AC 2008-1815: ANALYSIS OF THE CURRICULUM OF MANUFACTURING ENGINEERING TECHNOLOGY PROGRAMS

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Analysis of the Curriculum of Manufacturing Engineering Technology Programs

Manufacturing Engineering Technology programs have seen a decline in the number of students entering as a whole in the United States. There have been studies on recruiting measures, manufacturing perceptions, and program enhancements. This paper will look at the curriculum of these programs.

An analysis of what programs named manufacturing engineering technology contain in their curriculum will be performed. This will include what classes are taken, how many electives are offered, what new technologies are being learned and what form these classes take. Also programs in engineering technology will be surveyed and what manufacturing content is contained in those programs will be surveyed.

The purpose of doing this analysis is to see what are the best practices in curriculum composition in manufacturing engineering technology. This will give the reader an idea of what most programs are doing that are common and what are some programs doing that are unique. Also what will be looked at is what some programs not named manufacturing engineering technology are doing in regards to manufacturing curriculum.

Analysis of Requirements

There are certain requirements for a manufacturing engineering technology curriculum. The focus of this paper is on a baccalaureate degree program in the United States for manufacturing engineering technology. First what are the requirements of a program in manufacturing engineering technology? According to ABET each program must have published educational objectives. They also must have a program that includes a curriculum that enables graduates to obtain these objectives.[1] There is a list of various program outcomes that must be met. The curriculum must "provide an integrated educational experience that develops the ability of graduates to apply pertinent knowledge to solving problems in the engineering technology specialty"[1]. The assumption is that a program that is accredited meets these criteria. Only accredited programs are being analyzed here. Under criterion 5 there are various requirements. The technical content applies here. It states that the technical specialty must be between 1/3 and 2/3 of the total program.[1] Also:

"The technical content of the curriculum consists of a technical core and the increasingly complex technical specialties found later in the curriculum. The technical core must provide the prerequisite foundation of knowledge necessary for the technical specialties.

Technical courses must develop student knowledge and competence in the use if standard design practices, tools, techniques, and computer hardware and software appropriate to the discipline and goals of the program." [1]

There are also criteria specific to manufacturing engineering technology.

"Graduates must demonstrate the ability to apply the technologies of materials, manufacturing processes, tooling, automation, production operations, maintenance, quality, industrial organization and management, and statistics to the solution of manufacturing problems."[1]

Another source of possible requirements is the SME Certified Manufacturing Technologists' exam (CMfgT). See table 1 for the skills listed in the Body of Knowledge.

Mathematics, Applied and Engineering Sciences, & Materials Applications
Product/Process Design & Development
Manufacturing Process Applications & Operation
Production System and Equipment Design/Development
Automated Systems and Control
Quality and Customer Service
Manufacturing Management
Personal Effectiveness

Table 1 CMfgT Body of Knowledge

In 1995 a group of people including educators published a report titled "Manufacturing Education for the 21st Century". This also gave information on what should be included in a manufacturing engineering technology curriculum. One fact that is sobering is that there were 34 programs at the baccalaureate level at that time.[2](page vii) There is a much smaller number now . The expectation of a program in this field was defined:

"The bachelor's degree graduate in Manufacturing Engineering Technology is characterized by a balance of the requirements of technology, humanities, and management. The primary stress is upon technological capability founded upon an intimate relationship with industry. The new graduate will be will be industry oriented, cost-effective, job-ready, reliable and adaptable. The education of this graduate will be thoroughly intertwined with an identifiable industrial constituency. "[2]

There were many different skills in the program that were listed. In engineering fundamentals the topics were "statics, strength of materials, dynamics, electricity, digital and analog electronics, fluid power and fluid mechanics, and thermal sciences."[2] Various science and mathematics proficiencies were discussed. Specific to manufacturing were the skills of design, quality, teamwork, design for production, tool and fixture design, machine selection and design,

engineering materials, manufacturing processes, machine controls, and manufacturing information systems.

The 1995 paper "The Learning Factory – A new approach to integrating design and manufacturing into engineering curricula" gave some insight into what a 21st century program should contain. It stated that this new curriculum would integrate design and manufacturing together. Specifically the engineer would have the following qualities:

Strong foundation in engineering science fundamentals;
Well versed in the big picture of manufacturing and product realization, including the design process and business realities;
Knowledgeable of current technologies and tools, and most importantly, their management and application to solve new problems;[3]

All of these references give some insight into what a manufacturing engineering technology program should contain. There are many common threads throughout each of these. The next section will dissect some programs and look at what is actually offered.

