The Transition of Mechanical Engineering Technology Students to the Mechanical Engineering Program through the Leveling Courses at Georgia Southern University

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Abstract – Now that the Mechanical Engineering Technology (MET) program of Georgia Southern University (GSU) is phasing out due to the creation of the newly developed engineering program, many students are choosing to transfer to the engineering program at GSU to obtain an engineering degree that is preferred over a MET, in general, in many engineering professions. However, in the technology program the practical aspect of engineering rather than the theoretical aspect is emphasized. On the other hand, the mathematics requirement of the MET program is greatly relaxed as compared to its engineering counterpart. Transfer is allowed on an individual basis and is based on academic performances and academic level of the students. Coming down to individual courses from the technology program, there are four different approaches taken, (A) course was not transferred at all (B) course is transferred as it is as a direct substitution of an engineering course (C) a combination of two courses are transferred as substitution of one course in engineering program and (D) some of the technology courses are transferred to engineering program with leveling courses to compensate for the content level between the programs, such as, Engineering Statics, Dynamics, Mechanics of Materials and Fluid Mechanics. These students later in their junior and senior years take advanced engineering courses such as machine design, energy science lab, etc. The current study investigates the effectiveness of these leveling courses as described under item D and the findings of the research are discussed. Most of the students who have taken at least one of these leveling courses have graduated either in spring or in summer of 2013. This current study bears more significance since the first ABET visitation for the new Engineering program was scheduled for Fall 2013.

Keywords: Engineering Technology, Georgia Southern University.

INTRODUCTION

There are many universities in the US that offer a four-year undergraduate degree in Mechanical Engineering Technology. A study in reference [1] shows the history and backgrounds of such programs in the US. In the US, the MET graduates often perform similar duties as compared to their engineering counterparts in their professions. Even in many states the MET graduates are eligible to work as engineering interns and may take the PE exam and can obtain a PE license after attaining the necessary experiences [2]. The students in the technology program are supposed to obtain more hands on experience in engineering. The program overview of several universities [3,4,5] were reviewed and it was found that the mechanical technology program is designed such that it is more applied in nature as compared to the ME curriculum.

Another aspect of MET programs in contrast with ME programs is its lesser math requirement. The lesser math requirement of a technology program can be also supported by the definition that is given by ASME. According to

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ASME [2], a mechanical engineering program requires integral and differential calculus, multivariate calculus and differential equations, in addition to the basic science courses, whereas, a mechanical technology program requires the introductory mathematics and some basic integral and differential calculus in addition to the basic science courses. Similar information is also found from the ABET [6] website that "engineering programs typically require additional, higher-level mathematics, including multiple semesters of calculus and calculus-based theoretical science courses. Engineering technology programs typically focus on algebra, trigonometry, applied calculus, and other courses that are more practical than theoretical in nature". It is also noted that MET and ME programs are accredited by two separate accredited commissions in ABET. MET is accredited by the Engineering Technology Accredited Commission where the ME program is accredited by Engineering Accredited Commission.

Thus, it is obvious that, in most of these programs, a technology student is not required to take higher level mathematics. For example, in Georgia Southern University the highest level mathematics a mechanical engineering technology student was required to take was Calculus II only. Hence, the use of vector mathematics, calculus, and differential equations are very limited in technology curriculum. Thus, there is an obvious learning deficiency in terms of higher level mathematics and the theoretical aspects of engineering in the technology students in general.

Scopes and Purposes of the Current Research

The authors of the present research article perceived that it is worthy of conducting research to assess the preparedness of the engineering students that are transferred from the technology program and to investigate how well they can integrate themselves into the engineering program. GSU had been offering the four years degree in technology for approximately forty years. Now that Georgia Southern University started its own engineering program since the fall of 2011, an opportunity was given to those students currently in the technology program who wanted to pursue their degrees in engineering. Several leveling classes were offered to those students to bridge the gap between the technology program and the engineering program and to fulfill the deficiency of the technology program. The leveling classes that were offered and the corresponding equivalent classes are given in Table 1.

Table 1: Leveling courses and the equivalent engineering courses

Technology course + Leveling course	Equivalent Engineering course
TENS 2141 Statics + MENG 3010 Leveling Topics in Statics	ENGR 2231 Engineering Mechanics I
TENS 2142 Dynamics + MENG 3011 Leveling Topics in Dynamics	ENGR 2232 Dynamics of Rigid Bodies
TENS 2143 Strength of Materials + MENG 3012 Leveling Topics in Mechanics of Materials	ENGR 3233 Mechanics of Materials
TMET 2521 Mechatronics + MENG 3015 Leveling Topics in Controls	MENG 3521 Mechatronics Studio Laboratory
TENS 2144 Fluid Mechanics + MENG 3016 Leveling Topics in Energy Science	ENGR 3235 Fluid Mechanics

Those leveling courses were offered only once in Spring of 2012 semester and students were required to satisfy their MATH requirement before taking these courses. Since the MATH requirements were less rigorous in the technology program the courses' content were more simplified than the engineering counterparts. For examples, in Statics (TENS 2141), students did not learn the vector approach of the force analysis which is a requirement in its Engineering counterpart. Also, the topics that involve integration extensively have been avoided in the TENS 2141 course. The same approach was taken while teaching TENS 2142 Dynamics course. The students took this dynamics course without knowing or using vector mathematics at all. In the TENS 2143 Strength of Materials course, the use of higher level was completely avoided. Likewise, the TENS 2146 Electrical Devices and Measurement course is not quite equivalent to the MENG 2131 course; so a leveling course MENG 3015 Leveling Topics in Controls was required to take for those students to compensate the knowledge deficiency in that subject area.

