All project assignments except the opportunity proposal are to be completed as a team.

All assignments are to be delivered according to the following format:

- **Hand in only one copy per team with all team members names attached.**
- **Use electronic files to submit all assignments.**
- **Provide an graphics or pictures via electronic means.**
- **Be concise. Assignments should be two or three pages in length, when possible. The exception to this guideline is concept sketches, which we hope you will prepare with one concept per page.**
- **Provide a short, one page description of the process your team adopted in completing the assignment and a reflection on its effectiveness. You should also comment on any lessons learned related to team dynamics or project management.**

Part 1: Proposal Handout

Prepare a project proposal. We will photocopy the proposals and distribute them in class. Proposals should include: A brief, descriptive project title. Your name, electronic mail address, phone number. A description of the product opportunity you have identified. Your description may include any of the following: documentation of the market need, shortcomings of existing competitive products, and definition of the target market and its size. Please do not present any of your own product ideas at this point; our strict focus in this phase of the course is on the market opportunity and not on solution concepts.

Part 2: Proposal Presentation

Prepare a 90-second PP presentation to be delivered in class. Your presentation should include: Your name and school/department affiliation. A very brief biographical sketch, perhaps including your educational background and work experience. An explanation or visual demonstration of the product opportunity you have described in your proposal. Given that members of the audience will be able to read your proposal at their leisure, you might spend your time explaining the richness of the market opportunity or demonstrating existing competitive products.

Proposal Guidelines

We strongly encourage you to choose an opportunity satisfying all of the following constraints: There should be a demonstrable market. One good way to verify a market need is to identify existing products that meet the need. Your product need

not be a variant of an existing product, but the market need addressed by your product should be clearly evident. The product does not have to have a tremendous economic potential, but should at least be an attractive opportunity for a small firm. You should be confident of being able to create a prototype of the product on a student budget. For example, unless you have unusual access to fabrication facilities a new semiconductor device is likely to be prohibitively expensive to prototype. The product should require no basic technological breakthroughs. You should have access to more than 5 potential "lead users" of the product.

We encourage, but do not require, that you choose an opportunity possessing the following attributes: The opportunity should involve a material good rather than a pure service. Although many of the ideas in the course apply to services, some do not. If the product is likely to be a physical good, this product should have a high likelihood of containing fewer than 10 parts. Although you cannot anticipate the design details, it is easy to anticipate that an electric drill will have more than 10 parts and that a garlic press will probably have fewer than 10.

Some Project Examples:

- **stripping basket for fly fishing**
- **rowing foot stretcher for crew shells**
- **book bag for college students**
- **clamp for theatrical lighting**
- **grocery bag carrier for urban shoppers**
- **dinghy hoist for yachts**
- **personal stereo system for use while swimming**
- **reading/area lighting for backpackers**
- **hydration system for in-line skaters**

Part 3: Opportunity Preferences

Submit your project preferences on a project selection form via electronic means. List the ten projects you would most like to work on, in order of preference. If you would like to work with a particular group of classmates, you should all list the exact same project preferences and clip your forms together.

Team and project assignments will be posted via email.

Grading Scale:

Testing Procedures: 40% of grade. Two exams will be given, each counting for 20%.

Laboratory Expectations: 60% of grade

COURSE POLICIES: (All couses)

Academic Honesty: All university, college, and department policies on academic honesty will be strictly enforced in this course.

The University Code of Student Rights and Responsibilities establishes rights to which the student is entitled and the responsibilities, which the student must assume. Along with preparing for and attending class, each student has the responsibility of promoting high academic standards. The College of Professional Studies supports the University policy on academic dishonesty. Academic dishonesty includes: (a) cheating, (b) fabrications and falsifications, (c) multiple submissions, (d) plagiarism, (please visit this site to understand some procedures to help avoid it) (e) complicity in academic dishonesty. Proven cases of academic dishonesty will result in the study being denied admission to or dismissal from the College. Inappropriate classroom behavior may result in the student being withdrawn from the class.