Curriculum comparison of mechanical engineering technology programmes at Purdue University and Ming Chi University of Technology

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ABSTRACT: Career education instruction typically involves more application and less theory than what is taught in academic programmes. Comparing the mechanical engineering technology curricula in the USA and Taiwan may help to meet the preparation for employment in specific occupations. The mechanical engineering technology curricula of the two universities are different in the proportions of theory and the application they contain. This study found that manufacturing processes are more important at Purdue University due to the six credits courses within two semesters that are taught. Fundamental theories in the mechanical engineering field, such as thermodynamics, fluid mechanics and strength of materials are offered at Ming Chi University of Technology, while Purdue University provided heat power, fluid power and applied strength of materials. The oral communication and technical writing courses in the USA help the students to meet the requirements of employment. The curriculum comparison of the mechanical engineering technology between USA and Taiwan may provide a reshaping approach to the course arrangements.

INTRODUCTION

It is an important but difficult issue to understand the structure and coverage of tertiary education programmes. Recently, there has been an increased emphasis on monitoring the structure and coverage of tertiary education programmes, and on making the results more widely available. Baker indicated that the curricula could be compared in terms of curriculum characteristics including entrance requirements, accreditation, length of programme, instructional methods, scholastic standards, tuition costs, general education requirements and requirements in technical courses [1]. By comparing colleges in different countries, one can reveal that countries have their own styles. Berggren et al decided that the main goal of the teaching and learning theme is to increase a student's learning through problem formulation, increased active learning experiences, immediate feedback and improved instructor skills [2]. The linkage between teaching and learning is the curriculum.

One way to achieve this is to compare the curriculum to a known standard for programmes in the field of mechanical engineering technology. In the past decades, many institutions monitored their own programmes only informally, and little effort was made to enlighten outsiders. There has been an increased emphasis on monitoring the structure and coverage of tertiary education programmes by outsiders such as the official agent and the non-government organisation. The Accreditation Board for Engineering and Technology (ABET), one of the many non-government organisations, recently became the recognised accreditor for college and university programmes in applied science, computing, engineering and technology [3].

Traditionally, the baccalaureate Mechanical Engineering Technology (MET) courses provide the broad skill set required for both entry-level success and long-term advancement. The core courses include topics such as thermodynamics, dynamics, fluid mechanics, and automation and control systems. Effective written, oral and graphic communications are practiced throughout the curriculum along with computer literacy. Students in MET are prepared for a range of technical positions including system design, fabrication, manufacturing, heating, ventilating and air conditioning (HVAC), and construction [4]. In other words, the baccalaureate students of the MET programme are prepared for professional careers as mechanical engineers, and for graduate study in mechanical engineering or related fields. Mechanical engineers design and manufacture systems that convert energy into useful work. Using the laws of nature, along with mathematical analysis, communications and computational skills, students are educated to develop creative solutions for societal needs.

As a fundamental engineering discipline, mechanical engineers are sought by virtually every industry and government agency. Mechanical engineers are employed in areas specialising in design, research and development, manufacturing, production, management, project planning, consulting, testing, quality assurance and technical sales [5]. The previous material shows that the educational objective and the core ability, as well as the professional career are adequately

different between the ME and MET departments. The courses of each department should, therefore, be different for the achieved abilities of students.

Table 1: The first year courses of MET at MCUT and Purdue University.

First Year			
ME MCUT		MET Purdue University	
Course	Credit	Course	Credit
Calculus	6	Precalculus	5
		Calculus for Technology I	3
Statics	2	Applied Statics	3
Computer Aided Mechanical Drawing	2	Graphics Comm.	3
General Physics	6	General Physics	4
English	6	English Composition	3
Computational Program and Practice	1	Computational Analysis Tools in MET	1
Dynamics	3	Computer Analysis Tools for MET	2
Chemistry	3		
Engineering Thermodynamics	3		
Principles of Electrical Engineering	3		
Practical Machining Workshop Training	1		
Experimental Design and Analysis	1		
Special Project (I)	1		
Precision Measurement and Practice	2		
Chinese	6		
Constitutional Development (H/SS Elec,)	3		
Humanities and Social Sciences (Elec.)	2		
		Materials and Processes I, II	6
		Production Design and Specifications	3
Total	51	Total	34

Table 2: The second year courses at MET in MCUT and Purdue University.

