

## **Online Engineering Management Master's Program—Lessons Learned**

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# Development of Online Engineering Management Masters at Tennessee Tech University

## Abstract

A new Master's of Science in Engineering Management (MSEM) was created and deployed at Tennessee Tech University. In-depth planning began in 2016 with reviews of campus and regional online graduate programs. The program was designed to incorporate only asynchronous, online courses, via cohort enrollment, started each academic year. The curriculum was built around both College of Engineering and College of Business graduate courses. The program was approved for a Spring 2020 start date, with the first of the MSEM engineering classes developed and launched in Fall 2020. The first MSEM graduates completed their degrees in December 2022. This paper presents the primary challenges curriculum development, graduating student feedback, and future planning for the program.

## Keywords

Master's program, engineering education, curriculum development

## Introduction

Tennessee Tech University launched an effort in 2016 which addressed the planning, development, and operation of a new, online, graduate program in engineering management. The Master of Science in Engineering Management (MSEM) program was launched as a completely online and asynchronous program of study, with courses offered collaboratively between the College of Engineering (COE) and the College of Business (COB). The primary goal was to provide an early-career, technology-oriented degree to professionals that address leadership, management, and technical knowledge. Once completed, the degree will expand the graduates' career opportunities and add value to their organizations. [1], [2]

## Literature Review

The origin of the MSEM program differs from many other online master's programs in engineering management, in that other online programs were often designed around existing engineering management or industrial engineering courses in corresponding degree-granting departments. [3], [4], [5] This originating agency concept is common, though for Engineering Management programs, the courses may be interdepartmental or cross-disciplinary. [6], [7] However, Tennessee Tech University had no core engineering management or industrial engineering department.

Thus, the MSEM program is conducted out of the General and Basic Engineering (GBE) department, an engineering department that previously had no graduate programs or class offerings under its authority. The GBE department did have experience in hybrid online classes, in that it offered a Bachelor's of Science in Engineering (BSE) program, with many of these classes being offered as hybrid-online. The term "Hybrid-online" takes on different meanings in

the literature. A hybrid course may be considered as two types of teaching for universities: the first and original context typically requires on-campus learning events combined with online activities; “face-to-face” was literally requiring the faces to be in the same room at scheduled times. [8] [9] Starting in 2019, a hybrid course would also be considered as teaching synchronously to half of students in an enrolled section, face-to-face, with the other half of students attempting to engage online. The two student groups would switch roles (in-person or online) every week. [10] [11] The hybrid model for the aforementioned GBE BSE program meant something between the two, and was underway prior to the COVID-19 pandemic. Tennessee Tech University faculty taught some classes in-person on their campus while streaming the class real time to a remote campus classroom at a partner university, East Tennessee State University, where other BSE students were enrolled. Thus, the GBE department had some limited experience in a type of online-oriented class before starting this completely online and asynchronous MSEM program.

The start of the MSEM program was originated in 2016 with a survey conducted by the Tennessee Tech College of Engineering; they deployed a survey to engineering alumni, associated employers, and industry advisory board members. A total of 234 alumni responded; these alumni represented a relatively recent group of engineering graduates from the previous ten years. [1] The respondents were strongly supportive for the development of a graduate engineering management program, devoted to online offering. The alumni respondents communicated a very strong preference for “project management” as a specific interest area. The “asynchronous online” delivery method was favored strongly when compared to other methods: On-campus only, online synchronous, or hybrid campus/online delivery options. The survey also provided strong evidence of potential student and employer demand. In summary, industry need was present as well as the potential student demand to justify the development of the MSEM program.

Program objectives and outcomes were determined by considering the committee’s own literature review, which included two Bodies of Knowledge (Engineering Management and Project Management), the survey results from potential students and employers, and findings from a benchmarking survey of 55 existing engineering management programs. [1], [12], [6], [13] The alumni survey results (Exhibit 1) were of immediate interest in planning. Strong interest in five topics were noted: Overall interest in an engineering management master’s degree, enrollment in such a program from their alum institution, project management, certifications, and asynchronous delivery of course materials.

## **Methods**

### ***Curriculum***

The MSEM program objectives included 1) accessing both the College of Business and Engineering expertise, 2) addressing technology, techniques, and tools used in modern industry, 3) increasing the number of regional qualified engineering managers, and 4) increasing the number of qualified engineering managers who may successfully achieve an engineering or project management certification.

