AC 2010-940: DEVELOPING A NEW MANUFACTURING ENGINEERING TECHNOLOGY CURRICULUM

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DEVELOPING A NEW MANUFACTURING ENGINEERING TECHNOLOGY CURRICULUM

ABSTRACT

Manufacturing is one of the areas that had been deeply hit by globalization and most of the manufacturer’s associate globalization with outsourcing due to recent history of U.S. manufacturing. Approximately 300,000 jobs were outsourced to foreign countries in 2003 and research predicts that 3.4 million jobs will be lost by 2015 in manufacturing outsourcing. Does this mean manufacturing is going to decline? Global manufacturing enables engineering and manufacturing responsibilities to be distributed in such a way that the product is built efficiently.

In this paper authors would discuss about the new manufacturing engineering technology program for the north east Indiana where the courses would provide graduates with solid knowledge and readily marketable skills in the area of manufacturing engineering. In recent years virtually all markets around the world demand that products be engineered to meet local requirements and preferences. Incorporating all these concerns a survey was done to see the hiring trend for the proposed manufacturing engineering technology curriculum. Based on the survey manufacturing ET curriculum was developed that provides a foundation in sciences complemented by general technical courses in mechanical and industrial engineering disciplines. The general technical courses, focusing on the practical application of engineering knowledge, include the subject areas of engineering graphics, engineering materials and mechanics, hydraulics and pneumatics, CAD/CAM, geometric tolerancing, design and engineering economics. The manufacturing-specific courses cover subjects in manufacturing processes, CNC, quality assurance, facilities layout, material science, design for manufacturing, and lean manufacturing.

INTRODUCTION

Development of the proposed MFET (Manufacturing Engineering Technology) program at Indiana Purdue Fort Wayne (IPFW) has been in progress for many years. Manufacturing courses have been offered as part of the Mechanical Engineering Technology (MET) and Industrial Engineering Technology (IET) degrees at IPFW since the 1970’s. During the period of late 1970’s to the early 1990’s the department of Manufacturing Technology offered a Manufacturing option as part of the MET program. Because of declining enrollments in the MET program during the early 1990’s the Manufacturing option was discontinued. However as a part of the MET curriculum many of the manufacturing option courses have been continuously offered since that time. With the increased demand for manufacturing specific courses as requested by current students, the Industrial Advisory Committee (IAC) for the MET and IET programs, and from employer surveys the department started planning a new B.S. in Manufacturing Engineering Technology program in spring 2007.
The curriculum for this proposed B.S. in MFET was developed by a joint committee of faculty members from the MET and IET Programs in the MCET department with assistance of the members of the IAC.

The new Manufacturing Engineering Technology (MFET) offered by the Department of Manufacturing & Construction Engineering Technology and Interior Design (MCET) in the College of Engineering, Technology, and Computer Science (ETCS) at IPFW. Manufacturing Engineering Technology encompasses the field of manufacturing systems, processes, and operations. The objective of the program is to develop a B.S. degree program that will concentrate on process and systems design, manufacturing operations, maintenance, sales and service functions with sustainable initiatives in design and manufacturing.

The intention of the program is to prepare students for careers as professionals in manufacturing engineering technology (MFET) occupations that would be current with sustainable initiatives and efficient utilization of resources. It will provide employers within the northeast Indiana region with a highly trained workforce having technical and leadership skills in process and systems design, manufacturing operations, maintenance, and service functions.

Persons who will be attracted to the program will include:

- High school graduates or undecided students who choose to pursue a career in manufacturing related positions.
- Current students who are pursuing or completed the A.S. or B.S. in other programs such as industrial engineering technology or mechanical engineering technology at IPFW;
- A.S. Graduates of other Purdue statewide locations or other campuses such as Vincennes or Ivy Tech State college offering programs that provide a similar background;
- Individuals currently employed in related positions who desire to further their education;
- Technicians, supervisors, and shop floor personnel who need to broaden their professional knowledge in this area.
- Students currently enrolled in other programs who desire to learn theory and practice of some specific courses;

**PROGRAM OBJECTIVES**

The objective of the proposed Manufacturing Engineering Technology program is to prepare graduates with manufacturing and leadership skills necessary to enter careers in a manufacturing enterprise with emphasis on process and systems design, manufacturing operations, maintenance, sales and service functions.
Graduates will be prepared with knowledge and skills required for the manufacture of products using traditional and emerging technologies in foundry, forging, fabrication, and plastics industries.

