

Master of Science Degree in Engineering Technology at Purdue West Lafayette

1. Characteristics of the Program
 - a. The Master of Science degree in Engineering Technology is proposed for the Purdue West Lafayette campus.
 - b. This program is site specific.
 - c. The program will be offered on campus. As on-line courses are developed, they will be available for this program.
 - d. The program does not include co-ops, internships, clinicals, or practicals.
 - e. The College of Technology's School of Engineering Technology will offer this program.

2. Rationale for Program
 - a. Institutional Rationale

The program offers undergraduate students receiving a bachelor's degree in Engineering Technology a path for continued education and professional opportunities. Experience with research projects at the master's level will enhance the technical expertise of these students and afford them the capabilities for career advancement and promotion. This program is in keeping with the "Big Moves" established by Purdue University's President, Mitch Daniels, and provides more opportunities for advanced education and skills in a STEM area. The College of Technology at Purdue University currently offers a general master's degree in Technology that does not offer areas as a way for students to gain industry specific knowledge. This degree will replace that generalist master's degree and provide students with four concentration choices: Advanced Manufacturing; Sustainable Energy Systems; Healthcare Engineering Technology; and Electrical Engineering Technology.
 - b. State Rationale

Many of these graduates will be hired by Indiana companies. Many of the employers are in the manufacturing sector. Business is growing and they are having a hard time finding employees with the aptitude, experiences, and skills that our proposed degree program will provide. Cutting-edge manufacturing giants such Subaru of Indiana Automotive (SIA), Inc., Rolls-Royce, Inc., Chrysler (Fiat Chrysler Automobiles (FCA), Eli Lilly and Co., the Guidant Corp., Roche Biomedical, Cook Inc., Zimmer Corp., and Boehringer Mannheim Corp, to name only a few, currently have significant operations within the State of Indiana, with several additional companies in the process of locating operations here. As these and future efforts in advanced manufacturing technologies become more integrated across several industry sectors, the need for engineering technology leaders and managers become more pronounced. Fundamental and specialized training in the M.S in ET degree (with four different emphases) will increase the competitiveness of our Purdue graduates within these professional domains.
 - c. Evidence of Labor Market Need
 - i. National, State, or Regional Need

Indiana projections for employment growth related to a Masters in Engineering Technology from 2010 through 2020 are shown below. Almost a 7% growth is

expected for Engineering Managers in Indiana alone. “Engineering Manager” is the closest job title available for students with a Master’s degree in Engineering Technology. We anticipate that the overall number of job openings will be higher than the data below because it does not include jobs vacated by the retirement of older workers (www.hoosierdata.in.gov). Also of important note is the salary range paid by industry for students with these backgrounds. Salaries range from the low 70’s to the mid 90’s. This information was collected from exit interviews from students graduating from the master’s degree program and Indiana Department of Workforce Development.

Job Title	BLS Occupational Code	Indiana Employment Levels (1000’s)	
		Total for 2010	Total for 2020
Engineering Manager	11-9041	3.1	6.8

Students with the M.S. in Engineering Technology with the Electrical Engineering Technology concentration can also qualify for other related jobs in the Computer and Information Technology sector, professional science and technology service sectors. For example, the Indiana job growth rate in professional science and technological services by 2018 is expected to be 33.8% (www.hoosierdata.in.gov).

The national outlook for employees with an engineering technology M.S. degree is encouraging. The table below summarizes employment projections from the U.S. Department of Labor’s Bureau of Labor Statistics (BLS) (<http://www.bls.gov/bls/proghome.htm>).

We have compared employment levels in 2008 with projections for 2018 for the occupational codes as shown in the following table. We use the occupational code for engineering managers, the most likely occupational code for graduates with a Master of Science degree in Engineering Technology.

Job Title	BLS Occupational Code	National Employment Levels (1000’s)	
		Total number for 2010	Total number for 2020
Engineering Manager	11-9041	176.8	192

The employment of Engineering Managers is expected to increase 8.6% in the absolute number of jobs for the 10 year interval between 2010 and 2020. The Bureau of Labor Statistics reports that employment growth for engineering managers should be closely related to the growth of the occupations they supervise and of the industries in which they are found. Additionally, many employers are finding it more efficient to contract engineering and science management services to outside companies and consultants, creating good opportunities for managers in management services, scientific, and technical

consulting firms. After considering retirements, approximately 49,000 total openings for Engineering Managers are expected between now and 2020.