Second Year			
ME MCUT		MET Purdue University	
Course	Credit	Course	Credit
Mechanism Funda.	2	Dynamics	3
Strength of Materials	3	Applied Strength of Materials	4
Mechanical Elements Design	2	Machine Elements I	3
Principles of Electronics	3	Electricity Fund.	3
Humanities and Social Sciences(Elec.)	2	Humanities and Social Sciences (Elec.)	2
Comprehension and Oral in English	2	Fundamentals of Speech Communication	3
		Heat/Power	3
		Manufacturing Systems	3
		General Physics	4
		Fluid Power	3
History	3		
Materials Science and Engineering	3		
Mechanical Material Experiments	1		
Automatic Control	3		
Special Project (II)(III)	2		
General Physic Experiments	1		
Engineering Mathematics I	3		3
ME Elective	3	Technical Selective	3
ME Elective	3		
ME Elective	3		
ME Elective	3		
ME Elective	3		
Humanities and Social Sciences(Elec.)	2		
Total	47	Total	34

However, in Taiwan neither the engineering departments nor the engineering technology departments in the (Technological) Universities follow the accredited programme laid down by the Engineering Accreditation Commission (EAC) of ABET. The programmes offered by the Department of Mechanical Engineering at Ming Chi University of

Technology (MCUT) and the Engineering Department at Technological University followed the programme of the Technology Accreditation Commission (TAC) have not previously been examined. This paper reviews the undergraduate curricula of Mechanical Engineering Technology offered by MCUT and Purdue University, and then compares these two curricula. At Purdue University, the MET programme is a four-year one for the students enrolled from the community college and junior college. At the same time the MCUT programme in MET is similar to the one at Purdue University. Hence, in this article, the results of this curriculum comparison are presented, including a description of the departments' undergraduate curricula. The ABET accredited programmes led to the different abilities being achieved by students. The comparison of the curricula is especially interesting in the contained technology courses in which a mechanical technician emphasis is revealed.

ENGINEERING TECHNOLOGY CURRICULUM

The undergraduate programme is a general mechanical engineering technology curriculum designed to allow students within the MCUT and Taiwan degree framework to develop the knowledge necessary to begin a career as a mechanical engineering professional or to begin graduate study in mechanical engineering technology. Students may credit mechanical engineering technology courses to meet the requirements of undergraduate degrees, however, those that focus on a profession in mechanical engineering technology are typically working toward a baccalaureate of science (BS) degree. Degrees offered at the University and the Technological University of Taiwan are usually of two years' duration, are therefore the same as the BS. At the time of this study, the educational objectives of the department and the core abilities of the students prescribed mechanical engineering (technology) major requirements were similar, and so even for students intending to specialise in mechanical engineering technology, the programme is constrained only by the general BS requirements. The regulations for the mechanical engineering technology major were designed to reflect the usual advice given to BS students specialising in mechanical engineering technology. Consequently, this study generally applies to the current situation. The particular way the curriculum is structured into courses reflects the four-year nature of the degree. The course design has been influenced by previous published curricula, courses taught elsewhere and staff expertise. Based on the Web site of Purdue University, the baccalaureate MET programme provides a strong foundation in energy, motion, materials, fluid power and manufacturing processes. These MET courses are supplemented by courses that provide background in related technical and non-technical topics essential in modern industry. Graduates fill a variety of positions in areas such as product design/development, process design/development, plant operations, facilities management, quality assurance, field technical service, production supervision, technical sales and research.

Table 3: The third year courses of MET at MCUT and Purdue University.

Third Year			
ME MCUT		MET Purdue University	
Course	Credit	Course	Credit
Cooperative Education Factory Practice Programme I	10		
Cooperative Education Factory Practice Programme II	10		
		General Chemistry	3
		Visual Programming	3
		Calculus for Technology II	3
		Applied Thermodynamics	3
		Global Elective	3
		Applied Fluid Mechanics	3
		Advanced Materials in Manufacturing	3
		Controls and Instrumentation for Automation	3
		Elementary Statistical Methods	3
		Principles of Economics	3
Total	20	Total	30

Students must accomplish a total of 148 credits to meet the graduation requirement of MET in MCUT [6] and at Purdue University [7]. As Table 1 and Table 2 showed, the courses on Mathematics or Calculus, Manufacturing, Materials, Mechanics, Drawing and English are the general service courses and essentially considered part of our main undergraduate programme. Automatic Control and Special Project are the two courses in the first year in particular in MCUT.

