2006-796: CAN ENGINEERING AND ENGINEERING TECHNOLOGY PROGRAMS RESIDE WITHIN THE SAME DEPARTMENT?

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Can Engineering and Engineering Technology Programs Reside within the same Department?

Abstract

According to the October 2005 listing of the Accreditation Board of Engineering and Technology, there are 272 Bachelor of Science in Mechanical Engineering and 72 Bachelor of Science in Mechanical Engineering Technology accredited programs located throughout the United States. Of those, 40 reside within the same institution. An examination of these 40 institutions reveals that the BSME and BSMET programs seldom reside within the same department. In fact, some reside in different schools or colleges within the same institution. This paper will address some of the myths and biases surrounding engineering and engineering technology and explore a model that could enhance a more collaborative relationship between faculty of engineering and engineering technology programs.

In September 2005 Oregon Institute of Technology launched a new BSME program that complemented its mature BSMET program, first accredited in 1970. Both programs reside in the Department of Manufacturing and Mechanical Engineering and Technology. A discussion of the evolution of this relationship and its many positive attributes is presented along with a thorough description of the differences and similarities between these two programs.

The discussion within this paper centers specifically on BSME and BSMET programs. However, the issues and conclusions can extend to all similarly titled engineering and engineering technology programs.

I. Introduction

Oregon Institute of Technology (OIT) is the only public institute of technology in the Pacific Northwest. Founded in 1947, OIT is accredited by the Commission on Colleges of the Northwest Association of Schools and Colleges, and is part of the Oregon University System. All engineering technology (ET) programs (mechanical, manufacturing, electrical, and computer engineering technology) at OIT are 4-year Bachelor of Science programs and are accredited by the Technology Accreditation Commission[1] (TAC) of the Accreditation Board of Engineering and Technology (ABET). One of OIT's engineering programs, civil engineering, is accredited by the Engineering Accreditation Commission[2] (EAC) of ABET. The newest program, mechanical engineering, was introduced in the fall 2005 and must wait for its first graduate in 2007 before applying to EAC of ABET for accreditation.

Although conclusions are not drawn from this fact, OIT's administrative structure is somewhat unique in that there are no school deans. Administrative governance is derived from the institution's president, provost, associate provost, and finally department chairs. Department chairs are volunteer faculty members within the various departments that fill a three year term with half release time.

The Manufacturing and Mechanical Engineering and Technology (MMET) Department at OIT consists of three undergraduate bachelor of science programs in manufacturing engineering technology (MfgET), mechanical engineering technology (MET), and mechanical engineering (ME). A graduate program in manufacturing engineering technology was introduced into the MMET Department during the fall of 2004. The department consists of three sites, the main campus in Klamath Falls, OR the Metro campus in Portland, OR and the Boeing campus in Seattle, WA. The numbers of students in these programs as of winter quarter 2006 are given in Table 1.

TABLE 1. Number of Students in MMET	
Program	Number of Students
MfgET	128
MET	161
ME	30
MS MfgET	21
Total Students	340

The reasons that the ME program was housed within the same department as ET programs in MfgET and MET are listed below:

1. Considering institutional and department budgets. It is more cost effective to have a single department structure with two small programs than to have two small autonomous departments.
2. Sharing of resources between the programs. Both engineering and ET programs at OIT pride themselves on the hands-on nature of their curriculum which means lots of laboratories and laboratory equipment. With this much equipment, sharing of resources is a necessity.
3. Sharing of faculty between the programs. Faculty can specialize in the types of courses that they are experts in whether it is engineering or ET. Faculty is encouraged to associate with both programs. Enhanced interaction between engineering and ET students can lead to joint capstone projects which simulate real-life situations.
4. Sharing of common courses between ME and MET. Both ME and MET students sit in courses that are considered fundamental and that have the same student outcomes. This can be facilitated because the MET program has always required three quarters of calculus.
5. Providing a common first two years of curriculum for students. Students explore their strengths and interests during these early years then choose either ME or MET through a seamless path. Under this structure students that become disillusioned with engineering are not stigmatized by "not making it." Or students that see ET as not for them can easily move on the engineering.

