

Developing a Graduate Master's Degree Program in Engineering Technology: Overview of Program Objectives, Structure & Impact

Jorge Leon, Angie Hill Price, Mathew Kuttolamadom

Texas A&M University
College Station, TX, 77843
E-mail: mathew@tamu.edu

Abstract

A study was conducted to outline the state of graduate master's degree programs in engineering technology that are currently offered in the nation and particularly in the state of Texas, and to reflect on their core learning objectives, structure, demand, demographics, and impact. The trends identified were discussed in light of assembling a Master of Science in Engineering Technology (MSET) degree with a concentration in Manufacturing and Mechanical Engineering Technology (MMET) within the department of Engineering Technology & Industrial Distribution (ETID) at Texas A&M University (TAMU). Though Bachelor's degrees in engineering technology are generally larger in terms of the numbers of programs offered as well as in enrollment, graduate master's degrees in engineering technology are becoming increasingly popular, especially since they offer a unique hands-on and industry-focused education at a graduate level that many regional employers seek. In this paper, the commonalities among these currently offered programs were outlined and discussed, especially in terms of the makeup of the program structure, courses, and learning objectives; these were then contrasted with aspects of the degree program currently being developed at TAMU. Further, a brief assessment of the potential job market awaiting the graduates from this program, as well as the expected student demand was presented. Future work includes continued refinement of the curriculum and other program details by drawing upon the best attributes of currently offered similar programs.

1. Introduction

The need for a workforce with advanced technical talent can only continue to grow as the nature of work changes, impacted by the rapid pace of development of critical technologies such as mobile internet, knowledge automation, internet-of-things, autonomous vehicles, advanced manufacturing methods such as additive manufacturing and other advanced technologies, as well as project management abilities in these areas. In order to meet this need, faculty in the MMET program at TAMU

has developed a plan for a MSET degree. During the development phase, other programs around the country and especially in Texas were examined for their program objectives, structure and impact.

Purdue University Northwest has offered a Master of Science in Technology since 2008 [1]. The program has sub-disciplines including Mechanical Engineering Technology as an option for students. In a study reviewing the strengths of the program, Zahraee and Latif [2] noted that a successful program can be distinguished from engineering through the incorporation of leadership and managerial courses in addition to the technical content.

The need for advanced skills in areas beyond the traditional engineering background was noted in a study developing a Master of Science degree in Technology, specifically in energy technology for a university in Finland [3]. Industry executives were interviewed, and consistently identified project management, problem solving and leadership as essential skills required in addition to the traditional engineering based technical competencies.

Upon a review of the program objectives for relevant Master of Science programs across the US, a trend can be seen related to the content beyond advanced technologies. The curriculum for the MSET at Wayne State University [4] incorporates problem solving skills with communication and project management. The Purdue University online Master of Science in Engineering Technology program [1] emphasizes more general objectives such as "design and guide complex collaborations to drive optimal innovation and technical solutions in the workplace, and apply an agile approach to achieving strategic outcomes", and project management skills. These are combined with outcomes specific to different technical areas such as energy management and cybersecurity.

At the University of Houston, a Master of Science in Mechanical Engineering Technology [5] is offered along with other specialty engineering technology programs. The curriculum is more focused on research and appears to be a deeper extension of the undergraduate degree offered. Communication skills for the students are emphasized as

part of the curriculum, “helping to positioning them to be industry leaders in their fields of specialty”. Leadership and decision making skills are also incorporated in the objectives for the Master of Engineering Technology degree at Pittsburgh State University [6]. A number of other prominent master’s programs in engineering technology exist as well, such as those having concentrations/thrusts in manufacturing engineering (Arizona State University - The Polytechnic School [7]), mechanical systems (University of North Texas [8]), and manufacturing and mechanical engineering technology (Rochester Institute of Technology [9]).

2. Similar MSET Programs in Texas

The proposed MSET program has a unique focus and complement similar programs in Texas. Three universities in Texas currently offer a master of science in engineering technology (MSET) similar to the one proposed, each with structured concentrations similar to what is proposed here. The list below shows the university, degree name, concentrations offered, and program start date of the existing similar programs in Texas:

- University of North Texas’s (UNT) MSET offers concentrations in Construction management, Electrical systems, Engineering management, and Mechanical systems (program start date: 1992)
- University of Houston’s (UH) MSET offers concentrations in Biotechnology, Computational Health Informatics, Mechanical Engineering Technology, and Network Communications (program start date: 2006)
- West Texas A&M’s (WTAM) MSET offers concentrations in Renewable Energy Technology, Manufacturing/Industrial, and Industrial Distribution (program start date: unavailable)

The proposed MSET concentration in Manufacturing and Mechanical Engineering Technology uniquely integrates state of the art technical topics in their respective curricula while providing the graduates with application skills in engineering project and personnel supervision and management. None of the identified “similar” programs in Texas provide integrated manufacturing and mechanical engineering education.

