Comparative Curriculum Analysis of Mechanical Engineering Technology Programs at Purdue University and the National Taipei University of Technology

HSI-HSUN TSAI
Ming Chi University of Technology, Taiwan

Abstract

Career and technical education in tertiary education in the US or Taiwan is always linked to employment preparation in specific occupations or careers, which differs from traditional academic postsecondary education. Academic education at the tertiary education stage encompasses formal undergraduate programs designed to impart knowledge and skills. However, career education instruction typically involves more application and less theory than that taught in academic programs. Many manufacturing careers have transferred to Mainland China, causing the curriculum in a technological university in Taiwan to reform to the current situation. Comparing the curriculum for mechanical engineering technology between the USA and Taiwan may provide suggestions for reshaping the curriculum for employment preparation in specific occupations. The mechanical engineering curriculum for the department of National Taipei University of Technology differs from that of Purdue University in theory and applied courses because of more implementation of the cooperative activities in Purdue University. This analysis shows that Taiwan does not offer the fundamental courses of Physics and Calculus. Manufacturing processes are more important at Purdue University due to six credit courses within two semesters. NTUT offers fundamental theories in mechanical engineering such as Thermodynamics, Fluid Mechanics, and Strength of Materials, while Purdue University provides courses such as Heat Power, Fluid Power, and Applied Strength of Materials, projecting more application details. Oral communication and technical writing courses in the USA help students meet employment requirements. A curriculum comparison of mechanical engineering technology between the USA and Taiwan gives a reshaping approach to course arrangement in Taiwan.

Keywords: Comparative education, curriculum, mechanical engineering, educational objective.

Introduction

Radcliffe (2006) reports that the research priority for the new discipline of Engineering Education is to enhance engineering thinking, knowledge, and competencies of students' for facing the future. Previous enhanced items should connect to the curricula of each professional program (department). However, it is an important but difficult issue to understand the structure and coverage of tertiary education programs. Recent studies have increasingly emphasized monitoring the structure and coverage of tertiary education programs, and making the results more widely available (Gou et al., 2008). Baker (1983) compared the curricula according to curriculum characteristics including entrance requirements, accreditation, program length, instructional methods, scholastic standards, tuition costs, general education requirements, and technical course requirements. A previous comparison analysis to other colleges in various countries reveals that different countries have their own styles.

One way to achieve this analysis is to compare the curriculum for programs in mechanical engineering technology to a known standard. Many institutions monitor their own programs informally, and make little effort to enlighten outsiders (Kuo, 2006). Outsiders such as official agents and non-government organizations have placed increased emphasis on monitoring the structure and coverage of tertiary education programs. The Accreditation Board for Engineering and Technology (ABET) has recently become the recognized accreditor for university programs in applied science, computing, engineering, and technology (ABET, 2010).

Traditionally, baccalaureate Mechanical Engineering Technology (MET) courses have provided a 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. The curriculum includes effective written, oral, and graphic communications along with computer literacy. This curriculum prepares students in MET for a range of technical positions including system design, fabrication, manufacturing, HVAC (heating, ventilating and air conditioning), and construction (Old Dominion, 2010a). Program graduates 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 (Tsai & Wang, 2010). Using the laws of nature, along with mathematical analysis, communications, and computational skills, students are educated to develop creative solutions for societal needs. Virtually every industry and government agency seeks mechanical engineers, employed in areas specializing in design, research and development, manufacturing, production, management, project planning, consulting, testing, quality assurance, and technical sales (Old Dominion, 2010b). The above shows that the educational objective and core ability, as well as the professional career are different between the ME and MET departments. Each department course should therefore be different for the achieved abilities of students.

Table 1.

First year courses of MET in NTUT and Purdue University

First Year			
ME NTUT		MET Purdue U.	
Course	Credit	Course	Credit
Engineering Mathematics(I)	3	Precalculus	5
Engineering Mathematics(II)	3	Calculus for Technology I	3
Mechanical Drawing	1	Graphics Comm.	3
Computer Drawing	3		
Computational Program and Practice	2	Computational Analysis Tools in MET	1
Intermediate English and Practice (I)	1	English Composition	3
Intermediate English and Practice(II)	1		
		General Physics	4
Special Project (I)	2		
		Applied Statics	3
Manufacturing Processes	3	Manufacturing Processes I	3
Material Science and Engineering	3	Materials I	3
Practical Workshop Training	0		
Principles of Electrical Engineering and Experiments	3		
Automatic Control	3		
		Production Design and Specifications	3

However, in Taiwan, neither the engineering departments nor the engineering technology departments in the (Technological) universities follow the accredited program of the Engineering Accreditation Commission (EAC) of ABET. Neither the Department of Mechanical Engineering at National Taipei University of Technology (NTUT), nor the Engineering Department at the Technological University follows the Technology Accreditation Commission (TAC). This work thus reviews the undergraduate curriculums of the Mechanical Engineering Technology of NTUT and Purdue University, and then compares these two curriculums. Purdue University offers a two-year MET program for students enrolled from the community college and junior college. NTUT offers a MET program similar to Purdue University.

