Session 3563

Curriculum Development in Manufacturing Technology: A Survey of Society of Manufacturing Engineers (SME) College Fellows

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Introduction

Shortly after the end of World War II, American manufacturers diverted their considerable military manufacturing capabilities into the production of consumer goods. At that time, the worldwide demand for American products was strong and U.S. firms produced almost half of all the manufactured goods sold in the world.

During the past 20 years, America's manufacturing leadership and dominance has declined as competition for world markets has continually increased among industrialized nations. The automotive and electronics industries are perhaps the most visible part of America's manufacturing base to be impacted by this onslaught by foreign competitors (Dugger and Teagarden, 1998).

Recognizing the fact that manufacturing expertise and capability are factors vital to the stability of the nation's economy is an important step in keeping America's manufacturing base from being further eroded by ravenous foreign competitors. Cordtz (1992) noted that, "in an increasingly competitive and technology-oriented world, the pool of employees who are qualified--even by historical standards, much less by those of the future--will be shrinking instead of growing" (p. 66). In this new era, workers' knowledge and qualifications will have more to do with economic success than will other

resources (Drucker, 1993). The only way to enhance employees manufacturing qualities is through education and training.

As world economies continue to move toward more global competition, America's defined role as the leader in manufacturing technologies is being continually challenged. This trend places an even more urgent task before curriculum developers at institutions of higher learning, which offer Baccalaureate Degrees in Manufacturing Technology. The task facing curriculum developers as we rapidly approach the 21st century is to establish programs that will best fit the spectrum of manufacturing activities in the next millennium. As the discipline of Industrial Technology programs mature, the task of defining which technologies best fit the 21st century's manufacturing firms and which technologies have become obsolete is of critical importance in the realm of higher education curriculum.

The Role of Industrial Technology Programs

According to the Industrial Technology Accreditation Handbook (1997), "Industrial Technology is a field of study designed to prepare technical and/or technical management-oriented professionals for employment in business, industry, education, and government" (p.1). Many Industrial Technology departments offer industry-oriented programs in Manufacturing Technology, Production Technology, Computer Aided Design Technology, Computer Integrated Manufacturing, and Industrial Distribution Technology. These programs have been established and developed to prepare industrial technologists that are technically competent and are able to manage personnel and facilities in industrial organizations (Keith & Talbot, 1991; Rudisill, 1987).

Manufacturing Technology programs have been provided with an historic opportunity to effectively contribute to the improvement of the global economy by providing education and training appropriate for meeting the skills requirements of the 21st century's manufacturing industries. To accomplish this, institutions of higher learning should systematically assess their manufacturing programs in order to ensure the development and implementation of contemporary and relevant curricula.

Input from leading experts in the field is vital to the mission of revising Manufacturing Technology curricula. Experts have the unique ability to predict trends in technology, thus, providing curriculum developers with an insight into building exemplary Manufacturing Technology programs whose students are capable of being integrated successfully into the manufacturing environment. Increasing efficiency in production methods during the past 10 years has helped to fuel the fire of America's longest period of economic expansion in the 20th century. Technology, applied to the manufacturing process, has effectively reduced the cost of labor in most major companies; increasing corporate earnings and profits as well as contributing in large part to the phenomenal rise in most stock market indices.

In 1996, the Society of Manufacturing Engineers (SME) introduced its *Manufacturing Education Plan* with the objective of motivating the academic community to help improve the competency of the manufacturing workforce during the next five-year period. The SME's plan focuses on identifying and closing the competency gaps of graduating manufacturing engineers and technologists as perceived or identified by industry. Identifying the competency gaps is perceived to be a critical and necessary

prerequisite to formulating a solid groundwork for the plan (SME Manufacturing Education Plan, 1997).

The SME conducted research to determine the competency gaps of newly graduated engineering students by developing and releasing a survey, using a web site questionnaire, and by a consensus obtained through a structured workshop program which embraced critical and dominating segments of the industrial manufacturing sector.

The SME surveyed those engineers upon which the honor of Outstanding Young Engineer had been bestowed. Outstanding Young Engineer awards are presented to those engineers under the age of 35 who have achieved excellence in the manufacturing engineering profession. The purpose of surveying this group of engineers was to discover if they felt that there had been any competency gaps in their own education and if they had experienced such gaps upon graduating and entering the world of manufacturing. Of the 18 who responded, 16 respondents stated that they felt there is a lack of competency because of the distance between education and real world applications (SME Manufacturing Education Plan, 1997).

Methodology

This study was conducted in order to provide a basis for a plan of action regarding finding the "best fit" between those courses taught in institutions of higher learning and the needs and requirements of the manufacturing industry. It was also our aim to lend credence to the SME survey; providing useful and current information, opinions, attitudes, and ideas necessary to restructure and up grade Manufacturing Technology programs to better address the ever changing needs and requirements of manufacturers; both nationally and internationally.

A survey questionnaire was communicated to the Society of Manufacturing Engineers (SME) College Fellows in order to solicit their expert opinions regarding the effectiveness and relevance of Manufacturing Technology courses and programs designed to propel American and international manufacturers into the 21st century. Prior to mailing, the survey was pilot-tested for validity, relevance, and appropriateness by a group of 15 Industrial Technology advisory board members.