Job needs in the electrical power and energy sector (power engineering, smart grid etc.) are increasing and are expected to increase as the utility infrastructures are getting older, and needs replaced. Moreover, mass retirement from this sector will need trained professionals. Thus, our graduate students with an emphasis in sustainable energy systems will contribute to the growth and needs of the energy sector (<http://spectrum.ieee.org/at-work/tech-careers/where-the-jobs-are-2012>).

The anticipated growth rate of jobs in the healthcare sector is evident from multiple reports and sources. For example, the healthcare and social assistance sectors are projected to gain the most jobs (5.6 millions) by 2020 with a growth rate of 25.9% (*Source: Bureau of labor statistics, 2012 report – see reference*). Another report (<http://www.biomedscientistjobs.com/booming-biomedical-careers>) further supports the anticipated growth rate in healthcare jobs. This specific report refers to Bureau of Labor statistics information and indicates a 72% growth rate in biomedical engineering jobs. This report further illustrates the need for a Master's degree in biomedical engineering technology jobs. Our proposed M.S. program with its concentration in healthcare engineering technology will prepare our students for the anticipated growth in the healthcare sectors.

Similar job growth is expected in professional and business services (3.8 millions) by 2020. Our proposed M.S. degree, with four different concentrations, will contribute toward meeting the needs of our society. Other reports from the Bureau of Labor Statistics indicate that the employment growth rate is expected to be 21.7% (by 2020) in occupations where M.S. degrees are typically needed. Our personal communication with a national equipment manufacturer and system integrator reflects their preference for hiring M.S. students with Engineering Technology backgrounds. The rapid advancements in product development, materials, process and manufacturing production postulate that a M.S. degree will be beneficial for students to enhance their skills and training in the quickly advancing technological areas. Thus, we predict with confidence the proposed MSET degree in engineering technology will enhance the marketability of our students in the current and future employment market.

ii. Preparation for Graduate Programs or Other Benefits

These students will be prepared for the doctoral degree programs in Technology at Purdue University and the doctoral granting institutions that offer this degree.

iii. Summary of Indiana Workforce Development and/or U.S. Department of Labor Data (Please see i. above)

iv. National, State, or Regional Studies

A significant strength of the proposed program involves the creation of a Master of Science degree program that will be among one of the first of its kind in the United States. The program is unique among Engineering Technology graduate

programs nationwide because it offers areas of specialization that leverage existing strengths within our School of Engineering Technology. Having these concentrations not common among our peers in Engineering Technology that typically offer a one size fits all Masters. The program is further distinctive because it offers several paths to completion, from coursework only, direct project, to a research thesis option. These options accommodate a wider variety of students from international backgrounds for example from China and India who have been identified for course work only, to working professionals who seek a new degree to help earn their next promotion by completing a directed project that has industry problems in the workplace, to recent B.S. graduates who want to pursue the research option to increase the depth of their knowledge in a specific field by completing a thesis. This degree program is supported by the Engineering Technology Council (ETC) of the American Society for Engineering Education (ASEE).

v. Surveys of Employers, Students, and Letters of Support.

We conducted a survey among our Industrial Advisory Board (IAB) members and obtained 26 responses (Please see Appendix A). From the total population surveyed, 62% of the respondents indicated the need to recruit 1-2 M.S. graduates per year. Since this initial survey, and multiple IAB meetings since then, IAB members are looking to hire even more graduates. The economy and growth of the job markets we serve have expanded since the survey was administered. Of important note, the Master's degree was developed in direct collaboration with employers who hire our graduates. Our Engineering Technology bachelor's degree provides a broad introduction to most technical areas, from health care systems to energy systems to manufacturing without providing significant depth in any one area. Our students can become significantly more competitive in the workforce from the opportunity to be in the on-line program or focus in one of the technical specializations that are recognized as existing strengths within the Engineering Technology program. Though only 24% of them indicated the requirements of their technical personnel to pursue an M.S. program, we anticipate this need to grow once the proposed M.S. program is offered on-line. The forgotten full-time B.S. degreed working professionals, who are workplace and geographically bound in manufacturing for example, soon will be able to pursue the M.S. in ET. Of note, 100% of the five survey respondents opted to attend graduate on-line classes. For the graduate certificates, 42 % (out of 19 respondents) indicated their interests.