Further, within the Texas A&M University System, all masters in engineering technology programs, except for West Texas A&M University, are technology management oriented and different to the more technical MSET degree proposed. The list below shows more management-focused masters programs in the A&M University system:

- Texas A&M University – METM Engineering Technical Management (executive distance education only)

- Tarleton State University – MS Quality & Engineering Management
- Texas A&M University-Kingsville – MS Industrial Management
- West Texas A&M University – MS Engineering Technology
- Texas A&M University-Commerce – MS Technology Management

3. TAMU MSET Program Details

3.1 Learning Objectives

In alignment with the findings of the studies in this area, and with reference to the current programs available, the faculty developed a program which will provide a combination of technical knowledge and the leadership, and project management skills demanded by industry. The MSET program at TAMU will provide advanced application-oriented education in engineering technology. The program will reside in the ETID at Texas A&M University. This master’s degree will be the first resident graduate program in ETID. Currently, ETID has nationally recognized 4-year BS degrees in manufacturing and mechanical engineering technology, electronic systems engineering technology, interdisciplinary engineering (mechatronics), and industrial distribution. ETID also offers two distance learning master’s degrees focused on seasoned professionals in industry.

The MSET degree will allow students with a BS degree in related areas to hone their technical acumen beyond levels achieved in the limited time available to learn vast amounts of relevant knowledge during a bachelor’s program. The proposed MSET degree will initially offer two options: one in Manufacturing and Mechanical Engineering Technology (MMET) and one in Electronic Systems Engineering Technology (ESET). The program learning objectives for the MMET option aim at preparing students to:

- (1) Demonstrate advanced technical knowledge in product design, advanced manufacturing processes and materials, and smart production systems,
- (2) Develop practical solutions for complex manufacturing or mechanical problems present in industry, and
- (3) Apply engineering project supervision and personnel management skills for careers in manufacturing, design, installation, operations, technical sales, service functions, and similar.

3.2 Program Structure

The MSET will be a 3-semester resident program with a 30 credit-hour curriculum. The curriculum will include 3 credits of foundational math or statistics and 3 credits of

engineering project and personnel supervision and management and/or Technical Project Management depending upon the option selected. It is anticipated that each program will begin operations with a cohort of up to 20 students per program per year. The programs will provide flexibility for working students; it is anticipated that as the program matures, up to certain percentage of the course offerings could be available as distance education. Additionally, a number of advanced senior level undergraduate courses from the current BS programs may be stacked to encourage enrollment of students graduating from the existing undergraduate program in the department. A 4+1 track option for current undergraduate engineering technology students with the appropriate academic credentials is also under consideration. The program will also be offered to non-engineering technology majors with appropriate backgrounds.

The following table shows the degree requirements of the MMET concentration within the proposed master's program, and the student credit hours (SCH) needed:

Table 1: Degree requirements of the MSET degree

Category	Non-thesis SCH	Thesis SCH
a. Required Courses (all students)	6	6
b. Prescribed Electives	12	12
c. Free Electives	9	3
d. Thesis/Dissertation Research	0	6
e. Seminar (1 SCH/semester)	3	3
TOTAL REQUIRED SCH	30	30

The thesis and non-thesis options differ in the thesis and free-elective course requirements as summarized in the following table:

Table 2: Thesis vs. non-thesis option in the MSET degree

	Thesis option	Non-thesis option
Free-electives (selected by the student, subject to approval)	3 SCH	9 SCH
Thesis	6 SCH	Not required

The following tables identify the required courses and prescribed electives of the program. The majority of the courses would need to be added to the department catalog for the program to come to fruition. Both options, thesis and non-thesis options, share the same required, prescribed-elective and seminar course requirements; however, they differ in the thesis and free-elective requirements.

