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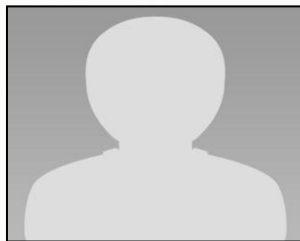
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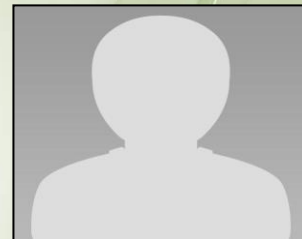
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**“Engineering Management an Innovative
Interdisciplinary Master’s program Preparing Students
for Challenging Careers”**



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Abstract

Professional Science Masters (PSM) is an interdisciplinary degree that instructs students in Science, Technology, Engineering, and Mathematics (STEM) while introducing them to the business industry. At MTSU this degree takes shape as the Masters of Science in Professional Science (MSPS) program. When the program began it housed two concentrations; biotechnology and biostatistics, and was the only of its kind in Tennessee. Due to increased interest and success the program has expanded to contain additional concentrations in Actuarial Sciences, Healthcare Informatics, Geosciences, and Engineering Management.

Most recently added the Engineering Management concentration is designed to emphasize an ideal symbiotic relationship between science and industry. The degree is oriented toward Engineering Systems students and those with related degrees. Engineering Management is a combination of two colleges which assimilate to teach students interpersonal, management, and engineering skills needed for success in manufacturing, industry, and business. The program requires students to take courses focusing on project management, safety planning, research methods, and technology trends. Additionally, the students gain credit towards their Project Management Institute (PMI) and gain full certification in Lean and Six-Sigma methodologies. The degree also requires a 250-hour internship which allows students to gain real-world working experience in an industry setting.

Key words: Engineering Management, Lean, Six-sigma methodologies, interdisciplinary

Introduction

Interdisciplinary research has been deemed necessary by the Council of Graduate Schools for the future competitiveness of America, because “knowledge, creation, and innovation frequently occur at the interface of disciplines.”¹ In order for American students to keep up with the ever growing percentage of out-sourced labor they need to learn to collaborate and innovate within their respective fields as well as reach beyond them to expand their knowledge base. It has become more important now than ever for up and coming students to be able to master more than one specialty. This could be encouraged through helping students master the science, technology, engineering, and mathematical disciplines while simultaneously introducing them to the logistics of the business industry. The Masters of Science in Professional Science degree is specifically designed to incorporate the strengths of collaboration and innovation to the planned course work. The students are taught upper level scientific applications while at the same time being introduced to the most fundamental concepts of business. This makes new graduates uniquely qualified to enter and conquer the American workforce. They will be challenged in areas that they are comfortable in and then faced with new obstacles that force them to actively learn and engage in the curriculum. In the future, various issues confronting the nation in the 21st century will be addressed by a workforce comprised of individuals working across disciplines.¹ Some problems facing our society have become so complex that they are no longer able to be solved by a single academic discipline.¹ Businesses, governments, and nonprofits will increasingly need to collaborate with universities to develop and expand professional master’s programs which produce graduates with interdisciplinary skills.¹ The multifaceted nature of the problems facing today’s society demand individuals that can work outside their comfort zone and through collaboration continue to gain knowledge in the pursuit of answers. Being singularly focused in a particular skill set is no longer enough. The Masters of Science in Professional Science program, and especially the Engineering Technology concentration, provides a broad

back bone of multiple skills for the students to fall back on as well as carry forward in the search of their careers.