There are lot of differences between the technology version of the fluid mechanics course (TENS 2144) content and the engineering version of the course (ENGR 3235). In TENS 2144, only the application aspects of the subject was

covered. Moreover, a one credit-hour lab is also associated with it. On the other hand in the engineering version of the same course, the theoretical aspects such as control volume equations, differential analysis of fluid motion, dimensional analysis, and internal and external viscous flow in details were emphasized that were merely present in the technology version of the subject. Table 2 shows the major topical outline

Table 2: Leveling courses and their topical outline

Leveling Courses	Topical Outline
Statics	Application of Vector Algebra in Mechanics, 3D problems in Statics, Application of double and triple integral in Centroid and Moment of Inertia. Application of Friction in Machine Component, such as, belt.
Dynamics	Kinetics and Kinematics of particles in 3D, Rigid body dynamics using vectors, 3D kinematics of Rigid Body.
Mechanics of Materials	Use of Integration in axial, torsional and beam deflection. Theories of failure. Curved beam. Concentric and Eccentric Column.
Control	Review of DC Circuits, Transient Circuits, Steady State Sinusoidal Analysis, AC circuit analysis using phasors, complex impedance, Op Amps – differentiators, integrators and active filters.
Fluid Mechanics	Differential Analysis of Fluid Motion, Incompressible Viscous and Inviscid Flow and Dimensional Analysis and Similitude.

The purpose of the current study is to investigate how prepared the student with the technology backgrounds were for the engineering program. Were these students prepared enough to handle the higher level engineering courses? Were those leveling courses enough to fill the knowledge gaps between the technology and the engineering courses?

Methodology

In the current study, the Mechanical Engineering Technology (MET) students that transferred to the newly developed Mechanical Engineering (ME) program at Georgia Southern University were chosen and their academic performances were compared with the "regular" Mechanical Engineering students. All Mechanical Engineering graduating students has to take a senior level one credit course called "Mechanical Engineering Senior Seminar" (MENG 4612). One of the major objectives of that course is to provide the students opportunities to practice Fundamentals of Engineering (FE) type Exam. Instructions in that course are limited to the topics that are not covered or lightly covered in the other courses in curriculum, such as Engineering Ethics. Students are given quiz on topics similar to Fundamental of Engineering exam in an identical multiple choice format. Since, each topic represent a particular course, the study provides more direct measurement of students' preparedness at the individual course level. Hence the performance of student from MENG 4612 that was offered during the Spring of 2013 are discussed in details. The first batch of ME graduates took this particular class. They either graduated in Spring or in Summer of 2013. There were a total of forty four students in that class out of which fifteen were transferred students from other programs including MET of Georgia Southern. In order to assess more specifically, the overall class grades of a specific area, such as, Statics, are compared with the group who has taken MET version of that course and the levelling course.

Also, the performances of both groups were compared in Machine Design class that was offered in Spring 2012. Machine Design has prerequisite as Mechanics of Materials which in turn has Statics as prerequisite. Hence, the performance in Machine Design class is a good indicator of the students' background in the applied mechanics area.

Results and Discussion

The table 3 below provides the comparative study of the performance of the entire class on a quiz based on the Statics with its subset who has transferred from MET program and had leveling course in that particular topics. There are several observations that can be made.

Lower the level of the course higher the number of students taken as leveling. For example the Statics leveling course was taken by nine students while the number drops down to only three when it comes to Mechanics of Materials.

With the exception of Fluid Mechanics, students with background in leveling courses outperformed the class average. Only in Fluid Mechanics, the students with the leveling course background scored below the class average. With the low sample size of four it is difficult to conclude statistically. However, looking at the overall scenario, it is obvious that there is no indication that the students with leveling courses were less prepared.

There were nine students who took the leveling course on control. However, there no quiz on that topic in the MENG 4612 course to compare the population.

There is another argument in favor of the leveling courses. Material Science course was allowed to transfer from MET to ME as it is, *without* any leveling course. Three of the students actually did transfer their Material Science course from Technology program to Engineering Program. While the overall class average for Material Science quiz in MENG 4612 was 82%, the students who transferred from MET only averaged 57%.

In Spring 2012, Machine Design course had twenty five students in total. Their class average was 81% with standard deviation 8.7%. There were seven individuals who were transferred from Technology program and thus had various leveling courses in their backgrounds. Their overall average was 81% as well with standard deviation 7.4%. Early in the semester Instructor of Machine Design conducted a quiz on Mechanics of materials in order to assess the background of the students. The overall class average was 43% and transfer students averaged 46%.

It is worth mentioning that the ABET evaluators in 2013 did not raise any question on the issues of transferring courses from MET to ME.

Table 3: Comparative Study of Student Performance in Quizzes conducted in MENG 4612

Module / Topic	Class Average (Standard Deviation)	No of Transferred Students with leveling class in the topic	Average of the Student with leveling class in the topic (Standard Deviation)
Statics	**41% (21%)**	**9**	**49% (18%)**
Dynamics	**42% (22%)**	**5**	**50% (16%)**
Mechanics of Materials	**51% (19%)**	**3**	**60% (17%)**
Fluid Mechanics	**57% (16%)**	**4**	**50% (18%)**

Conclusion

A comparative study has been made between the students who were regular Mechanical Engineering program versus the students who were originally in the Mechanical Engineering Technology program at Georgia Southern and subsequently transferred to Mechanical Engineering program. Some of the MET courses were transferred with an addition of a leveling course that was offered to the transfer seeking MET students. The result shows those leveling courses were very effective.

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