Programs

An analysis was performed of current programs in the United States that are named Manufacturing Engineering Technology. Only the programs with a baccalaureate degree were looked at. See appendix A for a listing of these schools. The following section describes some of the findings.

The number of programs analyzed was 18. Of these programs the description of the program was analyzed. What is interesting is that a majority of universities place their program objectives on their website amidst their description of the program. Another item of note is that a majority

describe what a manufacturing engineering technologist does as an occupation. Most placed these ahead of any "advertising" for their programs. This might be a direct result of the national misunderstanding of what manufacturing is and an appeal to bring more students into the field irrespective of any particular program.

What classes that are actually offered is summarized in Table 2. What is interesting is how some of the criteria are interpreted by a particular institution. The basics are in every program. But items such as specialty classes, numbers of electives, and special interests are wide open. Some reasons for this may include use of transfer students, sharing of classes amongst other programs, and region in which the University is housed. The classes listed are general categories; some universities name their classes differently.

The common classes nearly every program had were the following and are not listed in the table:

Engineering Graphics and CAD

Engineering Materials

Manufacturing Processes

Course offered	Number of schools
Statics	12
Dynamics	3
Strength of Materials	13
Quality	16
2nd Processes Class	9
Economics	12
Tool Design	12
CIM or CAM	13
Automation	7
Robotics	7
Production Engineering	9
Ergonomics	2
CNC Machining	9
Thermodynamics	3
Fluid Power	9
Controls	6
PLCs	4
Instrumentation	4
Polymers (separate course)	5
Project Management	5
Safety	7

Table 2 Course Offerings Summary

Various schools offered separate courses in Design for Manufacturability, product design, lean methods, and geometric tolerancing. Table 3 summarizes the amount of technical electives allowed for in the various programs.

Number of technical electives Credit hours	Number of schools
0	6
3	2
6	1
9	4
12	3
18	2

Table 3 Technical electives by credit hour

Some schools chose to completely regulate the program for the student. It should be noted that some schools also demand that a student pick a specialty (3 schools) and choose the electives from there.

Conclusions and Further Research

The following are some recommendations to come from this report:

One of the items that seem to be in common amongst many of the schools is the use of their website to describe what a manufacturing engineering technologist would do in industry. A study of the schools that do this and enrollment rates would be good to conduct. Educational objectives can be analyzed as a result of this.

Another study of curriculum against what industry is demanding similar to the study performed in 1995 by a group of people within SME and referenced in this report should be conducted. This would give insight into skills needed by graduates and update what industry is demanding.

It is possible to share some resources amongst universities. This can be performed by using the National Center for Manufacturing Education. Many classes are similar in nature so some best practice information would be valuable. This could include curricula, lecture materials, recruiting techniques and lab experiences among others.

An analysis of course content can be performed. This would be a major benefit from the standpoint of topics rather than classes. This analysis was a higher level analysis and more detail could be beneficial. This would consist of a more in depth analysis of topics covered in a class.

A study could be conducted on programs that are similar to manufacturing but not named as such. Some universities have this embedded in their mechanical or industrial engineering technology courses.

Bibliography

1) www.abet.org

2) SME 1995 *Manufacturing Education for the 21st Century Volume 1*

3) Lamancusa, John; Jorgensen, Jens; Zayas-Castro, Jose; Ratner, Julie *The Learning Factory – A new approach to integrating design and manufacturing into engineering curricula* 1995 ASEE Conference Proceedings

4) SME CFMfgT Body of Knowledge 2002

Appendix A

The following is a list of schools that were looked at for this study (not every school with Manufacturing Technology was analyzed:

Ball State University

Bradley University

Central Connecticut State University

University of Dayton

East Tennessee State University

Lake Superior State University

The University of Memphis

Midwestern State University

Minnesota State University, Mankato

University of North Texas

Northern Illinois University

Pittsburg State University

Rochester Institute of Technology

Southwestern Oklahoma State University

State University of New York, College of Technology at Farmingdale

Weber State University

Western Michigan University

Western Washington University