Competencies in Manufacturing Engineering Technology programs from employer's point of view.

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Abstract

This paper seeks to identify the competencies that employers of manufacturing engineering technology graduates must have in order to succeed in today's working environment. The result of this survey will provide a guideline, which will help improve existing manufacturing engineering technology programs, or assist in establishing new programs.

Introduction

The changes in the manufacturing environment caused by implementation of new technology and new production systems has created the need to update the competencies which employers seek in graduates of manufacturing engineering technology programs. Today's engineers are becoming an integrator, and a coordinator of information, technology, and people. Teamwork and people skills play an important role in the work of the future manufacturing engineers. This principle of integrating the environment must be reflected in manufacturing education. For graduates of manufacturing engineering technology programs to succeed in the manufacturing enterprise, they must possess the competencies that the employer desires.

Purpose

The purpose of this presentation is to report the findings of a survey based on competencies that employers identified to be essential to the success of manufacturing engineering technology in industry.

Engineering Technology Programs

Four-year Engineering Technology programs started in the early 1960's because engineering programs were becoming too theoretical. A baccalaureate in engineering technology prepares individuals to become engineering technologists. The Engineering Technology Council has defined engineering technology as a:

> Profession in which knowledge of the **applied** mathematical and natural sciences gained by higher education, experience, and practice is devoted to application of engineering principles and the **implementation of technological advances** for the benefit of humanity. Engineering technology education for the professional focuses primarily on analyzing, applying, implementing and improving existing technologies and is aimed at preparing graduates for the practice of engineering closest to the product improvement, manufacturing, and engineering operational functions[1].

Today, there are about 67 colleges and universities that offer over 117 Engineering Technology programs[2]. According to SME, nationwide there are 36 ABET accredited Manufacturing Engineering Technology programs. The review of the literature reveals that the Engineering Technology curriculum is composed of 33% mathematics and sciences, 25% liberal studies, and 40 to 45% in the major field of study. Approximately 67% of the course work in the major field of study are Engineering Technology subjects that involve some type of laboratory activities[3]. Manufacturing Engineering Technology is a field of study that has the responsibility of translating the designs and specifications of a product into manufacturing processes to produce a product that meets customer needs.

Careers in Engineering Technology

Graduates of Engineering Technology hold many different industrial positions with many of them being related to their undergraduate area of specialization. Some of the Engineering Technology graduates hold engineering jobs, which have been assigned to them by industry.

Engineering Curriculum

The Technology Accreditation Commission (TAC) of the Accreditation Board for Engineering Technology (ABET) requires a minimum of 124 semester hour credits for the baccalaureate degree. In addition, the engineering technology curriculum must include the following components[4]:

I. The first component is the 48 semester hours of credit in the following areas:
Technical science: Subject matter in this area requires the use of mathematics and basic science for the purpose of solving technical problems.

Technical specialties: Courses are those which provide students with the necessary skills and knowledge of appropriate methods, procedures, and techniques to adapt existing technical procedures to new situations and correctly complete given technical processes and procedures.

Technical electives: Any related technical courses that support the student's specialty.

II. Another curriculum component consists of 24 semester hours of basic sciences and

mathematics.
Eight of the 24 hours must be in laboratory science.
Twelve of the 24 hours must be in mathematics.

III. The third curriculum component is 24 semester hours of communications, humanities, and
social science courses, with4 minimum of nine hours in written and oral communications. According to ABET, "The remaining 28 semester hours or more should be designed for a well-rounded engineering technology graduate who can function successfully as an engineering technologist. Use computer to solve technical problems along with a cooperative education experience for a maximum of eight semester hours is strongly recommended."

According to ABET accreditation guidelines the curriculum requirements for a program are as follow:

Technical Science
Technical foundation courses
Technical Skills and Techniques
Instrumentation and data collection
Documentation required in labs and graded for both technical content and writing skills.
Technical Design
Standard design procedures and methodologies
Basic Sciences
Basic Science courses must be laboratory based
May include physics, chemistry, and the life and earth sciences in accordance with programs needs.
Mathematics
Concepts of calculus must be included in bachelor degree program.
The upper level baccalaureate technical courses must include applications of calculus.
Communications
Oral communication assignments in some technical course are required.
Oral and written communications must be evaluated in students' technical work to a reasonable extent.
Computer Competency
Instruction in software applications required for all programs
Use of computer as problem solving tool required in all programs.
Instruction in computer language required for bachelor degree program
Programming skills should be used in some baccalaureate technical courses to an extent appropriate for the discipline.
Technical currency
Positive procedure must be established and monitored to safeguard against technical obsolescence.
By such means as:
An inquisitive faculty

Active industrial advisory board
Adequately funded budget, which encourages faculty development.
Modern library collection

Competencies in Engineering

To reflect the new manufacturing environment, CASA redeveloped the Manufacturing Enterprise Wheel. According to Tillman the Manufacturing Enterprise Wheel provides an overview of today's best practices in a manufacturing integrated enterprise[5]. In justifying this approach, CASA stated that[6]:

> "In the mid-1980s we understood the need to break down the walls between design and manufacturing. We did not articulate other issues so well, such as the importance of simplifying processes before automation and the enterprise with its customers and suppliers."