Due to the significant demand of individuals concentrated in the science, technology, engineering, and mathematical disciplines the Professional Science Masters (PSM) is developing into a prominent degree program at various universities across the nation. The Professional Science Master's is an innovative graduate degree designed to provide advanced training in science without a Ph.D, as well as training in business without an MBA². A PSM degree fits the niche for those individuals wanting to advance their academic careers while at the same time opening doors in multiple arenas. Supported by the Alfred P. Sloan Foundation, the Professional Science Masters (PSM) is a two-year interdisciplinary degree that is nationally recognized. A Professional Science Master's degree allows students to pursue advanced training in Science, Technology, Engineering, and Mathematics (STEM) while simultaneously introducing the students to subset of core business courses. A Professional Science Master's degree prepares students for a science career in industry, academia, business, government, or non-profit organizations. The available course works allows the students to become comfortable with their chosen field of study. It also provides a wide range of options allowing the students to familiarize themselves with the multiple possibilities they have upon graduation. Throughout their course work they are gradually introduced to the building blocks of any good business such as management and accounting. This interdisciplinary style of course work allows the students to understand both sides of the so called coin. They have a better grasp on how a company functions in turn making them better employees. Along with the grueling course work the degree demands the students to undertake a 250 hour internship with a local business or public enterprise. The internship requires the students to apply the skills they have learned in the classroom to real-world situations. This experience allows the students to gain hands on knowledge. The experience also provides the students with business connections that will help them in their future endeavors. The internship takes place of the typical thesis required during a Master's program. A thesis, while teaching the students work ethic and proper research skills, does not provide the much needed hands on experience the students gain from the internship process. The students also begin to understand the interplay of a true business environment and they get to experience first-hand what goes into solving real world industry issues.

At Middle Tennessee State University this degree takes shape as the Masters of Science in Professional Science (MSPS) program and was established in 2004. Due to the renowned success of the Middle Tennessee State University program it has since become recognized as the national model for Professional Science Master's degrees and is the fastest growing program at the university. At its inception the program housed concentrations in only Biotechnology and Biostatistics. Due to the enormous success of the program and its graduates it has expanded the subsequent skill sets available to now include concentrations in Actuarial Sciences, Engineering Management, Geosciences, and Health Care Informatics. The goal of the Masters of Science in Professional Science degree is to enhance the interface between science and business by providing strong degrees which emphasize expertise in the areas of business and science.³

The MSPS degree is an exemplary program which began in 2005. The program is designed to promote the professional development of students through its interdisciplinary education. The program is a partnership among the College of Basic and Applied Sciences, College of Behavioral and Health Sciences, and the Jennings A. Jones College of Business. As part of

the business core students are introduced to highly valued skills through courses in Probabilistic & Statistical Reasoning, Business Law: Legal Issues for Managers, Accounting, Management and Leadership, and Managerial Communications. These courses provide the basic fundamentals that every great business person should know. They also create a junction between the far reaching gap of the business and science, technology, engineering, and mathematical industries. By learning these simple tools students concentrating the science, technology, engineering and mathematical fields are already leaps and bounds ahead of their counterparts who lack the knowhow of basic business mechanisms. This not only put Masters of Science in Professional Science students ahead of the game academically, it also makes them more qualified for higher paying managerial positions. Employers are keen to find young individuals that are not only apprised in a highly sought after STEM discipline but also understand the elemental nature of business as well.

The interdisciplinary nature of the Masters of Science in Professional Science program fills a niche in industry management by bridging the gap between the business and science cultures. By having experience in both the science and business disciplines, the career prospects for the students doubles. The Masters of Science in Professional Science degree is an essential step for those students pursuing a career in a science-related industry or academia. Classes involving advanced knowledge of scientific principals and research experience are required to ensure a solid educational foundation. By being able to analyze, understand, and present scientific data in a business setting, the Masters of Science in Professional Science graduate provides a valuable asset to the professional scientific community. By learning proper management and communication skills throughout the business heavy course work of the Masters of Science in Professional Science degree students will have the ability to communicate their scientific findings in layman's terms. This is essential for any science business partnership. Students will be able to research and develop as a scientist and also communicate as a business man. The Masters of Science in Professional Science graduates will be a double edged sword ready to achieve and a tremendous asset to any company.