At Purdue University, the Production Design and Specifications is different from the one at MCUT. In addition, the zero-credit courses which are compulsory subjects at MCUT are usual in Taiwan. The students in MCUT are at the frontier in Taiwan, so MCUT provides Engineering Mathematics worth six credits. It has been proved that the quality and level of students is not determined by their majors, but are based on the whole system and content of the courses

and the knowledge, quality and capacity. Thus, the configuration of the course system in the whole teaching is very important. To a certain extent, the courses system is the actual reflect of the professional training goal.

Table 4: The fourth year courses of MET at MCUT and Purdue University.

Forth Year			
ME MCUT		MET Purdue University	
Course	Credit	Course	Credit
ME Elective	3	MET Elective	3
ME Elective	3	MET Elective	3
ME Elective	3	MET Elective	3
Elective	3	IET Elective	3
Elective	2	Int./Basic Sci Elective	3
Humanities and Social Sciences (Elec.)	2	Humanities and Social Sciences (Elec.)	3
Elective	3		
Special Project (IV)	1		
Seminar in Profession and Practics	1		
Seminar on New Technologies for Smart Living	1		
ME Elective	3		
ME Elective	3		
Experiments for Mechanical Engineering I, II	2		
		OLS Elective	3
		Technical Writing	3
		MET Elective	3
		(COM) Small Group Discussion	3
Total	30	Total	30

In Tables 3 and 4, the course on Intermediate Mechanics of Materials is a general service course and is not considered part of the main undergraduate programme. The most important and difficult point is the joint of courses. In many cases, to emphasise the entity of the course configuration, students are required to obtain the quantity of information and knowledge, but ignore the level and the continuity of the courses, which leads to the situation that different courses are disconnected and the training goals cannot be fulfilled.

RESULTS AND DISCUSSION

To compare the curriculum, it was necessary to estimate the number of knowledge units covered by the course. This was concerned primarily with lecture hours. In fact, the actual listing of the comparison results by spreadsheet is shown in Table 5. Each cell in the table is the course of the knowledge unit such as mechanics and so on. The number of lecture hours is identified as *credit* for each course. The physics course, worth eight credits, is a fundamental one at Purdue University but is never offered at MCUT. Manufacturing processes is more important at Purdue University due to the six credits courses within two semesters. Fundamental theories such as thermodynamics, fluid mechanics and strength of materials are offered at MCUT, while at Purdue University, heat power, fluid power and applied strength of materials are offered.

These can be arranged or augmented in many ways to suit the requirements of many different kinds of degree programme. In fact, knowledge units can even be split across courses. Each knowledge unit is described in the report together with the minimum amount of lecture time necessary for the pre-requisite knowledge units. Of course, this is reasonable and explicitly allowed in this analysis because it seems to be broad agreement between the MET Programme I MCUT and Purdue University. Finally, one should acknowledge that in the architecture subject area, there are a few knowledge units with hours. However, at Purdue University the MET provides several courses involving fundamentals of speech communication and mechanical drawing, as well as production design and specifications indicating that the communications either orally or graphically are important for a mechanical technician. Furthermore, calculus is essential for technician training at Purdue University, instead of engineering mathematics.

To a certain extent, this difference is reduced by the importance attached to breadth requirements in Purdue University baccalaureate degrees. Such requirements are less usual in Taiwan in general, and in particular, there are no such requirements in ABET. The courses to achieve the core abilities of students are decided on by the curriculum committee of their department. The ABET identifies the procedure established rule, and never proof the effectiveness of the arrangement. This might suggest that the MET curriculum could possibly abandon some of the advanced material in favour of greater emphasis on some more basic units. However, the Technological University in Taiwan should make sure that the coverage of the basics is sufficiently good that the students will benefit more from the provision of the more advanced courses. Many of the graduating students leave the Technological University directly to begin careers as an associate engineer, not as a technician. The curriculum committee must structure the programme to support that transition.