A total of 33 credits was established for the degree, comprising classes denoted in Exhibit 2. At the time of the program proposal (2018), Tennessee Tech’s MSEM program integrated four (4) COB online courses already in existence. These courses were already offered as part of the online MBA program and could feasibly accommodate additional students with planning.

Additionally, the *Statistical Inference for Engineers* course was already being taught online, though not asynchronously. The approval was granted for a start of Spring 2020, but was delayed for the official start until Fall 2020, due to a delay in hiring the MSEM faculty. Some students enrolled prior to Fall 2020, registering for the existing COB courses offered.

**Exhibit 1. Alumni Survey Results**

Survey Question	Top Responses	Percentage of Responses
Level of interest in an engineering management master’s degree program	Somewhat interested or strongly interested	82.4%
Primary interest in the offerings of an engineering management graduate program	Enrolling in an engineering management master’s degree program offered by Tennessee Tech University, or taking engineering management courses from Tennessee Tech	67.0%
Preferred specialties of interest	Project management	76.3%
Preferred certifications of interest	Professional Engineering Manager (PEM) Project Management Professional (PMP)	88.5% 86.0%
Preferred method of degree delivery	Asynchronous online	69.4%

**Exhibit 2. Required Courses for the Master of Science in Engineering Management  
F—Fall; SP—Spring; SU—Summer**

Component	Courses	Credit Hours	Course Status	Offering Semesters
<b>Business Core</b>	ACCT 6010: Accounting Information for Management Decisions	3	Existing	F, SP, SU
	BMGT 6200: Organizational Leadership	3	Existing	F, SP, SU
	FIN 6020: Financial Management	3	Existing	F, SP, SU
	MKT 6100: Strategic Marketing	3	Existing	F, SP, SU
<b>Engineering Core</b>	ENGR 6200: Statistical Inference for Engineers	3	Existing	F
	EMGT 6100: Introduction to Engineering Management	3	New	F
	EMGT 6210; Project Management 1	3	New	SP
	EMGT 6220: Project Management 2	3	New	SU
	EMGT 6230: Project Management 3	3	New	SP
	EMGT 6300: Decision Analysis	3	New	SP
	EMGT 6900: Professional Project	3	New	SU
<b>Total credit hours for degree</b>		<b>33</b>		

All courses in the MSEM program are all conducted in an online, asynchronous format. All survey respondents preferred online asynchronous delivery methods and on-demand, with no start or end dates scheduled. However, conducting such on-demand courses would require

significant and additional information technology support, as the existing Tennessee Tech learning management system (LMS) currently supports on-campus and online offerings that start and end consistent with the University's academic calendar. Thus, the MSEM courses were planned to conform start and end dates to the campus schedule, with 15-week durations in Fall and Spring, and ten weeks for summer, the latter being the typical summer course length. However, lectures were planned to be recorded and materials posted for asynchronous consumption.

The COB currently offers all of the four Business core courses each semester (Fall, Spring, Summer) as part of the MBA program, which has sufficient MBA student enrollment to support the multiple sections over the course of the academic year. This arrangement also offered flexibility for the MSEM program, as limited enrollment in the program would not allow for more than one section per year offered for the Engineering core courses, at least initially. Thus, a cohort model was proposed. As the enrollment increased over time, the cohort model would be reexamined with the objective of students being able to start the program in any semester.

## **Limitations**

### ***Program Challenges***

The MSEM program required development of several of the Engineering core courses. A new MSEM faculty member was required to serve as program coordinator and oversee the development of these courses, due to existing Tennessee Tech faculty transitions as the program started. This faculty hire would also assist marketing the MSEM program and advise new MSEM graduate students. The new faculty member was in place by Fall 2020. However, some students were enrolling in the MSEM program as early as Summer 2020, enrolling in the COB classes available. As with all academic programs in the United States at the time, the 2020 COVID 19 pandemic impacted offering and especially the promotion of the program. Thus, these first enrolled students from Summer 2020 through Spring 2021 were considered as being in a first cohort, at least for the purpose of persistence evaluation.

The initial MSEM curriculum concept required EMGT6100, ENGR 6200, and EMGT6210 to be prerequisites of later Engineering core courses. This curriculum strategy supported the second program objective to provide some depth in management tools and techniques presently used in engineering and technology-intensive organizations. However, students were not desiring to stay on the cohort plan of both starting only in Fall semesters and also taking two (2) courses per semester. Thus, many were predicted to be unable to complete the MSEM program in two (2) years, and many may also have a gap in one or more future semesters of enrollment.