Like the Professional Science Master's program the Masters of Science in Professional Science program requires an internship which polishes the student's professional preparation. The students must complete a 250-hour internship at an industry in his or her chosen field of study. The internship is at the heart of the Professional Science Master's degree because it provides the student with a "real-world" experience and helps them to gain a full grasp of the knowledge they gained within the classroom. Throughout the internship the students are responsible for completing assignments given to them by their employer. At the culmination of their internship, the students compile a portfolio and give a professional presentation of their experience at the company. This presentation allows the students to celebrate the accomplishments of their past two years. The students have the chance to brag about their achievements and count the invaluable lessons they learned. They also have to briefly report on the actions of their internship and the impact it will have on them in the future. The presentation helps the students prepare for the future.

The Middle Tennessee State University Masters of Science in Professional Science program has been recognized both at the local and national level. In 2010 the program received the Tennessee Board of Regents' (TBR) *Academic Excellence Award* for its promotion of math and science and for its unique contributions to the community and state. Moreover, the Council of Graduate Schools in Washington, D.C. recognizes Middle Tennessee State University as a signature program and uses Middle Tennessee State University as a model for

traditional Professional Science Master's programs. Currently the program has a 95% retention and graduation rate. When the program initially started in 2004 it housed only a handful of students. Now that the program has grown and contains six different concentrations it is home to over a hundred graduate students. This remarkable program made its transformation in less than ten years. As a further testament to the strength of the Masters of Science in Professional Science program approximately 75% of MSPS students have gained employment from their place of internship.

Interdisciplinary Program

One of the greatest successes of the Masters of Science in Professional Science program at Middle Tennessee State University is the model collaboration of three colleges and over thirty faculty members. The MSPS program is a partnership among the College of Basic and Applied Sciences, College of Behavioral and Health Sciences, and the Jennings A. Jones College of Business. The success of this massive collaboration is due in large part to the MSPS Program Director, Dr. Saeed Foroudastan.

An interdisciplinary program has been pivotal in the renowned success of Middle Tennessee State University. Many however questioned whether the colleges should merge in the business and science arenas. There have been studies suggesting the without the fluid relationship of business and science societies would crumble. The inadequate numbers if United States citizens trained in science and engineering threatens to destabilize the economic welfare and the scientific growth of our country¹. By coupling students that are training in the science, technology, engineering, and mathematical disciplines with business it strengthens the projected economic standings of the United States. Reports from the Department of Labor indicate an increasing demand for individuals with master's level training with a specialty in science. The Masters in Science in Professional Science degree at Middle Tennessee State University combines the business management skills commonly found in the traditional Master of Business type program with an important distinction - advanced education in science, technology, engineering and mathematic fields. Middle Tennessee State University is home to the only Masters of Science in Professional Science program in Tennessee and prepares "business savvy scientists"; for the 21st century job market. Students mastering in the science, technology, engineering and mathematical fields need to know business industry fundamentals before they leap into a new career. With the collaboration of Middle Tennessee State University's three elite colleges students entering into the program are in safe hands as they prepare to master more than one field of study.

Through the approach Dr. Foroudastan, the program director, took when initially enlisting faculty for the new interdisciplinary degree he was able to promote a sense of respect and understanding between the multiple colleges. Due to the initial program's success a sense of pride and accomplishment was felt among the original faculty involved. Through the success of not only the program but the students and the professors involved the MSPS program has been able to expand with a growing number of faculties wanting to become MSPS contributors. The Masters of Science in Professional Science degree program at Middle Tennessee State University is an innovative, cutting edge, award winning degree program. The success of the program has brought recognition not only to the university but also to the staff involved as well as the entire state. What started as a simple Master's program trying to bridge two fields of study has sparked a phenomena. Interdisciplinary degrees such as Middle Tennessee State University's Masters of Science in Professional Science degree program fills a gapping hole and that spans the distance between science, technology, engineering,

mathematics and business. The STEM disciplines and the business industry rub elbows on a daily basis. By educating new graduates in both sides of the coin new partnerships can be formed and better trades can be made. This degree establishes a knowledge base that propels the science and business industries into the future.