Table 5: All MET courses at MCUT and Purdue University.

ME MCUT		MET Purdue University	
Course	Credit	Course	Credit
English	6	English Composition	3
Chinese	6		
Comprehension and Oral in English	2	Fundamentals of Speech Communication	3
		Technical Writing	3
		(COM) Small Group Discussion	3
Calculus	6	Precalculus	5
		Calculus for Technology I	3
Engineering Mathematics I	3	Calculus for Technology II	3
General Physics	6	General Physics I	4
General Physic Experiments	1	General Physics II	4
Chemistry	3	General Chemistry	3
Statics	2	Applied Statics	3
Dynamics	3	Dynamics	3
Strength of Materials	3	Applied Strength of Materials	4
Engineering Thermodynamics	3	Applied Thermodynamics	3
		Heat/Power	3
		Applied Fluid Mechanics	3
		Fluid Power	3
Computer Aided Mechanical Drawing	2	Graphics Comm.	3
Computational Program and Practice	1	Computational Analysis Tools in MET	1
		Computer Analysis Tools for MET	2
		Visual Programming	3
Mechanical Elements Design	2	Machine Elements I	3
Mechanism Funda.	2	Production Design and Specifications	3
Principles of Electrical Engineering	3	Electricity Fund.	3
Principles of Electronics	3		
Materials Science and Engineering	3	Materials and Processes I	3
Mechanical Material Experiments	1	Materials and Processes II	3
		Manufacturing Systems	3
		Advanced Materials in Manufacturing	3
Precision Measurement and Practice	2		
Practical Machining Workshop Training	1		
Automatic Control	3	Controls and Instrumentation for Automation	3
Experimental Design and Analysis	1		
Experiments for Mechanical Engineering I, II	2		
Special Project I,II,III, IV	4		
Humanities and Social Sciences (Elec.)	2	Humanities and Social Sciences (Elec.)	2
Humanities and Social Sciences (Elec.)	2	Humanities and Social Sciences(Elec.)	3
Constitutional Development (H/SS Elec,)	3		
Humanities and Social Sciences (Elec.)	2		
Humanities and Social Sciences (Elec.)	2		
History	3		
		Elementary Statistical Methods	3
		Principles of Economics	3
ME Elective	30	Technical Selective	3
		MET Elective	12
Elective	3	OLS Elective	3
Elective	3	IET Elective	3
Elective	2	Int./Basic Sci Elective	3
		Global Elective	3
Cooperative Education Factory Practice Programme I	10		
Cooperative Education Factory Practice Programme II	10		
Seminar in Profession and Practics	1		
Seminar on New Technologies for Smart Living	1		
Total credits	148	Total cridits	128

A weakness in Taiwan that has recently been detected in the MCUT programme is that there is insufficient emphasis on engineering software applications. The design process in several courses the MET programme does not provide enough opportunity for students to acquire the necessary skills in this area. There is a similar problem with user-interface design and software reuse - both issues that are now acknowledged as being of great importance in modern software development.

CONCLUSIONS

Traditionally, the baccalaureate Mechanical Engineering Technology (MET) courses provide the broad skill set required for both entry-level success and long-term advancement. In this analysis of the four-year MET programmes between MCUT and Purdue University, one concluded that the Automatic Control and Special Project are the two courses in the first year in particular in MCUT. At Purdue University the Production Design and Specifications is different from the one at MCUT. In addition, the zero-credit courses which are compulsory subjects at MCUT are specific to Taiwan. The students at MCUT are at the frontier in Taiwan, so MCUT provides the engineering mathematics worth six credits. Within the design process, several courses of the MET programme do not provide enough opportunity for students to acquire the necessary skills in package software application. Furthermore, the ABET has identified the procedure for the students' core abilities established the curriculum. However, it does not prove the effectiveness of the arrangement rule of the curriculum. The Technological University in Taiwan should make sure that the coverage of the basics is sufficiently good that the students will benefit more by the provision of more advanced courses. This is because so many of the graduating students leave the Technological University directly to begin careers as associate engineers, not as technicians. The curriculum committee must structure the programme to support that transition.

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