## **Results and Discussion**

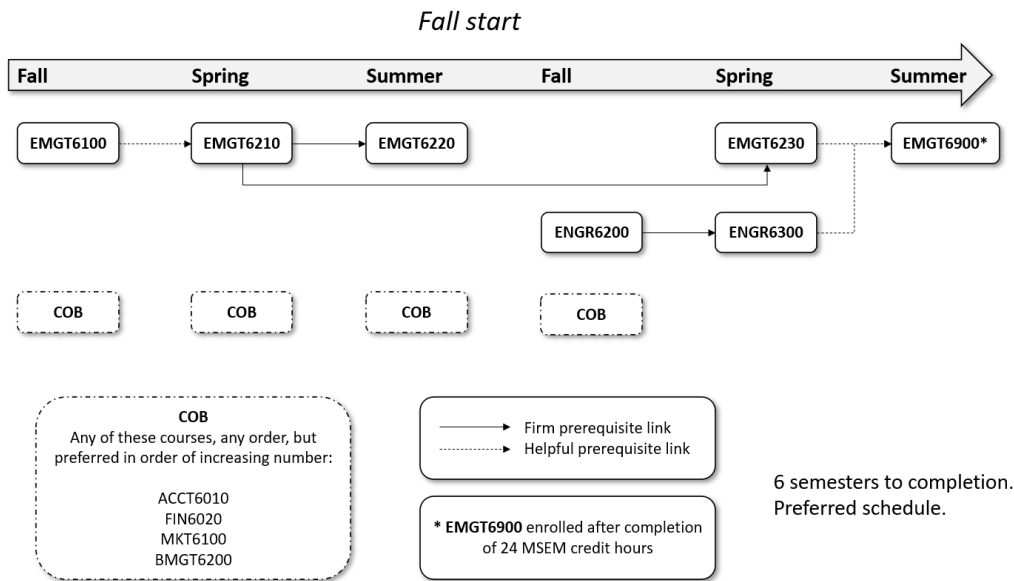
### ***Cohort Concept and Changes***

Originally, a cohort group was considered to be starting only in Fall semesters, and thus Exhibit 3 was the initial schedule advised for incoming students. However, students started applying for Spring and Summer semesters initial admittance as well. The original concept of a rigidly defined course progression thus was quickly abandoned and the MSEM instructing faculty reviewed the structure of the later Engineering core courses in an attempt to break one or more prerequisite requirements, allowing for more flexibility in student selection as the program grows. An updated course structure now allows for at most two pairs of sequenced courses: ENGR 6200 followed by EMGT 6300, and EMGT 6210 followed by EMGT 6220 and EMGT

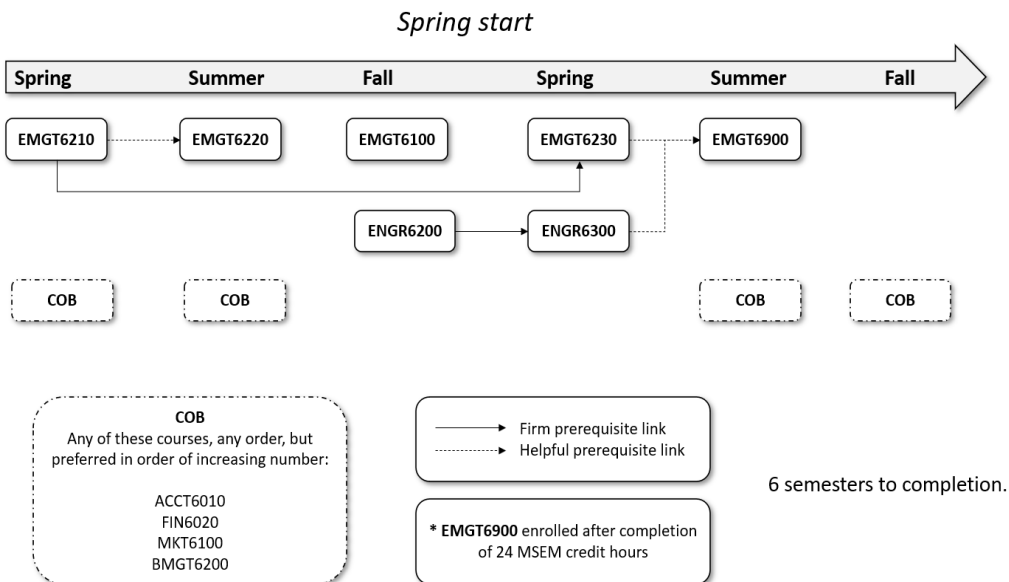
6230. EMGT 6210 is the prerequisite for both the latter courses, but the latter courses may be taken in any order beyond EMGT 6210 completion.