As part of the MSPS initiative, courses such as Probabilistic & Statistical Reasoning, Business Law: Legal Issues for Managers, Accounting, and Managerial Communications were reworked in order to give the classes a scientific emphasis. For instance the Accounting class now includes student projects concentrated on performing profit-margin analysis, completing income statements, statements of cash flow, and balance sheets for companies such as Sarah Cannon Institute, Eli Lilly, Fisher Scientific, Johnson and Johnson, and State Farm. The Managerial Communications course focuses on presenting scientific information in a business format as well as how to write appropriate documents such as letters, memos, and public announcements; this class has proven to be especially beneficial. Due to the fact that most graduates of this program will enter management positions upon entering the workforce these reworked MBA courses are advantageous for STEM students as they have not encountered these subject matters in previous undergraduate coursework. The Masters of Science in Professional Science degree was constructed for students with a mind for interdisciplinary studies; as the motto states "Creating students with a mind for business and a heart for science." The course work of this program is more than ample to prepare students for careers in management. The core requirements include a sampling of management, accounting and communications. All of the courses are found and also required in Masters of Business degrees. While the subject matter has been somewhat altered the students are still receiving the basic outline of the course and the principle behind it. Why go to school to master one subject when you can master two. The graduates of this program have the opportunity to accomplish just that with the course work laid out for them.

Engineering Management

The bridge between Engineering and Management has been a successful one with long standing Masters in Engineering Management degrees being offered by such universities as Duke University, George Washington University, Cornell, and many others. MTSU hopes to continue this success with the introduction of the Masters of Science in Professional Science: Engineering Management (EM) concentration. The Engineering Management degree at Middle Tennessee State University is designed to reinforce the ideal of the symbiotic relationship between science and industry. During the fabrication of this program creators took in to account the needs of the current job market. This was in order to shape the program to best benefit not only the students but the companies that are looking to hire new graduates. MTSU partnered with local businesses targeting engineering employees to streamline the process.

Engineering Management, as an integration of two colleges that teaches students the interpersonal, leadership, management, and engineering skills needed for success in manufacturing, industry, and business. The program requires students to take courses focusing on project management, safety planning, research methods, and technology trends. The Masters of Science in Professional Science Engineering Management degree is oriented to Engineering Systems students and those with related undergraduate degrees; however, it is not limited to these students.

The students that opt in to the Engineering Management degree are faced with two courses of study that of science and that of business. The business courses are required for all Masters of Science in Professional Science concentrations but each has specific courses all their own as well. The Engineering Management concentration requires three credit hours in safety planning. This section teaches the students the advanced study of planning in occupational safety and health management. This includes program planning and developmental methods and techniques as well as various systems and methods to hazardous control. The Engineering Management criterion also requires three credit hours in the Six Sigma methodology. This is defined as a comprehensive and flexible system for achieving, sustaining, and maximizing business success.

Through class instruction, simulations, and hands-on projects, students will be able to identify and focus on customers' critical-to-quality (CTQ) characteristics and solve problems using the define, measure, analyze, improve, and control (DMAIC) process and its associated tools. A Green Belt certification will be awarded upon successful completion of an industry/business Green Belt project. Due to the restricted time available in a semester Middle Tennessee State University is not able to provide the students with means for achieving an American Society of Quality (ASQ) Black Belt certification. Along with safety planning and Six Sigma the student are also required to take three credit hours of project management and soft skills. This involves Project management processes and knowledge areas as sanctioned by the International Project Management Institute (PMI). Successful completion of the course will earn 23 contact hours/professional development units (PDUs) issued by PMI. Students trained in project management gain sufficient hours to sit for the PMP exam. An additional certification gained through the course work Middle Tennessee State University lays out is a certification is Lean Manufacturing. Engineering management students are asked to take three credit hours in productive strategies and lean systems and in doing so earn the credentials need to receive their certifications. The Lean courses range from topics including the human element (supervisory and teamwork skills), the theoretical aspect (laws and science covering service and production systems), and the practical aspect (tools for lean operational systems implementation). Next Engineering Management masters are asked to complete three credit hours in Advanced Topics in Technology. This allows the students to have a small amount of freedom on the subject of their study. They are asked to conduct an independent investigation and then report current problems of their particular interest. They are of course during this time directed by a faculty advisor. The Engineering Management students are also required to partake in three credit hours of Research Methods. This introduces the students to scholarly research principles as well as thesis formatting for research reporting. Essentially the students take the time to research a problem and write their findings in thesis proposal format. The last course curriculum requirement of the Engineering Management majors in three credit hours in Current and Future Trends in Technology. These courses highlight the latest advancements and practices in various engineering and technology fields. Selected topics may include computers and electronics, networking and telecommunication, instrumentation, lasers, automation and robotics, manufacturing and rapid prototyping, bioengineering and biotechnology, and renewable energy sources. Takes a student-centered, hands-on learning approach and focuses on understanding new technologies and how technology is used in the industry. Research projects will provide appropriate experience and accommodate individual's interest.