According to CASA the Manufacturing Enterprise Wheel enhances the understanding of six key areas which are critical to success in today's competitive manufacturing environment[6]. They are as follows:

1. The customer becomes the central focus of the organization.
2. The importance of teams and human networking.
3. The interface between knowledge and the system for the purpose of sharing information.
4. A focus on key processes from marketing through design, manufacturing, and customer support.
5. A leaner and more agile organization, and less bureaucratic structure.
6. Recognition and integration of external environmental factors such as customers, competitors, suppliers, and the global manufacturing infrastructure.

Considering this, one can conclude that in order for professionals entering or working in today's manufacturing environment to be successful, they must have the following competencies[7]:

1. Interface successfully with the customer, form teams, and work with a multi-cultural workforce.
2. Gather and process data, and formulate accurate concepts.
3. Determine system and software architecture requirements.
4. Implement and supervise system tests.
5. Manage and control projects.

Recently, the Boeing Company identified a list of desired attributes of engineering graduates. The list included the following factors[8].

1. A good understanding of the engineering fundamentals, including:
   Mathematics (including statistics),
   Physical and life sciences, and

Information technology.

2. A good grasp of the design and manufacturing process.
3. A basic understanding of the context in which engineering is practiced, including:
   Economics and business practice,
   History,
   The environment, and
   Customer and societal needs.
4. A multidisciplinary systems perspective.
5. Good communication skills:
   Written,
   Verbal,
   Graphic, and
   Listening.
6. High ethical standards.
7. An ability to think critically and creatively as well as independently and cooperatively.
8. Flexibility, ability and the self-confidence to adapt to rapid/major change.
9. Lifelong desire and commitment to learn.
10. A profound understanding of the importance of teamwork.

Methodology

A questionnaire was developed based on the review of literature and consultation with the experts in the field for the appropriateness of the questions. A cover letter explaining the purpose of the survey and the questions were mailed to eighty companies within 100 miles of surrounding communities. These companies were randomly selected from the Industrial Technology Department's database, and the overall return was sixty percent.

There are 10 questions in the questionnaire, and each question was rated from 1(lowest) to 5(highest), as it is shown below.

Please circle the following competencies accordingly:

	Lowest				Highest
1. Mathematics	1	2	3	4	5
2. Applied & Engineering Sciences	1	2	3	4	5
3. Product/Process Design & Development	1	2	3	4	5
4. Production Systems and Equipment Design	1	2	3	4	5
5. Automated Systems & Control	1	2	3	4	5
6. Quality	1	2	3	4	5
7. Project Management/Concurrent Engineering	1	2	3	4	5

8. Computer Skills		1	2	3	4	5
9. Communication Skills		1	2	3	4	5
10. Interpersonal/Team Work	1	2	3	4	5	

Survey Finding

The response to the above 10 questions were as follow:

	Lowest				Highest
	1	2	3	4	5
Q#1	0%	6%	44%	25%	25%
Q#2	0%	0%	6%	62%	32%
Q#3	0%	6%	25%	31%	37%
Q#4	6%	6%	12%	25%	50%
Q#5	6%	6%	12%	25%	56%
Q#6	6%	6%	12%	25%	44%
Q#7	0%	12%	12%	44%	31%
Q#8	6%	0%	31%	31%	31%
Q#9	0%	0%	6%	50%	44%
Q#10	0%	0%	6%	44%	50%

Analysis:

The above data suggests that industry rated the following competencies as important and very important:

- Mathematics 50%
- Applied & Engineering Science 94%
- Product/Process Design & Development 68%
- Production Systems and Equipment Design 75%
- Automated Systems & Control 81%
- Quality 69%
- Project Management/Concurrent Engineering 62%
- Computer Skills 62%
- Communication Skills 94%
- Interpersonal/Team Work 94%

The applied engineering, communication skills, and interpersonal/team work received the highest rating. Perhaps the interesting factor from the author's point of view has been the emphasis which industry placed on the applied engineering.

Conclusion

The result of this survey implied that the emphasis of the today's manufacturing engineering technology programs should be the integration of communication skills, teamwork, and applied engineering. To succeed in the manufacturing environment, team work, people skills, and communication skills will play an important role in the work of engineers.

Today's engineer is becoming that of an integrator, and more of a coordinator of information, technology, and people. Engineering Technology programs should be based on a broader perspective of engineering, technology, and management and work to integrate content and processes across the curriculum.

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