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Articulation of Certification for Manufacturing

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Abstract

Engineering Technology curriculum provides wide spread knowledge in problem solving, management of resources, and process planning. Manufacturing is important and has great impact on economic development. Thus, it is imperative to provide pathways for students to pursue careers in the manufacturing field.

This paper discusses the development and implementation of articulated college credit for holders of "Louisiana's Fast Start Program C4M Certification for Manufacturing". This certification was developed by Louisiana Economic Development – Fast Start Program and is offered by different technical and community colleges in the state. It requires the completion of one year of training on manufacturing oriented topics to include: Introduction to Manufacturing, Tools and Equipment Used in Manufacturing, and Introduction to Fabrication, Process Technology and Machining. Engineering Technology is an applied discipline, and these topics can articulate to 4-year Bachelor of Science programs. The process for awarding college credit for certification for manufacturing is described. The paper provides justification used to map certification for manufacturing curricula to courses in the selected Engineering Technology program. The paper concludes by discussing how to use this articulation to recruit students and devises a data collection plan to track the impact of implementing the articulation of certification for manufacturing on the economic development in the state of Louisiana.

Introduction and Background

The National Academy of Engineering forecasts that engineers and technologists will continue to operate in a rapidly changing innovation environment[1].This is compounded by globalization of economies, diversity of social and business groups, multidisciplinary research trends, and cultural and political forces. Engineering systems are of increasing complexity in energy, environment, food, product development, and communications[1]. Hence, it is imperative to introduce engineering and technology practices in undergraduate education, where students can experience the iterative process of designing, analyzing, building and testing. There is a growing importance for engineering practice, but the engineering profession seems to be held in low regard compared to other professions and industry tends to view engineers and technologists as disposable commodities[2].

Engineering Technology prepares graduates with knowledge skills and technical problem solving abilities necessary to success in a wide range of engineering technology disciplines[3]. The specific ABET ETAC student outcomes for Engineering Technology are[4]:

a. An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities
b. An ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies
c. An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes

d. An ability to design systems, components, or processes for broadly-defined engineering technology problems appropriate to program educational objectives
e. An ability to function effectively as a member or leader on a technical team
f. An ability to identify, analyze, and solve broadly-defined engineering technology problems
g. An ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature
h. An understanding of the need for and an ability to engage in self-directed continuing professional development
i. An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity
j. A knowledge of the impact of engineering technology solutions in a societal and global context
k. A commitment to quality, timeliness, and continuous improvement

Certification of Manufacturing (C4M) was developed by Louisiana Fast Start to provide a mechanism of stackable credentials to satisfy the growing needs of manufacturers in the state[5]. C4M is:

- A certificate program that is equivalent to 12 college credit hours.
- Consists of courses that can be completed in one semester, with topics such as:
    - Introduction to Manufacturing
    - Tools and Equipment Used in Manufacturing
    - Introduction to Fabrication, Process Technology and Machining
- Incorporates 180 contact hours of class and laboratory work.

This research takes a pragmatic approach to develop an articulation of college credit for C4M towards a B.Sc. degree in Engineering Technology. The paper proceeds by discussing the method used to carry out the research. After that it provides a summary of the results. The paper concludes by discussing how to use this articulation to recruit students and devises a data collection plan to track the impact of implementing the articulation of certification for manufacturing on the economic development in the state of Louisiana.

Method

This paper uses a case-study approach. A faculty team of an Engineering Technology department at a University in Louisiana worked with members of their industry advisory committee, and representatives from technical and community colleges in the state to develop an articulation of college credits for holders of the C4M. The team studied the body of knowledge provided by the C4M, and reviewed the university documentation and catalog information (including course descriptions and dependencies, course syllabi, course competencies, and course assignments). The team identified courses within the selected four year B.Sc. in Engineering Technology curricula that map to the knowledge acquired through C4M.

Results and Discussion

The selected Engineering Technology program has both major and support courses to prepare graduates for technical and supervisory careers in a variety of industries. The program combines technical knowledge with communications skills and teamwork to provide the flexibility needed in today's rapidly changing marketplace. The selected program educational objectives are:

- Demonstrate technical proficiency in the field
- Apply quantitative reasoning and critical thinking in solving technical problems
- Effectively communicate technical knowledge, ideas, and proposals to others, including upper management
- Lead project teams in successful completion of projects
- Have strong organizational and management skills

Students who receive a C4M certificate and enroll at the institution will be given 7 (seven) credit hours towards the Bachelors of Science Degrees in Industrial Engineering Technology and Electronics Engineering Technology. The credit will be given for the following courses:

- Engineering Tools and Dimensional Analysis (3 credit hours): Principles and practices of measurement technology; use of tools; dimensional analysis; and the use of all the above in applications of technology.
    - Where C4M holders take a course on Tools and Equipment Used in Manufacturing, which provides an introduction to math, measurements, schematics, drawings, and prints used in manufacturing. Facilitates application of these skills to safely and correctly use hand tools, power tools, hydraulic systems, and pneumatic systems.
- Occupational Safety and Health (3 credit hours). Principles and practices of accident prevention and safety program operation in industrial facilities and school laboratories; effective safety organization, management and supervision; teacher, administrator and management liabilities; Occupational Safety and Health Act (OSHA).
    - Where C4M holders take a course on Introduction to Manufacturing, which provides an overview of the functional and structural compositions of manufacturing; including processes, plant safety, and quality in the manufacturing environment. Presents the personal and interpersonal skills required to be part of a high performing team in a manufacturing environment. Topics include team building, effective communication skills and ethics in the workplace.
- Electronics Fabrication Laboratory (1 credit hour). Fabrication techniques for analog and digital circuits. Device symbols and markings, soldering, antistatic techniques, measurement, testing and troubleshooting.
    - Where C4M holders take a course on Introduction to Fabrication, Process Technology and Machining, which presents an introductory knowledge of fabrication, process technology and machining. Offers hands on experience in each area.