Target employment areas are expected to be in the use and application of manufacturing technologies using science, math, statistics, and computer hardware and software to solve manufacturing problems.

There are many students who desire a practical manufacturing-based program. Enrollment is expected to be comprised of individuals seeking a career-oriented educational experience. The student body will consist of recent high school graduates and persons employed in the manufacturing field attending school to obtain a four-year MFET degree or to upgrade specific technical and professional skills. The degree will meet the accreditation guidelines of the Accreditation Board for Engineering and Technology (ABET). Assessment of student academic achievement will be based on ABET and IPFW requirements.

Additional related objectives are to:

- Provide the industrial/manufacturing community with the technically trained manpower base to support manufacturing and commerce in the Northeast Indiana community;
- Provide an educational center for retraining of workers with needed MFET skills;
- Fill a need for trained professionals in the machining, fabrication, plastics, and foundry industries;

The proposed MFET program is designed so that the B.S. graduate will have a broad knowledge of the available technologies and the necessary background in which to apply the appropriate solution. The MFET program will focus on practical applications in the respective industry work areas.

**PROPOSED CURRICULUM**

The proposed degree has a major area of concentration of different and common manufacturing processes. The major areas of the degree are shown in the following table. The curriculum described below provides a technical education in the area of industrial and enterprise computer networking. The core provides the student with basic instruction in materials and manufacturing processes with hands-on laboratory work. It also introduces the fundamentals of design for manufacturing and assembly, computer applications using, spreadsheet and database suites. The specialization area provides in-depth technical knowledge about common manufacturing processes found in majority of industries. Other required courses provide mathematical and communication skills, and sufficient knowledge of the industrial environment to perform
effectively in the workplace. The semester hour breakdown by area is shown in the following table.

<table>
<thead>
<tr>
<th>MFET B.S. Degree</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Science and Mathematics</td>
<td>23 hours</td>
</tr>
<tr>
<td>Manufacturing Specialty</td>
<td>21 hours</td>
</tr>
<tr>
<td>Technical Specialty</td>
<td>54 hours</td>
</tr>
<tr>
<td>*General Education Areas III, IV, and V</td>
<td>15 hours</td>
</tr>
<tr>
<td>English and Communications</td>
<td>12 hours</td>
</tr>
<tr>
<td>Technical Electives</td>
<td>6 hours</td>
</tr>
<tr>
<td>Total</td>
<td>131 hours</td>
</tr>
</tbody>
</table>

*General Education is an IPFW requirement, with pertinent areas defined as:
Area III: The Individual, Culture, and Society
Area IV: Humanistic Thought
Area V: Creative and Artistic Expression

The MFET degree program will attract students who desire to pursue a career in process and systems design, manufacturing operations, maintenance, and service functions. The program is designed to meet the needs of technically inclined individuals, both those who are recent high school graduates and those who work in the field and wish to upgrade their skills. The program will be offered for daytime full-time students, evening part-time students, and some courses will be offered via distance education. Opportunities also exist in the northeast Indiana area for students who have moved here or who commute from nearby communities. Depending on the students’ academic performance and course records, transfer students may need to take some first and second year courses to fulfill prerequisite requirements.

Two-year programs in manufacturing are in place at other Indiana institutions such as Ivy Tech State College. Articulation agreements are currently in place between IPFW and Ivy Tech State College with respect to Ivy Tech MTT and IT courses and their transfer to IPFW MET and IET courses.