Along with the grueling Engineering management courses the Masters of Science in Professional Science students have to also take a set of core business courses. One of those

courses includes Accounting and Legal Issues for Managers. It is a three credit course that surveys accounting skills and legal perspectives necessary for managers. Also included in the business core of the degree is a course called Managerial Communication. This course also serves three hours and analyzes the communication theory and communication process with emphasis on development of executive communication skills essential for understanding organizational processes from a holistic perspective. It additionally covers organizational theory, behavior, and interpersonal communication from both a domestic and global perspective. Leadership and Motivation is another course meant to encourage the interdisciplinary framework of the Masters of Science in Professional Science program. The course covers issues in leadership and motivation in business organizations. It is also an examination of the theoretical framework for leadership and motivation processes and serves as strong foundation of the two. It is taught with special emphasis on practical issues and applications of leadership development and motivation. Finally, all Masters of Science in Professional Science masters are required to take a three hour credit of Probabilistic and Statistical Reasoning. The course focuses on probability and statistics concepts. Topics include binomial and normal probabilistic modeling; important statistical concepts such as confounding, randomization, sampling variability and significance; statistical testing of significant differences and associations; and design experiments to test research hypotheses. It is the hope that with the strong framework of these core courses and the flexibility of the required master course that the students will emerge with a solid understanding of both engineering and business. It is also the hope that he students will be able to bridge the ever growing gap between the two industries.

The Engineering Management concentration prepares students for careers in the management of technology and engineering in such diverse occupations as: Technology Managers for Manufacturing Operations in assembly & fabrication, Healthcare, Food Production, and Governmental research initiatives. Additionally Engineering Management students will be prepared to work as Project Managers for the Concrete and Construction Industries, Process Control Companies, and Automotive Industries. The course work provided throughout the two year degree prepares the students for high pressure and high paying jobs. They will learn the skills needed to manage others while at the same time learn how to manage a job site.

The goal of the Engineering Management program is to create individuals with a mind for business and a heart of a scientist. The concentration requires students to take core business courses such as Managerial Communications, Leadership and Motivation, and Accounting and Legal Issues for Mangers. In addition, at the core of the Masters in Science in Professional Science degree is the 250-hour internship which allows students to gain real-world working experience in an industry setting. This internship is a major part of the degree program for the students. It is, for some their first real taste of real live work environment which could help them prepare for their future careers. Also during the internship process the students have the opportunity to work in an actual industry and gain hands on experience. They have the chance to use the skill set that they acquired in the classroom. Additionally it is a huge networking opportunity for the students. Most individuals only have the opportunity of send a resume out and hope that they get a call back. The Masters of Science in Professional Science students have the chance to met and engage with potential employers. They have the chance to show off their skill set and ingenuity and impress those people that have the hiring power. As the courses are set up the graduates are prepared to start working immediately upon graduation. They are equipped with real world work experience as well as globally recognized and acclaimed certifications. The Engineering Management degree is

fully prepares its graduates to step into the workforce with experience and proper credentials ready for their next opportunity.

Other MSPS Concentrations

In addition to the Engineering Management concentration the Masters of Science in Professional Science program also offers degrees in Actuarial Sciences, Biostatistics, Biotechnology, Geosciences, and Health Care Informatics. It is also the Middle Tennessee State University's hope to add an additional concentration, Forensic Science, in the near future.