Table 1 provides a side-by-side comparison of the learning objectives for selected courses and their C4M counterparts.

Table 1. Course Learning Objectives mapped to C4M Topics

Institution Course/Learning Objectives	**Related C4M Learning Topics**
Engineering Tools and Dimensional Analysis *Objectives:* A. Be able to use basic tools employed by engineering technologist. B. Understand the principles and practices of measurement. C. Understand dimensional analysis. D. Be able to apply measurement technology and dimensional analysis to selected technology problems. *Related Program Outcomes*: a. An appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines specifically including the following: an ability to apply knowledge of probability, statistics, engineering economic analysis and cost control, and other technical sciences and specialties necessary in the field of industrial engineering technology. f. An ability to identify, analyze and solve technical problems.	Tools and Equipment Used in Manufacturing. (3-2-3) *Topics:* A. Provides and introduction to math, measurements, schematics, drawings, and prints used in manufacturing. B. Facilitates application of these skills to safely and correctly use hand tools, power tools, hydraulic systems, and pneumatic systems.
Occupational Safety and Health *Objectives:* A. Become knowledgeable of the Occupational Safety and Health Act, its administration, and operations. B. Understand the responsibilities of employers, managers, supervisors and employees for maintaining safe and healthful working environments. C. Be able to recognize unsafe/unhealthy work conditions. D. Understand ethics and safety. *Related Program Outcomes*: a. An appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines specifically including the following: an ability to apply knowledge of probability, statistics, engineering economic analysis and cost control, and other technical sciences and specialties necessary in the field of industrial engineering technology. i. An ability to understand professional, ethical, and social responsibilities.	Introduction to Manufacturing. (3-2-3) *Topics:* A. An overview of the functional and structural compositions of manufacturing; including processes, plant safety, and quality in the manufacturing environment. B. Presents the personal and interpersonal skills required to be part of a high performing team in a manufacturing environment. C. Team building, effective communication skills and ethics in the workplace

Electronics Fabrication Laboratory *Objectives:* A. To understand and use standard laboratory techniques and processes. B. To use basic analog and digital lab equipment C. To know device markings, symbols, values and circuit schematics. D. To assembly, soldering, testing and troubleshoot simple circuits. E. To work on teams on a simple laboratory project. *Related Program Outcomes*: a. An appropriate mastery of the knowledge, techniques, skills and modern tools of their disciplines, specifically; the application of circuit analysis and design, computer programming, associated software, analog and digital electronics, and microcomputers to the building, testing, operation, and maintenance of electronic systems. e. An ability to function effectively on teams.	Introduction to Fabrication, Process Technology and Machining. (3-2-3) *Topics:* A. Presents an introductory knowledge of fabrication, process technology and machining. B. Offers hands on experience in each area.

A key challenge in establishing the mappings is that the learning objectives for each C4M course are still evolving. It is expected that over the next couple of years, as students actually complete the C4M program, that these learning objectives will evolve, and at that time better mapping of to the selected Engineering Technology program.

The selected Engineering Technology department developed a comprehensive recruitment plan for the C4M articulation to include:

1) Publicizing signature ceremonies for each agreement
2) Newscasts on university website
3) Newscasts through local newspapers and other media channels
4) Newscasts and twitters through Louisiana Economic Development
5) Preparing and distributing fliers to community and technical colleges affected by the agreements

The department is in the process of developing a tracking system to include information on students who benefit from such agreement. The data collected will include information such as:

- Date of completion of high school
- Date of completion of C4M
- Date of enrolling in college
- Date of receiving B.Sc. Degree
- Among other pertinent information

Conclusions

This paper presents initial efforts to articulate Louisiana's Fast Start Program C4M Certification for Manufacturing into a 4-year Bachelors of Science Degree. Students who receive a C4M certificate and enroll at the institution will be given 7 (seven) credit hours towards the Bachelors of Science Degrees in Industrial Engineering Technology and Electronics Engineering Technology. Currently, initial articulation agreements are in place with two technical colleges and one community college in the state of Louisiana. Additional agreements are in progress. The articulation of C4M provides a set of stackable credentials, where high school students can go to a technical college or a community college and obtain skills that enable them to work in the manufacturing sector. The students can then chose to enroll in a 2-year or a 4-year program, where the C4M credential that they hold is valued at 7 hours of college credit.

The articulation of C4M was indeed challenging, since it is a new program, and not fully defined yet. For example, the team was faced with situations where there is no direct one-to-one mapping between C4M curricula and the courses within the selected Engineering Technology program. Once, C4M gains popularity, there will be a need to revisit the articulation agreements, and provide detailed mappings along with alignment of specific course learning outcomes.

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