The accredited programs of ABET induce different student abilities; for example, in Purdue University, the MET having more internship education, and the quantity of the experimental courses under the Technology Accreditation Commission of ABET. The description would link this curriculum comparison study and the higher technological education. Since the MET of Purdue University provides consistently the practical training courses and the optional internship which give the average starting salary of 50k UND per year of graduated students. At the same time, the MET of the technological Universities in Taiwan provide the curriculums nearly insignificant variation respect to the ones of ME of Universities. Based on this comparison the authors hope to feedback the curriculum approach of MET in USA to be the reference for the MET curriculum reforming in the future in Taiwan. Hence, this paper describes the department's undergraduate curriculums and presents the results of curriculum comparison of these two universities. The accredited programs of ABET induce different student abilities for examples of the cooperative education between college and enterprise, and the quantity of the experimental courses. The current study is especially interested in comparing technology courses with a mechanical technician emphasis. Finally, this research discusses the findings and presents conclusions.

Engineering Technology Curriculum

The undergraduate program is a general mechanical engineering technology curriculum designed to allow students within NTUT and the 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 undergraduate degrees; however, those in mechanical engineering technology typically work toward a Baccalaureate of Science (B.S.) degree. Both degrees offered from the university and the Technological University are two-year degrees, the same as a B.S. At the time of this study, neither the major educational requirements of the department nor the core abilities of the students with a mechanical engineering (technology) major are different. Therefore, the program students specializing in mechanical engineering technology is constrained only by the general B.S. requirements. The regulations for the mechanical engineering technology major reflect the advice given to B.S. students specializing in mechanical engineering technology. Consequently, this study applies to the current situation, and structures the curriculum into courses for a two-year degree. Previous published curricula, courses taught elsewhere, and staff expertise influence the course design.

Table 2.

Second year courses of MET in NTUT and Purdue University

Second Year			
ME NTUT		MET Purdue U.	
Course	Credit	Course	Credit
Dynamics	3	Dynamics	3
Strength of Materials	3	Applied Strength of Materials	4
Intermediate Mechanics of Materials	3		
Practical English	1	Fundamentals of Speech Communication	3
Thermodynamics	3	Heat/Power	3
Fluid Mechanics	3	Fluid Power	3
Special Project (II)	2		
Engineering Mathematics(II)	3		
Engineering Materials	3		
Mechanical Design	3	Machine Elements I	3
Mechanical Engineering Experiments	1		
		Manufacturing Processes II	3
		Elect. Light(Physics)	4
		Electricity Fund.	3

Students must accomplish 72 credits to meet the graduation requirement of MET in NTUT (Tsai & Wang, 2010)and in Purdue University Purdue University, 2010). Table 1 shows that the courses on "Mathematics or Calculus," "<Manufacturing," "Materials," "Mechanics," "Drawing," and "English" are the general service course and essential to the main undergraduate program. "Automatic Control" and "Special Project" are two courses in the first year in NTUT. Purdue University offers a different course, "Production Design and Specifications," compared to NTUT. Zero-credit courses are compulsory subjects in NTUT, particularly in Taiwan. Students in NTUT are the frontier in Taiwan, so NTUT provides six credits of Engineering Mathematics. Research has demonstrated that the quality and level of students are not dependent on their majors, but upon the whole system and course

content, knowledge, quality, and capacity of the university. Thus, the configuration of the course system in the teaching curriculum is very important as the course system reflects the professional training goal.

In Table 2, the course on "Intermediate Mechanics of Materials" is the same course as that offered to frontier students enrolled in NTUT, a general service course not considered part of the main undergraduate program. The most important and difficult point is course continuity. In many cases, students are required to obtain a quantity of information and knowledge, but ignore the level and continuity of the courses, leading to disconnected courses and an unfulfilled training goal.

Table 3.