We have carefully reviewed the suggestions of the respondents related to professional educational needs. We believe that by developing graduate courses and an on-line program, in addition to the classroom setting, which pertains to their workplace needs and professional desires, will create additional demands of the proposed program. (To see survey, please see Appendix A)

vi. Letters of Support

Please see Appendix B for letters of support from potential employers and past graduates.

3. Cost and Support for the Program

a. Costs

- i. No new faculty are required to make the transition to this new degree. However, as the online program grows, additional faculty will be needed to teach these additional students.
- ii. No new facilities are required.
- iii. No new capital costs are associated with this degree program.

b. Support

- i. Nature of Support
Existing Support will be used for this program.
- ii. No special fees above baseline tuition are associated with this program.

4. Similar and Related Programs

a. List of programs and Degrees Conferred

i. Similar Programs at Other Institutions

Comparable Degree Programs, however, no MSET with the concentrations offered.

Locale	Institution	Graduate Technology Degree
Purdue	Purdue Calumet	Master of Science in Technology
	IUPUI	Master of Science in Technology
	IPFW	Master of Science in Technology
Indiana	Ball State University	Masters of Arts in Technology Education
	Indiana State University	Master of Science in Technology Education
Region	University of Southern Illinois	Master of Science in Manufacturing Systems
	University of N. Kentucky	Master of Science in Technology
Nation	Pittsburg State University. KS	Master of Engineering Technology
	Texas A&M	Master Industrial Distribution
	Oregon Institute of Technology	Master of Science in Engineering Technology
	Southern Polytechnic (GA)	Master of Science in Engineering Technology

ii. Related Programs at the Proposing Institution

The M.S. in Engineering Technology differs from that of a traditional Master’s in Engineering degree through its linkage with industry as a direct context for the development of learning outcomes, hands-on training, and project development. Curricula in the M.S. in Engineering Technology is oriented toward application and innovation based upon the foundation of science, technology, engineering, and mathematics. The focus of the program is to apply technological training and skills to current industry challenges.

The proposed Master of Science in Engineering Technology (MSET) is the replacement of an existing Masters of Science Degree in Technology. The program is designed for both the traditional student and the full-time working professional who has already obtained a B.S. in Engineering Technology,

Engineering, Science, or Business disciplines who seeks further development and/or knowledge of recent advances in the management, development and innovation of technology systems. The program expands the knowledge of students into areas of established and emerging engineering technologies with specific concentrations. This repurposed degree will better prepare students who enter into positions requiring responsibilities in managerial, leadership, engineering, research, and teaching positions. Graduates work in a variety of sectors including business and industry, nonprofit, government, and academia. The MSET degree program will allow faculty to better prepare Engineering Technology students to engage and excel at business, industry, research, academia, and government challenges leading to multiple opportunities for both students and faculty. The degree program has the course work only, directed project, and thesis option depending upon student professional direction. The course work only option is planned to be developed into traditional learning and online delivery.

Within the Purdue University system there are four other independent ET programs at autonomous campuses. Purdue North Central campus only has a Bachelors program, but Purdue Calumet, IUPUI, and IPFW all offer a Master of Science in Technology. This is the same broad Masters degree that we want to move away from. The program at West Lafayette has achieved the critical mass to sustain a graduate degree that emphasizes the proposed specializations.