Given these new circumstances, the program coordinator developed three schedules for student progression, as shown in Exhibit 3, Exhibit 4, and Exhibit 5. A student may start in any semester and still be able to graduate in six (6) semesters (Fall and Spring starts) or seven (7) semesters (Summer start). Even the Summer start schedule could be compressed to six semesters if a student showed sufficient academic prowess in the first three semesters to be waived into the EMGT 6900 Professional Project course in his or her second summer semester.

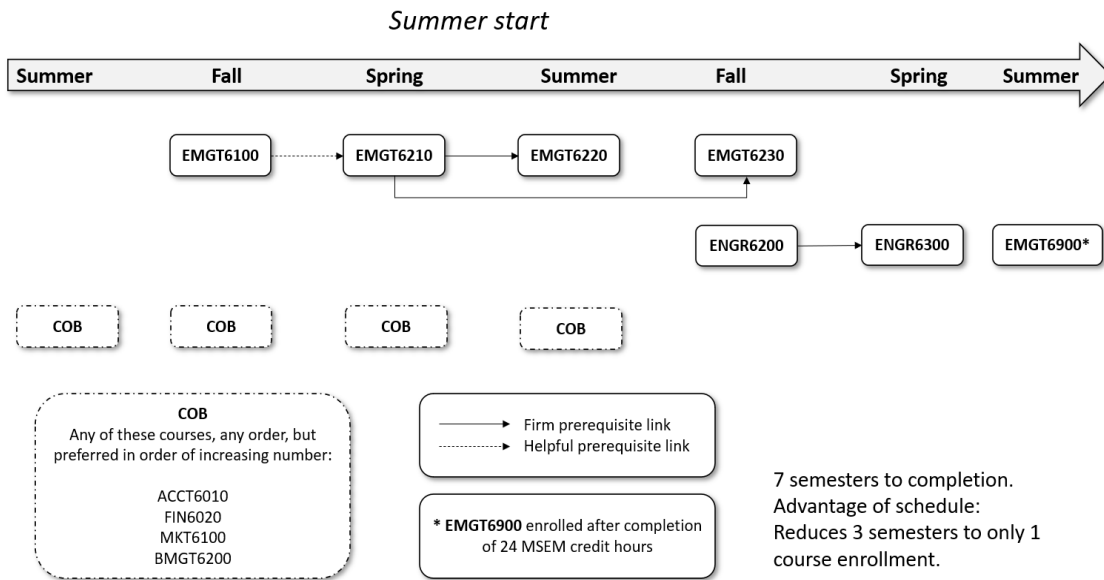
### Exhibit 3. Fall Start Schedule



### Exhibit 4. Spring Start Schedule



## Exhibit 5. Summer Start Schedule



The program coordinator and hosting department has also determined that the cohort emphasis will be deleted in future, published, academic information and advertising.

### *Admissions and Enrollment History*

The original plan approved for the MSEM program estimated that the first cohort would start in Fall 2019 with 15 students and increase each subsequent Fall semester with 5 additional students to a steady state of 25 new students enrolled per Fall semester. Roughly ten percent of the newly enrolled students were expected to not continue; of the remaining, half were anticipated to enroll in two classes per semester to graduation and the rest to be enrolling in one class per semester.