Whole courses of MET in NTUT and Purdue University

ME NTUT		MET Purdue U.	
Course	**Credit**	**Course**	**Credit**
Intermediate English and Practice (I)	1	English Composition	3
Intermediate English and Practice (II)	1	Fundamentals of Speech Communication	3
Practical English	1		
Engineering Mathematics(I)	3	Precalculus	5
Engineering Mathematics(II)	3	Calculus for Technology I	3
Computational Program and Practice	2	Computational Analysis Tools in MET	1
		General Physics	4
		Elect. Light(Physics)	4
Mechanical Drawing	1	Graphics Comm.	3
Computer Drawing	3		
	2	Applied Statics	3
Dynamics	3	Dynamics	3
Material Science and Engineering	3	Materials I	3
Strength of Materials	3	Applied Strength of Materials	4
Intermediate Mechanics of Materials	3		
Thermodynamics	3	Heat Power	3
Fluid Mechanics	3	Fluid Power	3
Principles of Electrical Engineering and Experiments	3	Electricity Fund.	3
Mechanical Design	3	Machine Elements I	3
Automatic Control	3		
Mechanical Engineering Experiments	1		
		Production Design and Specifications	3
Manufacturing Procrsses	3	Manufacturing Processes I	3
		Manufacturing Processes II	3

Comparison Results

This study estimates the number of knowledge units covered by a course to compare curriculums, primarily the number of lecture hours. Table 3 shows the actual listing of the comparison results by the spreadsheet. Each cell in the table is the knowledge unit in the course, such as Mechanics. The number of lecture hours identifies the "credits of each course. The eight-credit Physics course at Purdue University is a fundamental one, not offered at NTUT. Manufacturing Processes is more important at Purdue University due to the six credit courses within two semesters. Fundamental theory courses at NTUT include Thermodynamics, Fluid Mechanics, and Strength of Materials, while Purdue University offers Heat Power, Fluid Power, and Applied Strength of Materials. These courses project more application details.

Students can arrange or augment these courses to suit the requirements of many different degree programs. Knowledge units can even split across courses. The current report describes each knowledge unit together with the minimum amount of lecture time necessary for the pre-requisite knowledge units. This method is reasonable and explicitly allowed in this analysis because of the broad agreement between the MET program at NTUT and Purdue University. Finally, 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 oral and graphic communications are important for a mechanical technician. Furthermore, Calculus at Purdue University is essential for technician training instead of Engineering Mathematics.

The importance Purdue University attaches to its requirements for baccalaureate degrees reduces this difference to a certain extent. Such requirements are less typical in Taiwan, particularly because there are no such requirements in ABET. The courses to achieve core abilities of students depend on the curriculum committee of each department. The ABET identities the established procedure without proof of its effectiveness. This might suggest that the MET curriculum could possibly abandon some of the advanced material in favor of greater emphasis on more basic units. However, the technological university in Taiwan should make sure that it sufficiently covers the basics so that students will benefit from more advanced courses, since so many graduating students directly leave the technological university to begin careers as associate engineers, not as technicians. The curriculum committee must structure the program to support that transition.

A weakness in Taiwan recently detected in the NTUT program is insufficient emphasis on engineering software application. The design process in several courses in the MET program does not provide enough opportunity for students to acquire necessary skills in this area. A similar problem exists with user-interface design and software reuse--both issues that are of great importance to modern software development.

Conclusion

Traditional baccalaureate Mechanical Engineering Technology (MET) courses provide a broad skill set required for both entry-level success and long-term advancement. This analysis of the two-year MET programs between NTUT and Purdue University concludes that “Automatic Control” and “Special Project” are two courses in the first year, particularly in NTUT. In Purdue University, “Product Design and Specifications” is a different course compared to NTUT. Zero-credit courses are compulsory subjects in NTUT, particularly in Taiwan. Students in NTUT are the frontier in Taiwan, so NTUT provides Engineering Mathematics of six credits. However, the design process in several courses of the MET program does not provide enough opportunity for students to acquire necessary skills in the software application package. Furthermore, the ABET identifies the procedure of students’ core abilities established in the curriculum. However, it does not prove the effectiveness of the curriculum. The technological university in Taiwan should make sure that it covers

the basics sufficiently well so that students will benefit from more advanced courses, since so many graduating students directly leave the technological university to begin careers as associate engineer, not as technicians. The curriculum committee must structure the program to support that transition.

HSI-HSUN TSAI

Ming Chi University of Technology, Taishan 243, New Taipei City, Taiwan

Correspondence to Hsi-Hsun Tsai, email: hhtsai@mail.mcut.edu.tw

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