- b. List of Similar Programs Outside of Indiana
Within the Midwest region, the University of Southern Illinois and the University of Northern Kentucky both offer Masters in Technology. Both of these programs are significantly smaller than the M.S. in ET program at West Lafayette. The Masters in Manufacturing Systems that is offered at Southern Illinois is similar to the West Lafayette proposal, but the two campuses are located far enough apart to avoid direct competition for students. These degree programs have seen a rise in student enrollment because of high placement and starting salaries.
 - c. Articulation of Associate/Baccalaureate Programs
Does not apply.
 - d. Collaboration with Similar or Related Programs on Other Campuses
None at this time.
5. Quality and Other Aspects of the Program
- a. The proposed Master of Science has a minimum requirement of 30-34 semester credit hours depending on the program of study chosen. A student may select to complete the coursework only option for a total requirement of 30 semester hours. The directed project option requires a minimum of 31 hours of coursework and an additional 3 hours of research. For the thesis option, students complete 28 course hours and 6 hours of thesis work. Students select from four Concentration areas: Advanced Manufacturing, Sustainable Energy Systems, Electrical Engineering Technology, and Healthcare Engineering Technology.
 - b. Exceeding the Standard Expectation of credit Hours
Does not apply.

c. Program Competencies for the MSET Concentrations

School of Engineering Technology graduate education faculty members create quality learning experiences for students both in the classroom and advisement throughout their graduate program. Individual course competencies coupled to learning outcomes make it clear to faculty and to students the expectations faculty have for the knowledge, skills and/or perceptions that students will have at the end of a course and/or program. Program competencies can serve as the basis for useful assessment. Learning outcomes for courses taught in this graduate program are defined by individual faculty members teaching a given course and are measured by observable and measured actions that are accomplished by the student.

For the Master of Science in Engineering Technology, program competencies including student learning outcomes can be summarized as follows:

1. An ability to formulate, down select and optimally solve engineering technology problems:
 - a. Students will design and carry out original applied research studies, which could include case studies, directed projects, and/or thesis, that involve data collection and analysis, interpretation of findings, and presentation of findings to a broader scholarly community.
 - b. Students will prepare and refine scholarly papers that are clearly written, exhibit professionalism, and apply or reflect a current and accurate understanding of the engineering technology topic.
2. An ability to apply knowledge in both the course work only option or in any one of the concentration areas of the engineering technology body of knowledge;
 - a. Students will demonstrate the capacity to engage in analytical thinking on a variety of discipline-related topics, including the ability to find and apply credible trustworthy sources of information, to present a defensible point of view based on data to engage in collegial dialogue that promotes broader understanding of the engineering technology challenge.
 - b. Students will design and carry out original applied research problems that involve data collection and analysis, interpretation of findings, and presentation of findings to peers, faculty, business and industry leaders, and potentially a broader scholarly community.
 - c. Students will develop and apply advanced technical skills, including such skills as materials testing and processing, computer modeling, building investigational apparatus, making 3D prototypes, or producing other work that is representative of advanced technical work within one of the concentrations or on a funded research project.
3. An understanding and application, including technology from a global perspective, project planning and management, innovation management, engineering technology leadership, and entrepreneurship.

4. And an understanding of the role of engineers in society.

Master of Science degree in Engineering Technology (Advanced Manufacturing Concentration)

The Advanced Manufacturing concentration was created to address an acute need for applied research, employment opportunities, and teaching in the areas of technology innovation management, applications of computer integrated manufacturing, optimization of metal casting, optimization and design for manufacturability, nanotechnology and applications, leadership and the management and integration of technology in the manufacturing environment, and global supply chain logistics. These topics are beyond the scope of an undergraduate curriculum, but this technical expertise is in high demand by manufacturing companies in Indiana, the country, and around the globe. Job opportunities are significant in the current economy; Indiana is near the top of most national manufacturing lists in terms of jobs. If we are to be part of the economic engine for the State of Indiana, we must prepare graduates who can have immediate impact to these employers. Engineering Technology students currently working on Indiana-based manufacturing research projects include companies like Zimmer, Chrysler, Litter, ArcelorMittal, GM, Medtronic, Koontz Wagner, and Nucor Steel. This topic is also lucrative for funded research as evidenced by School of Engineering Technology faculty securing almost \$1M dollars in sponsored research in the past few months.

Advanced Manufacturing concentration includes the optimization of manufacturing processes, materials, design, technology innovation, supply chain challenges, and technology management of system integration.