Based on these reasons, the choice to house the mechanical engineering degree in the MMET Department was never seriously debated. It seemed to be a logical decision to move the department away from ET-only and to embrace engineering and ET.

Although not exhaustive, the list of other institutions where BSME and BSMET programs reside within the same department are California State University, Sacramento, Milwaukee School of Engineering, Lake Superior State University, California State University, Long Beach, California State Polytechnic University, Pomona, Montana State University, and Western Michigan University. Other institutions have had both ME and MET in the same department at one time, but have since split, e.g., the California Maritime Academy began a ME program in the early 1990's. Students sat in many of the same classes and grades tended to stratify according to program. At that time, both TAC and EAC of ABET did not look favorably on this relationship and forced the Academy to separate the programs into two departments.

An informal survey of the 3600 plus members of the Technology List-Serve[3] was conducted to flush out issues that exist between ME and MET programs both in and outside of the same department. Two of the various issues that were raised in this survey are listed below.

1) ***Faculty Credentials.*** Engineering programs require a Ph.D. and ET programs require a minimum of a M.S. degree with a Ph.D. preferred.

2) ***Clear Separation in Programs.*** For accreditation, ABET likes engineering and ET programs to be at kept at arms length.

There were three additional common comments that were raised various times in the survey. Those were that:

- MET's are viewed as inferior to ME's,
- Recruitment of students will be slanted toward ME because the recruiter is someone that believes ME is better, and
- Institutional requirements for faculty to hold a terminal degree and conduct research in order to receive tenure exist throughout the country.

The first two comments fall into the category of personal opinions and biases that we have no control over. The third comment is unique to individual institutions and is not necessarily pertinent to the undergraduate education of students. All three of these latter comments are not addressed herein.

II. Discussion

The two issues identified above, i.e., faculty credentials and separation in programs, will be discussed in the context of applicable ABET criteria, and then in the way in which OIT is addressing these issues.

Faculty Credentials –
As "Conventional Wisdom" might say, "engineering programs require a Ph.D. and engineering technology programs require a minimum of a M.S. degree with a Ph.D. preferred." Here is what ABET has to say concerning this issue, taken from the EAC and TAC Criterion 5, Faculty. Both EAC and TAC criteria state that there must be sufficient numbers of faculty to offer the program and achieve program objectives. In addition:

EAC
"The overall competence of the faculty may be judged by such factors as:
EAC-1: education,
EAC-2: diversity of backgrounds,
EAC-3: engineering experience,
EAC-4: teaching experience,
EAC-5: licensure as Professional Engineers,
EAC-6: level of scholarship,
EAC-7: participation in professional societies,
EAC-8: ability to communicate, and
EAC-9: enthusiasm for developing more effective programs."

TAC
"Overall competence of the faculty will be evaluated through such factors as:
TAC-1: formal education,
TAC-2: balance of academic experience and professional practice,
TAC-3: industrial experience,
TAC-4: teaching experience,
TAC-5: professional certification,
TAC-6: scholarly activity,
TAC-7: professional society participation,
TAC-8: communication skills,
TAC-9: technical currency, teaching effectiveness, and extracurricular support for student activities, …."

Contrary to conventional wisdom, there is no mention of a Ph.D. required for engineering programs or a M.S. with a Ph.D. preferred for ET programs. Quite the contrary, from EAC-1, 2, 3, 4, and 5 and TAC-1, 2, 3, 4, and 5 it becomes evident that ABET criteria is encouraging diversity in a program's faculty. The OIT MMET Department's faculty diversity in context of the EAC and TAC criteria is given in Table 2.

Clear Separation in Programs -
As "Conventional Wisdom" might say, "For accreditation, ABET likes engineering and ET programs to be kept at arms length." There are no criteria in EAC or TAC that would dictate that the two programs must be separate. Hence, an institution that desired to have both programs in the same department would be free to do so. However, it would be up to the institution to "clearly" articulate the differences to prospective students and to keep clear divisions among the ENGR-only, ET-only, and ET/ENGR-common courses.

The OIT MMET Department's curriculum is given in Table 3. Here, the EAC and TAC requirements are given along with the ME and MET program's number of quarter credits associated with each category. Note that the last column indicates the number of credits in a category that are common to both the ME and MET programs.