The SME's Fellow grade is conferred upon a highly select group of uniquely qualified individuals who have reached the pinnacle of their respective professions; dedicating many years of service to the betterment of the manufacturing profession. With approximately 68,000 members and 33,000 senior members, the total number of current SME Fellows is 197. We submit that the findings of this survey have the potential to be an invaluable source of information for those colleges and universities seeking knowledge with regard to upgrading existing Manufacturing Technology programs or designing and implementing new ones.

Results

Of the total of 197 questionnaires mailed, 10 were returned blank to sender, and 76 were returned completed. This is a 40% return rate. The survey questionnaire used a Likert-type rating scale numbering from 0 to 5. The magnitude of the ratings are as follows: 0 = no opinion, 1 = no relevance, 2 = unimportant, 3 = moderately important, 4 = important, 5 = essential. **(NOTE: the "0 = no opinion" rating was not factored into the mean rating because it is neutral and does not denote any degree of relevance.)**

The responses were analyzed and organized around the following topics:

Manufacturing Occupations

Occupations available for manufacturing technologists in the 21st century:

Table 1

Title	Rating
Manufacturing Engineering	4.40
Quality Control (QC)	4.08
Process Control	4.02
Project Management	3.98
Production Management	3.83
Applications Engineering	3.75
Project Design	3.75
Production Supervision	3.55
Materials management	3.35
Industrial sales/purchasing	2.98

Course Content

Table 2

Content requirements for a B S in Manufacturing Technology

Title	Rating
Problem solving skills	4.55
Preparation, analysis, and presentations of technical reports	4.34
Study of Computer aided manufacturing	4.31
Study the methods of improving industrial productivity	4.06

Study of materials processing, materials properties, and machining processes	4.05
Study of computer applications, documentation, database management	3.91
Study of interpersonal communications in organizations	3.88
Statistics and Data Analysis	3.84
Study of Total Quality Management	3.81
Study and analyze labor relations, ethics in the workplace, quality of work life, and productivity	3.77
Study of productivity analysis	3.75
Study of computer aided design	3.69
Study of technological developments, innovations, and transfer	3.66
Study relationships between the design elements and characteristics of products such as rapid prototyping	3.66
Study the use of data in decision-making	3.65
Study of management strategies to adapt change and manage manufacturing organizations	3.63
Study of Quality and Reliability testing	3.62
Study of *Just-in-Time* manufacturing	3.54
Study of ergonomics in manufacturing organizations	3.45
Study of operations research and production management	3.44
Study of human resource management	3.42
Study of technology impact	3.38
Study of the planning of industrial organizations	3.38
Study of *Group Technology*	3.28

Study of designing, implementing, developing, and evaluating training and development programs in organizations	3.28
Study of energy and environment in industry	3.22
Study of organization theories and behavioral processes	3.08
Study international trade and global competition	3.03
Study techniques of auditing organizations	2.75

Involvement

Your company's involvement in hiring Manufacturing Technology professionals.

Rating 3.24

Your involvement in providing internship/cooperative education for Manufacturing Technology students.

Rating 3.24

Table 3

Competencies

Competencies you expect from Manufacturing Technology graduates

Competency	Rating
Technical	4.48
Communications	4.18
Management	3.10

Salary: The survey asked for the entry-level salary range for Manufacturing Technologists: $20 – 25K, $25 – 30K, $30 – 35K, $35 – 40K, $40 – 45K, > $45K. The mean entry-level salary range indicated by the respondents is listed below:

Entry-level salary for Manufacturing Technologists with a BS degree

Average Entry-Level Salary Range	$30 - 35K

The following is a selection of comments made by the respondents in the comments section of the survey questionnaire:

Comments

1) The academic world could do a greatly improved job of educating engineers and technologists if they understood better what it is that engineers and technologists should be able to do (not only what they should know) to be successful in the manufacturing environment.
2) Until employers and academics begin to focus on what people are able to do on a generic level, rather than on a specific small task to which they may be assigned today, we won't have the engineers and technologists to be competitive in the manufacturing world.
3) Although HERO of Egypt invented the jet engine 2000 years ago, it was not until the 20th century that its principle was perfected for aircraft use. The 21st century will repeat the same principle but the pace of technology development and implementation will be much faster.
4) Individuals must be able to assemble and balance facts, ideas, and propositions and be able to make informed decisions and recommendations.
5) Graduates should be able to work as an essential part of a team.

6) Individual should be a self-starter.
7) Technologists should be able to grow both technically and personally.
8) Clearly, character is as important as technical strength.
9) The following competencies should be developed: marketing, consulting, product development, research and development, process & equipment development, social and society awareness, communication: lack of it stifles production, cooperative attitude, problem-solving and data analysis, computer applications, and financial and business aspects of manufacturing

Conclusions and Implications

Based on our preliminary evaluation of the survey results, the following conclusions can be drawn:

1. Career positions for industrial technologists in the 21st century will include: Quality Control, Materials Management, Production Supervision/Management, Process Control, Project Management, Systems Management, Project Design, Applications Engineering, Manufacturing Engineering, and Industrial Sales/Purchasing.

2. Programs required for preparation of Industrial Technologists in the 21st century will include: Electrical/Electronics Technology, Graphic Communications Technology, Manufacturing/Robotics Technology, Packaging Technology, Computer Technology, Computer-Aided-Design Technology, Industrial Distribution Technology, Computer Integrated Manufacturing, Facilities Management, Design for Manufacturing, and Architectural Drafting.

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