Table 3: Core courses and electives of the MMET MSET degree

Required Courses (of all students)	SCH
A 600-level Mathematics or Statistics course	3
Technical Project Supervision & Personnel Management	3
Seminar/Other (1-credit per semester)	3
Prescribed Elective Courses (select 4 from list)	SCH
Data Analysis, Simulation & Experimental Methods for Industry	3
Product & System Lifecycle Management	3
Advanced Materials, Selection & Analyses/Testing	3
Advanced Manufacturing Processes & Systems	3
Computer-Aided & Cyber-Enabled Manufacturing	3
Production & Inventory Planning (Stacked course)	3
Another stacked course, as necessary	3

4. Initial Program Demand/Impressions

4.1 Job Market Demand

A number of surveys were conducted to confirm that graduates from the proposed MSET programs would have ample job opportunities. For this, job postings that listed engineering technology majors as eligible candidates were surveyed. In evaluating the Manufacturing and Mechanical Engineering Technology option, it was estimated that a MSET graduate would be a good fit for at least 368 out of 2,871 engineering technology job postings per year (April 2016 - March 2017 data). The estimate assumes that position titles applicable to MSET with a concentration in MMET were Mechanical Engineer, General Engineer, Manufacturing Engineer, Engineering Technician, and Chief Engineer. Furthermore, 2013-2015 data from the NCES clearly suggests that the excess demand for the students from the new MSET programs will be large considering the total number of MS of all engineering technology degree completions per year is 233 versus 368 job postings specific to MMET or similar programs.

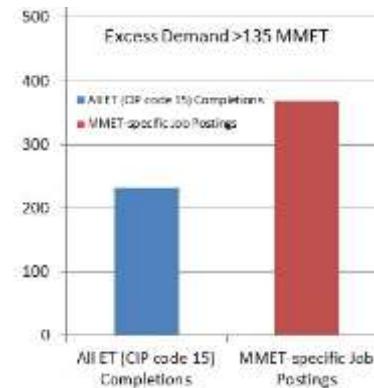


Figure 1: MMET-specific job postings vs. all MSET completions

Further, results of a survey of companies in the Industrial Advisory Board of the Manufacturing and Mechanical Engineering Technology program indicates that the MSET degree will be viewed favorably by potential employers and the companies they represent. Companies representing the industry advisory board for the MMET program responded favorably when asked whether graduates from the proposed MSET degree were needed. The results are summarized below:

Question: Do you think a graduate from this degree program (MS in MMET) would have the added knowledge/skills that would benefit your company?

Responses:

- Yes, we have a direct need for candidate with such graduate-level knowledge/skills (**67%**)
- Yes, such candidates could be valuable to our company in the long run (**33%**)
- No, the knowledge/skills of a BS in MMET graduate is adequate for us (**0%**)
- No, we have no need for such/related candidates (**0%**)

Additionally, from among the comments received from the industry advisory board representatives, one is reproduced here as it reiterates the long standing 'issue' that engineering technology graduates face vs. engineering, showing that it is in fact a perspective-based issue:

“Although I see the need for such a curriculum and degree, my main concern is industry perception. ET has long had this challenge. The degree is excellent, but the market value is less than it should be purely due to industry perception. I don't know how to overcome this, but I can imagine graduates having difficulty explaining their degree and why it has value. That's a hard place to start when trying to find a job.”

4.2 Student Demand

The expected student demand for the proposed MSET program is promising. New students will originate from undergraduate feeder programs at Texas A&M and students from other engineering technology programs.

Considering feeder programs, during the initial five-years, the MMET program will admit cohorts of up to 20 students, once a year. Demand for the programs is expected from the undergraduate ET program (MMET) in the department, undergraduate ET programs in Texas, and nationwide. The number of graduates from the BS in Manufacturing and Mechanical ET program in the ETID department at Texas A&M University is around 70-80 graduates/year; it is expected that that 20+ students would desire to continue onto a MS degree if provided the option. This estimate is based off a survey conducted on 103 current 400-level MMET undergraduate students on their

interest in joining the program. Responses were very encouraging, and are summarized in the following list:

Question: When this program (MSET-MMET) is offered, would you be interested in obtaining this graduate degree?

Responses:

- Yes, right away or within the next 5 years (~**48%**)
- Yes, possibly after 5-years or longer (~**22%**)
- No (~**30%**)

As with the industry advisory board representatives, the student voiced their impression about the proposed MSET in MMET program. There were a number of positive and encouraging comments, and strong interest. Additionally, student also voiced their (valid) concern on being able to market their engineering technology degree (compared to their counterparts in engineering).