TABLE 2. MMET Department Faculty Diversity								
	TAC-2&3, EAC-2&3	TAC-7, EAC-7	TAC-5, EAC-5	TAC-6, EAC-6	TAC-4, EAC-4	TAC-1, EAC-1		
Faculty #	Yrs Acad/ Industrial Exp	Society participation	licensure	Scholar-ship	teaching	MS	Ph.D.	Pending Education
1	3/15			Low	3	X		ABD
2	21/5			High	14	X		
3	21/5	X	X	Low	14	X		ABD
4	16/9			Low	13	X		
5	8/14	X		High	9		X	
6	1/5	X		Med	1		X	
7	8/5			Low	9		X	
8	6/15	X	X	High	5	X		
9	15/5	X		High	11		X	
10	19/7	X	X	High	26		X	
11	41/5	X	X	High	26		X	
12	1/10			Med	3	X		ABD
13	2/25	X	X	Low	2	X		

Table 4 is a continuation of Table 3 where specific courses offered in the OIT MMET Department and typical of any mechanical program are grouped under the general categories of Technical Fundamentals, Computer Aided Engineering, Mechanics, Controls, and Thermo/Fluids. An X indicates which program requires the courses, which are common, and the level, i.e., Freshman (Fr), Sophomore (So), Junior (Jr), or Senior (Sr), in which the student sits in the class.

It is noteworthy that the only senior level common course is the Capstone course. Here both ME and MET students can interact. In fact, the MMET department encourages interdisciplinary projects in which ME and MET students work on a common project. Recently, there have been instances where the electrical and computer engineering departments have also collaborated with MMET on senior projects. Except for the Capstone course, there are not any senior level common courses shown in Table 4. Additionally, several of the sophomore and junior level courses are offset, i.e., taken by a ME student in their sophomore year and taken by a MET student in their Junior year.

The most applicable ABET statement appropriate to the separation of the programs is that there must be clear responsibility for the programs and clear assessment roles. From EAC , Criterion 5, Faculty - The program faculty must have appropriate qualifications and must have and demonstrate sufficient authority to ensure the proper guidance of the program and to develop and implement processes for … From TAC, Criterion 5, Faculty - The program faculty must have sufficient responsibility and authority to define, revise, implement, and achieve program objectives.

TABLE 3. Total Quarter Credits for BSME and BSMET Degree Requirements					
Category	**EAC Requirement**	**ME**	**TAC Requirement**	**MET**	**Common MET/ME**
Communications	d	18	d	18	18
Humanities	d	9	d	9	9
Social Sciences	d	15	d	15	12
Math & Basic Science	***45 Credits***		***Integral & Diff Calc***		
Basic Math		0		8	0
Math above Trig	Multi-variable calc, DE, Statistics, & linear alg	23		16	16
Chemistry	knowledge of	8	d	4[e]	0
Physics	knowledge of	12	d	12[f]	12
Technical Content	***67.5 Credits***				
Computer Aided Engineering		17	b	13	10
Technical Fundamentals		18	a, b	21	18
Material Science		6	b	6	3
Mechanics	Mech Systems	19	a, b, c	13	7
Controls		12	b	12	6
Thermo/Fluids	Thermal Systems	18	a, b, c	21	3
Capstone	Yes	9	Yes	9	9
Professional Registration	None	1	None	0	0
Technical Electives	d	6	d	12	0
Totals		191		189	123

a Technical expertise in materials, statics, dynamics, strengths, fluid power or fluid mechanics, thermodynamics, and either electrical power or electronics.

b Technical expertise having added technical depth in a minimum of three subject areas chosen from: manufacturing processes, mechanical design, computer-aided engineering graphics, engineering materials, solid mechanics, fluids, thermal sciences, electro-mechanical devices and controls, and industrial operations.

c Expertise in applied physics having an emphasis in applied mechanics, plus added technical topics in physics and inorganic chemistry principles….

d Must support program objectives.

e 100 or 200 level.

f Algebra or calc-based.