**PROGRAM STRENGTHS**

The MFET program will provide a graduate of the program with the training and skills encompassed by a combination of IET, MET, ECET, CS, and new specialized manufacturing courses. A number of existing courses may be modified to include applications to manufacturing. Another feature is that the program will help students develop advanced skills required in most of the manufacturing industry such technologies related to casting, forging, stamping, fabrication, plastics, and CNC machining.
This proposed MFET program will become a collaborative effort between MCET department and industry. This program is compatible with the MFG program at IUPUI. The proposed degree program will maintain a close relationship and undertake cooperative endeavors whenever possible with other MFG and CIMT programs in the Purdue system. The MFET program will primarily use facilities of the MCET department, which currently has laboratories that are equipped with computer stations and manufacturing equipment including the new $300,000 HAAS manufacturing equipment. Details of available equipment are given later. These laboratories will support the courses. In addition, all of the laboratories are part of the college’s network and have access to a suite of licensed software. IPFW also has many open student laboratories that are part of a campus-wide intranet and that support all non-specialized courses on campus.

DEMAND AND EMPLOYMENT FACTORS

MFET degree graduates find career opportunities in many areas involving manufacturing systems and operations. Some of these are based on industries having processes such as, fabrication, stamping, welding, forging, casting, plastics processing, advanced CNC machining, and other emerging technical areas. Program graduates have titles such as process engineer/technician, manufacturing engineer, design engineer, lab technician, tooling engineer, project engineer, engineering manager, and maintenance engineer.

MARKET DEMAND

The employment outlook is favorable for graduates possessing the knowledge and skills required for the manufacture of products using traditional and emerging technologies in foundry, forging, fabrication, and plastics industries. Target employment areas are expected to be in the use and application of manufacturing technologies using science, math, statistics, and computer hardware and software to the solution of manufacturing problems.


“Overall engineering employment is expected to grow about as fast as the average for all occupations over the 2004-14 period. Engineers have traditionally been concentrated in slow-growing manufacturing industries, in which they will continue to be needed to design, build, test, and improve manufactured products. However, increasing employment of engineers in faster growing service industries should generate most of the employment growth. Overall job opportunities in engineering are expected to be favorable because the number of engineering graduates should be in rough balance with the number of job openings over this period. However, job outlook varies by specialty, as discussed later in this section.
Competitive pressures and advancing technology will force companies to improve and update product designs and to optimize their manufacturing processes. Employers will rely on engineers to further increase productivity as investment in plant and equipment increases to expand output of goods and services. New technologies continue to improve the design process, enabling engineers to produce and analyze various product designs much more rapidly than in the past. Unlike in other fields, however, technological advances are not expected to limit employment opportunities substantially, because they will permit the development of new products and processes.

There are many well-trained, often English-speaking engineers available around the world willing to work at much lower salaries than are U.S. engineers. The rise of the Internet has made it relatively easy for much of the engineering work previously done by engineers in this country to be done by engineers in other countries, a factor that will tend to hold down employment growth. Even so, the need for onsite engineers to interact with other employees and with clients will remain.

Compared with most other workers, a smaller proportion of engineers leave their jobs each year. Nevertheless, many job openings will arise from replacement needs, reflecting the large size of this profession. Numerous job openings will be created by engineers who transfer to management, sales, or other professional occupations; additional openings will arise as engineers retire or leave the labor force for other reasons.

The Indiana Workforce Development Agency for the National Bureau of Labor Statistics does not classify or list Manufacturing Engineers as an occupational title. However most Manufacturing Engineers are either Industrial Engineers or Mechanical Engineers by education.

Therefore, it is reasonable to use projections for Industrial and Mechanical Engineers employed by Manufacturing Industries to estimate the long-term projection for employment of Manufacturing Engineers in North East Indiana, Workforce Investment Act Planning (WIAP) Region 3, consisting of the Counties of Adams, Allen, Dekalb, Huntington, LaGrange, Nobel Stuben, Wells, and Whitley.

Table 10-2 shows the long-term Indiana occupational projections for Industrial and Mechanical Engineers in the state of Indiana. Table 10-3 and 10-4 show the long-term occupational projections for Industrial and Mechanical Engineers in Manufacturing Industries in North East Indiana, WIAP Region 3.