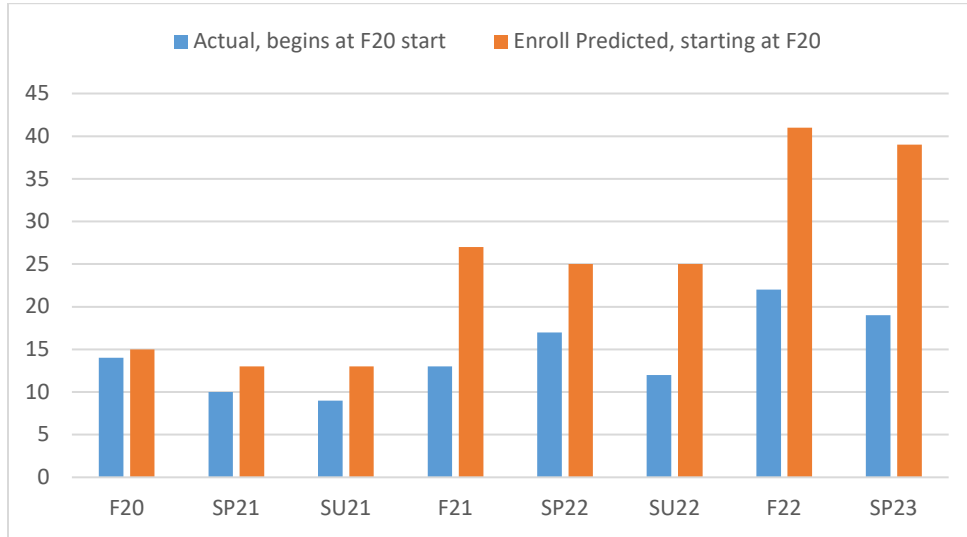
[1] Since the start of the MSEM program, 58 applications have been processed, with 48 accepted. Thus, the average admission rate was 82%. Of those accepted, 11 never enrolled in a course. Four students were dismissed from the program due to academic underperformance; two of these have applied for readmission and have been accepted.

The program started the Engineering core courses on schedule for Fall 2020. The enrollment start was significantly below original estimates and stayed low, likely due a combination of the pandemic and some issues related to advertising. If the original enrollment predictions were shifted to start in Fall 2020, then the enrollment history to present is compared to the estimates in Exhibit 6.

Given the low numbers, the enrollment trend indicates the program is growing, though at a lower rate than what was originally predicted. There was virtually no advertising reaching the potential student population due to the pandemic in 2020 and 2021. The Program Coordinator was authorized a travel budget for visiting regional companies and venues in order to advertise the program, but with travel restrictions, this approach was not possible to implement. Also, there was no online advertising budget specifically targeting the MSEM program. The enrolled students were surveyed in the EMG T6100 and EMGT 6210 courses. Anecdotally, the information gathered was that no admitted student ever heard of any advertising but did hear of

the program through either a co-worker or simply by searching on the internet for online university MSEM degree programs, and landing on the university's website.

**Exhibit 6. Predicted verses Actual enrollment for the first eight (8) semesters**



The EMGT 6900 course first offering was delayed from Summer 2022 to Fall 2022, to allow a slightly larger initial enrollment in the section. This Professional Project class completed, and four of the six students enrolled completed the program in December 2022, earning the first MSEM degrees from the program. Three students earned their degrees with seven semesters enrolled, and the fourth student after eight semesters. The latter started with a COB course in Summer 2020. The remaining two EMGT 6900 students will finish in Spring 2023, and the second offering of EMGT 6900 will be back on schedule for Summer 2023 enrollment.

Recently admitted MSEM students as well as graduating students were interviewed by the program coordinator. There are insufficient enrollment numbers to allow for statistical validity of data, but anecdotal reports may be stated. The most repeated observation by the new students was that, though the MSEM program was not well known as other similar online programs, the reason to enroll was that all the courses were guaranteed to be asynchronously offered. Synchronously offered lectures frequently would require them to take time off from work if the courses were offered during a 40-hour work week. These courses also allowed them to plan business trips around the courses within the course published due dates. The students in their final semesters noted that several courses provided knowledge that was immediately applicable to their work as project engineers. The courses they reported as most immediately useful included Introduction to Engineering Management (EMGT 6100), Project Management 1 (EMGT 6210), Decision Analysis (EMGT 6300), and the COB course Organizational Leadership (BMGT 6200). From a programmatic point of view: Students informed the Program Coordinator that their decision to take one, two, or no course per semester is primarily dependent upon their employer's educational compensation plan.



## Conclusions

Tennessee Tech MSEM program had a slower than predicted start, but enrollments have remained steady at the initial levels. The new MSEM advertising budgets emphasize online advertising, and promotional travel is scheduled again for 2023. The MSEM program is also now integrated into a new university and college advertising campaign for graduate programs overall. It is anticipated that the enrollments will be at or above the original predictions within two years.

With the first graduates completing in the 2022-2023 academic year, the MSEM faculty and the GBE department are discussing a review of the existing courses, in an effort to further assist students in course scheduling flexibility and appropriate knowledge content for working engineers.

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