TABLE 4. BSMET & BSME Course Breakdown				
	ME	MET	Common	ME/MET Level
Technical Fundamentals				
Introduction to Engineering	X	X	X	Fr/Fr
Manufacturing Processes		X		Fr/Fr
Machining & Welding	X	X	X	Fr/Fr
Geometrical Dimensioning & Tolerancing	X	X	X	So/Jr
Statics	X	X	X	So/So
Computer Aided Engineering				
CAD	X	X	X	Fr/So
Solid Modeling	X	X	X	Jr/Jr
Engineering Programming	X	X	X	So/So
Numerical Methods	X	X		Sr
Finite Element Analysis	X	X		Sr/Sr
Mechanics				
Strength of Materials	X	X	X	So/So
Machine Design I	X	X		Jr/Jr
Machine Design II	X	X		Jr/Jr
Dynamics I	X	X	X	Jr/Jr
Dynamics II				Jr
Vibrations				Sr
Controls				
Electric Circuits	X	X	X	So/Jr
Instrumentation	X	X		Jr/Jr
Electric Power Systems	X	X	X	Jr/Sr
Control Systems	X			Sr
Thermo/Fluids				
Fluid Mechanics I	X	X		Jr/So
Fluid Mechanics II	X			Sr
Thermodynamics I	X	X	X	Jr/Jr
Thermodynamics II	X	X		Jr/Jr
Heat Transfer	X	X		Sr/Sr
Experiments in Thermodynamics		X		Sr
Fluid Power Systems		X		Sr
Capstone				
Senior Projects	X	X	X	Sr/Sr

The structure in the OIT MMET Department is for a common department chair that oversees and encourages the collaboration between the programs and takes care of the administrative details common to both. Then there are four faculty designated as Program Directors (PD), one for MfgET, MET, ME and MS MfgET. Each PD has responsibility for all program curricula decisions and for the assessment coordination for their respective programs.

By sharing the fundamental courses of CAD, Solid Modeling, Engineering Programming, Strength of Materials, Dynamics I, Electric Circuits, Electric Power Systems and Thermodynamics I the first two years of the curriculum is essentially common to both the ME and MET programs. Students are allowed almost two years time to explore their strengths and interests. They have time to speak to faculty, industry, and peers to make a more informed decision about which educational path to take. A survey was given the freshman students asking the question: "Do you understand the difference between engineering and ET when you walked on campus?" and 90% said no.

As a student enters the MMET department as a freshman and if they are inclined to pursue the ME path, they are advised to take the higher level chemistry courses and the calc-based physics. Thus, they have either the ME or MET option available to them as they finish their sophomore year. The only difference in the curricula during these first two years is a second quarter of chemistry and the calculus based versus algebra-based physics. However, both would satisfy the MET requirements.

III. Concluding Remarks

A thorough examination of the appropriate ABET criteria provides evidence to refute the claims that faculty credentials and the co-mingling of engineering and ET programs presents barriers to the efficient operation of both programs under a single entity. The positive aspects of this arrangement far outweigh the negatives. A model is proposed and discussed where a ME and MET program reside under the umbrella of a single department. Several conclusions may be drawn from this discussion:

- We must uncouple undergraduate engineering education from graduate engineering education. In undergraduate education, student outcomes are measured by their worth to industry upon graduation. In graduate education, a student's worth many times is based on their potential to help faculty sustain research dollars. Engineering-only institutions are more likely to be in search of research dollars. Institutions dependent on research dollars for their existence must reward these faculty, thus creating an atmosphere where a Ph.D. is a requirement for tenure and promotion. This arrangement is not conducive to faculty collaboration between engineering and ET programs.
- A seamless transition for students to go from ET to engineering and back again is promoted when the ET program requires differential and integral calculus in their curriculum.
- With the change in the ABET criteria to an outcomes-based assessment approach, schools of engineering have more flexibility in defining their programs. Schools can maximize their offerings more efficiently depending on their resources and not sacrifice quality.

In answer to the question posed in the title of this paper, "Can engineering and engineering technology programs reside in the same department?" the answer is an astoundingly – YES. It is hoped that as new innovative programs are introduced and as older established programs are enhanced, that the wall between engineering and engineering technology can be lowered. Under this environment more collaboration between faculty can and will occur.

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