A survey of local manufacturing industries completed in April 2007. About 115 manufacturing companies were surveyed and 48 companies responded. Thirty-nine companies of the 48 responses indicated that they plan to hire about 149 graduates of the manufacturing program on a 5-year basis. To another question, their response was they have approximately 146 current employees to whom they will recommend taking the manufacturing courses.
Table 10-2. Long-Term Indiana Occupational Projections- High Wage/High Demand Occupations.

<table>
<thead>
<tr>
<th>Code</th>
<th>Occupational Title</th>
<th>2004 Employment</th>
<th>2014 Projection</th>
<th>Growth</th>
<th>Change</th>
<th>Total Replacements</th>
<th>Total Openings</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-1011</td>
<td>Architects, Except Landscape and Naval</td>
<td>1,630</td>
<td>1,970</td>
<td>340</td>
<td>21%</td>
<td>190</td>
<td>530</td>
</tr>
<tr>
<td>17-1022</td>
<td>Surveyors</td>
<td>1,010</td>
<td>1,170</td>
<td>160</td>
<td>16%</td>
<td>340</td>
<td>510</td>
</tr>
<tr>
<td>17-2031</td>
<td>Biomedical Engineers</td>
<td>390</td>
<td>560</td>
<td>170</td>
<td>44%</td>
<td>70</td>
<td>240</td>
</tr>
<tr>
<td>17-2051</td>
<td>Civil Engineers</td>
<td>3,080</td>
<td>3,590</td>
<td>500</td>
<td>16%</td>
<td>490</td>
<td>990</td>
</tr>
<tr>
<td>17-2071</td>
<td>Electrical Engineers</td>
<td>3,860</td>
<td>4,340</td>
<td>480</td>
<td>12%</td>
<td>760</td>
<td>1,240</td>
</tr>
<tr>
<td>17-2072</td>
<td>Electronics Engineers, Except Computer</td>
<td>2,330</td>
<td>2,580</td>
<td>260</td>
<td>11%</td>
<td>460</td>
<td>720</td>
</tr>
<tr>
<td>17-2081</td>
<td>Environmental Engineers</td>
<td>830</td>
<td>1,010</td>
<td>180</td>
<td>22%</td>
<td>140</td>
<td>320</td>
</tr>
<tr>
<td>17-2112</td>
<td>Industrial Engineers</td>
<td>5,980</td>
<td>7,050</td>
<td>1,070</td>
<td>18%</td>
<td>1,450</td>
<td>2,520</td>
</tr>
<tr>
<td>17-2121</td>
<td>Mechanical Engineers</td>
<td>6,820</td>
<td>7,430</td>
<td>620</td>
<td>9%</td>
<td>1,860</td>
<td>2,480</td>
</tr>
</tbody>
</table>

*Indiana Workforce Development Agency for the national Bureau of Labor Statistics does not classify or list Manufacturing Engineers as an occupational title. However most Manufacturing Engineers are either Industrial Engineers or Mechanical Engineers by education.*

Formatting modified by K. Perry, 9/18/2007

Table 10-3. Long-Term Projections for North East Indiana, Workforce Investment Act Planning Region 3, Industrial Engineers in Manufacturing Industries.

<table>
<thead>
<tr>
<th>Geography</th>
<th>State Fips</th>
<th>Geography Code</th>
<th>Year</th>
<th>Job Title</th>
<th>Industry Title</th>
<th>Job Title</th>
<th>Industry Title</th>
<th>2004 Jobs</th>
<th>2014 Year Jobs</th>
</tr>
</thead>
<tbody>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Manufacturing</td>
<td>172112</td>
<td>310000</td>
<td>1,030</td>
<td>1,120</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Textile Product Mills</td>
<td>172112</td>
<td>314000</td>
<td>20</td>
<td>30</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Plastics and Rubber Products Manufacturing</td>
<td>172112</td>
<td>326000</td>
<td>90</td>
<td>100</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Nonmetallic Mineral Product Manufacturing</td>
<td>172112</td>
<td>327000</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Fabricated Metal Product Manufacturing</td>
<td>172112</td>
<td>332000</td>
<td>140</td>
<td>160</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Machinery Manufacturing</td>
<td>172112</td>
<td>333000</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Computer and Electronic Product Manufacturing</td>
<td>172112</td>
<td>334000</td>
<td>230</td>
<td>190</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Electrical Equipment, Appliance, and Component Manufacturing</td>
<td>172112</td>
<td>335000</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Miscellaneous Manufacturing</td>
<td>172112</td>
<td>339000</td>
<td>70</td>
<td>90</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Management of Companies and Enterprises</td>
<td>172112</td>
<td>550000</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>EGR 3, IN</td>
<td>18</td>
<td>470309</td>
<td>2014</td>
<td>Industrial Engineers</td>
<td>Management of Companies and Enterprises</td>
<td>172112</td>
<td>551000</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