The Actuarial Sciences concentration trains students to make practical use of probability theory and statistical analysis for managing risks and solving problems in insurance business. Students take required courses such as Construction and Evaluation of Actuarial Models, Actuarial Models for Life Contingencies, and Actuarial Models for Financial Economics. The graduates then take twelve hours of their chosen field credits from within the concentration. Graduates of this concentration are positioned to fill the growing need for individuals with this highly specialized training in the financial services and consulting industries in addition to the traditional insurance and health care industries.

The Biostatistics concentration provides training in statistical methods that can be applied to biomedical and health-related fields. These methods involve using mathematics and statistics to solve real-world problems that influence health. The statistical areas of study include clinical trials, experimental design, categorical and longitudinal data analysis, and survival analysis. Students take required courses such as Advanced Mathematical Statistics I and II, Biostatistical Methods, and Advanced Biostatistical Methods. The graduates then take an additional six hours of credits of their own choosing from within the concentration. Biostatistics graduates are prepared to work in health care agencies, governmental agencies such as the National Institutes of Health, the Centers for Disease Control and Prevention, and the Environmental Protection Agency, and the pharmaceutical industry.

Biotechnology studies prepare students for careers in the management of bioscience firms and organizations. Students take two required courses Biotechnology and Issues in Biotechnology. The students then choose sixteen additional credit hours from courses such as Advanced Virology, Advanced Plant Biotechnology, Advanced Animal Development, Advanced Cell and Molecular Biology, Transmitting Electron Microscopy, and Experimental Immunology. Graduates have opportunities as research scientist in laboratories applying biotechnology to problems in medicine, industry and agriculture and management positions in the biotechnology and pharmaceutical industries. With the growth of positions in the biotechnology industry nationwide, the demand for persons with training in both biological science and management is expected to grow significantly.

The Geosciences concentration provides the knowledge, skills, and experiences for students seeking careers as geoscientists in private industry and government agencies, as well as working professionals seeking advanced training in the geosciences. There is a high demand for well-trained and experienced geoscientists in areas such as geographic information systems and environmental geology. Students in this concentration elect to complete specializations in either Geographic Information Systems or Environmental Geosystems, or may elect to complete a general Geoscience program of studies. Geoscience graduates take

courses such as Geoscience Colloquium, Geospatial Systems and Applications, Advanced GIS, Engineering Geology, Environmental Geoscience, and Advanced Hydrogeology.

The Health Care Informatics discipline combines computer science, information science, and the healthcare sciences in order to manage and communicate data, information, and knowledge in the healthcare environment. The Health Care Informatics concentration is aimed at healthcare professionals who have strong computer skills and an interest in technology integration within the healthcare environment. Students take courses such as Health Care Information Systems and Technology Integration, Project Management in the Design and Analysis of Health Care Information Systems, Project Management in the Implementation & Evaluation of Health Care Information Systems, and Health Care Data Analysis and Evidence-Based Practice. Graduates of this concentration fill the growing need for healthcare leaders with training in the application and design of information technology to health care to continue to improve patient care delivery.

Conclusion

At Middle Tennessee State University, the Masters of Science in Professional Science program gives students an advanced scientific background in Biostatistics, Biotechnology, Geosciences, Healthcare Informatics, Actuarial Science, and Engineering Management while introducing them to the building blocks of business. The program's goal is to train graduates to serve dual competencies within the same job, which is an increasingly advantageous quality for career placement. Those students graduating with a degree in Engineering Management are highly capable and able to fill broadening gap between the science and business industries. These individuals will be able to create, innovate and problem solve while at the same time coordinate and communicate fluidly with upper level business personnel. Perhaps most importantly, MSPS addresses the current national need to develop a workforce with more master's level students that are highly skilled and well-educated in the critical areas of science and engineering. The MSPS program at MTSU serves as a national model, as it is not only the fastest growing degree program at the university but also the fastest growing PSM program in the nation.

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