For both options, any remaining students needed would come from the pool of graduates from other engineering technology programs in the state or any of the 8,573 students that were awarded BS degrees in 2014 in in 4-year engineering technology programs nationally. The potential student demand clearly exceeds the planned 20 students per cohort per year in the program.

Enrollments and completions at similar programs in Texas and the nation are healthy. For instance, the two universities in Texas, UNT and UH, are included in the 10 largest programs nationally ranked by number completions for master's level engineering technology programs [10, 11]. The 2015 completions were 41 and 23 for UNT and UH, respectively; annual growth averages in completions during 2013-2015 of 28% and 53% with respect to 2013-completions, for UNT and UH, respectively. The estimated double-digit completion growth rates suggest an opportunity for the proposed MSET program to satisfy the large excess of national demand for master's level graduates mentioned earlier in this section (i.e. 368 completions versus 2,871 job postings). In summary, there should be sufficient demand for the new program without affecting existing programs.

5. Current Status and Next Steps

This MSET program is currently halfway through the proposal stage, with positive responses and approval from the college-level committees and faculty senate. It is expected to go through the upper administration and Texas Higher Education Coordinating Board (THECB) in the upcoming months.

5.1 Student Recruitment Efforts

General recruitment efforts, including plans to recruit and retain students from underrepresented groups, can be categorized as follows:

Undergraduate students in current programs at TAMU:

As detailed earlier, it is expected that a significant number of students will be recruited from the existing BS programs in the same undergraduate programs. Awareness among existing undergraduate students will be achieved during existing undergraduate courses, (e.g. faculty will mention how specific topics will be covered in greater detail in the graduate level courses), MSET informational events held every semester, as well as easy to find information in the departmental and college webpages.

Industry Professionals:

As a technical master's program, the main recruitment efforts will be focused on recruiting industry professionals from technical fields such as oil & gas, energy, construction, manufacturing, electrical, electronics, building systems & HVAC, systems integrators, and related channels. Each program's Industry Advisory Board members will be engaged as recruiting channels in industry. Efforts will be made to make sure the candidates have an appropriate bachelor's degree and sufficient industry knowledge and experience to make them successful in the MSET program.

Industry Partnerships:

A concentrated effort will be taken to forge industry partnerships where the companies sponsor their top talent for the MSET program. Capstone projects will be designed to include industrial sponsors to bring value / innovation to the company, add continuous ROI for students while attending A&M as well as add competitive advantage to the industrial sponsor.

Other Recruiting & Marketing Programs:

The following recruiting and marketing programs will be developed as needed to ensure planned enrollment levels:

- Print advertising – Industry related trade publications and engineering education journals.
- Electronic advertising – E-mails, banner ads and sponsorships in industry related trade publications and engineering education outlets / associations.
- Informational events & sessions: conduct admissions informational events in key cities to present, interact and recruit students.
- Corporate meetings and visits: Visit key partner companies to meet prospective students and company leadership sponsors.
- Educational institutions: Recruit faculty at multiple universities / colleges as well as academic conferences and events.
- Industry events, conferences and presentations: Participate in industry conferences, events and present the new MSET program.

6. Summary

This paper outlined the state of graduate master's degree programs in engineering technology that are currently offered in the nation and particularly in the state of Texas, and reflected on their core learning objectives, structure, and demand. These were discussed in light of assembling a MSET degree with a concentration in Manufacturing and Mechanical Engineering Technology (MMET) within the ETID department at TAMU. The learning objectives of the proposed program were laid out as well as the program structure in terms of its requirements, options and courses proposed. Further, a brief assessment of the potential job market awaiting the engineering technology graduates from this program was conducted – it was observed that the number of jobs that the ET graduates were a good fit for (and eligible) far exceed the number of graduates. The Industrial Advisory Board representatives of the existing counterpart B.S. program in MMET also echoed their support and demand for these graduates. Next, the expected student demand was surveyed. It was observed that the demand for the program far exceeded the expected enrollment of the program; new students are expected to originate from undergraduate feeder programs at TAMU and from other engineering technology programs in the state/nation. In particular, the interest from the current undergraduate ET students in TAMU was very positive. Currently, the program is in the proposal stage, and if approved is slated to commence in Fall-2019. Future work includes continued refinement of the curriculum and other program details.

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