Master of Science degree in Engineering Technology (Sustainable Energy Systems Concentration)

The Sustainable Energy Systems concentration was created to address an acute need for research and teaching in the areas of energy efficiency, renewable energy, and high performance buildings. These topics are beyond the scope of an undergraduate curriculum, but this technical expertise is in significant demand by the mechanical design firms, mechanical contracting firms, and building control firms that hire Engineering Technology graduates. This topic is also lucrative for funded research as evidenced by Engineering Technology's success in the 2011 Solar Decathlon.

Energy efficiencies include the optimization of manufacturing process or building performance, particularly related to post-construction retro-commissioning. Renewable energy includes solar, wind, biomass and other technologies that are slowly becoming a viable alternative to traditional power from the utility grid. High performance buildings include both energy efficiency and renewable energy, but with an overall goal of net zero energy, which means that the building generates 100% of its own energy on an annual basis. The requirements for net zero energy buildings are leaving the realm of research and are being actively codified into newer building standards and codes.

Master of Science degree in Engineering Technology (Healthcare Engineering Technology Concentration)

The Healthcare Engineering Technology concentration is proposed due to student interest, faculty research and scholarship. Healthcare is “one of the largest growing industries due to an aging population and the many advances in healthcare science and technology” (EMBS, 2011). Healthcare generally involves four primary sectors: preventative, diagnostic, therapeutic and rehabilitative (assistive) technologies. Research and development is also a critical area of industry. Healthcare technologies may occur in clinical settings, laboratories or hospitals. Healthcare Engineering topics can include facilities infrastructure, telecommunications, electrical and mechanical devices, ethics and economics, prototype development, security of drugs and technology management.

Master of Science degree in Engineering Technology (Electrical Engineering Technology Concentration)

The Electrical Engineering Technology concentration focuses its curriculum and research on the application of engineering techniques to address technological challenges faced by the public and private sectors. Graduates augment their skills as “managers of technology” by complementing the application of engineering techniques with existing and emerging technologies and standards. Curriculum in this concentration strives to develop targeted skills in broad but continuously changing areas such as product design and development processes, documentation, and product and customer acceptance testing. Specific competencies include system and subsystem design, characterization, and their application in targeted areas such as radio frequency electronics, embedded systems and subsystem electronics, software, and sensor and actuator network hardware. These areas touch a vast range of industries regionally and globally. Graduates in the Electrical Engineering Technology concentration advance their careers as engineers and engineering managers.

d. Assessment

Quality of the degree program and impact to both internal and external stakeholders will require assessment through a combination of methods which will vary from course to course, including a participation grade based on performance of learning activities and learning outcomes reported in a summative evaluation. Assessment methods will include, but are not limited to, student quality demographics, time to degree completion, publications with students, and qualitative metrics based on survey research from stakeholders. Degree program assessment will also be by graduate faculty involved in the program, employers of our graduates, peer academic reviews, and assessments completed from external stakeholders hiring graduates within the State of Indiana to help in determining economic impact. Assessment inputs will come from the Industrial Advisory Board members every three years regarding the graduate program and employers of our graduates, including a survey among M.S. alumni. The SoET Graduate Education Committee will also monitor the course developments and modifications based on assessment feedback

- mentioned and incorporate changes to improve the program and market vitality. The graduate program quality will be monitored and ensured not only by the faculty involved, but also College of Technology graduate education policies and the administrative oversight provided by the Graduate Education Director, SoET School Head, Associate Dean for Graduate Education, Dean of the College of Technology, and the Senior Associate Dean and Dean of the Graduate School.
- e. Licensure and Certification
None available
 - f. Placement of Graduates
The partnerships between Purdue’s College of Technology and many employers in the region will make placement of these graduates for positions smooth and efficient.
 - g. The ABET ETAC Accreditation Board does not provide accreditation for graduate Engineering or Technology programs.
6. Projected Headcount and FTE Enrollment and Degrees Conferred

7. Table 7 - Projected Headcount and FTE Enrollment and Degrees Conferred					
	Year #1	Year #2	Year #3	Year #4	Year #5
	FY 2016	FY 2017	FY 2018	FY 2019	FY 2020
Enrollment Projections (Headcount)	57	60	69	80	100
Enrollment Projections (FTE)	46	51	59	68	85
Degree Completions Projection	0	51	54	62	72

APPENDICES CAN BE FOUND IN THE COMPLETE VERSION