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The proposed program is designed to be flexible in providing reasonable transfer credit for entry into the program, and program transfer without major loss of credit. The initial degree focus on computer networking can be converted to other computer based application areas in reaction to market trends and employment opportunities. The adoption and integration of evolving technologies to meet changing needs will also be a priority in the proposed program.

Immediate market or short-term demand for the Manufacturing Engineering Technology graduates will be gathered and tracked through company human resources departments, local job listings, technical managers of local industries, and industrial advisory committee members. Long-term market demand will be gathered from the Indiana Department of Workforce Development, State and Local Labor Market Information, and the National Bureau of Labor Statistics Reports.

**PROGRAM EVALUATION AND IMPLEMENTATION**

The Manufacturing Engineering Technology (MFET) B.S. degree program is proposed for implementation in fall 2010.

1. Quality and Efficiency
Annual assessment reviews of each program are conducted by each department in accordance with IPFW requirements. These assessments include measurements of success for the goals for each program and include pertinent data such as enrollment figures, retention rates, and student academic progress. Measures used for assessment include student course evaluations, student success in completion of selected courses, evaluation of student projects by faculty, and annual surveys of alumni and employers of alumni. A continuous improvement component is contained in each program assessment. National TAC/ABET accreditation will begin using assessment-based evaluations during the next program accreditation cycle (2016) for accreditation of Engineering Technology programs at IPFW. The department has maintained continuous TAC/ABET accreditation for over 30 years, and it is expected that the proposed program will be implemented effectively and build on the department’s strengths.

2. Appropriateness

Feedback and quantitative data will be used to modify or extend the program’s offerings. An assessment plan will be developed by MFET/MCET faculty to evaluate the strengths and weaknesses of the program and to implement a continuous improvement cycle.

4. Personal and Social Unity

There are many campus-wide student organizations that will strengthen ties and communications for students at all levels. Some of these organizations are Indiana Purdue Student Government Association (IPSGA), Student Activity Board (SAB), (the engineering technology honor society), and the student chapter of the (SME) Society Of Manufacturing Engineers. The College of Engineering, Technology, and Computer Science recently hired a new Director of Outreach Programs to coordinate national outreach programs such as Future Cities, Lego League, and Math Counts, as well as local programs such as Math/Science summer camp.

5. Student Demand

Figures from IPFW enrollment data indicate student demand for the educational opportunities offered by the Manufacturing Engineering Technology program. Forecasted program enrollments are shown in Table 1. Continuous monitoring of actual enrollment and retention rates will be conducted along with the annual program assessment to show student demand and satisfaction levels. A recent increase in enrollment in the MCET department has been, in large part, due to the interest of students in the Manufacturing Degrees in the MET program. Continued demand is anticipated and the proposed degree provides a more focused opportunity for students.
6. Student Access

IPFW has an institutional commitment to facilitate student academic success. Currently, many support programs and tutoring opportunities are available through such academic programs as Department of Mathematical Science, Department of English and Linguistics, and Transitional Studies to assure that student access to the proposed Computer Engineering Technology is available. In addition, IPFW also has an office of Services for MFET Students with Disabilities to provide people with disabilities an equal opportunity to participate in, contribute to, and benefit from university programs, services, and activities.

CONCLUSION

The geographic region to be served by this proposed program is primarily northeast Indiana. As a regional campus, many students attending IPFW are considered “non-traditional” and are employed in the area. Most students at IPFW are linked to the northeast Indiana community by family, employment or other financial responsibility. Most graduates of the proposed degree program with sustainability initiatives are expected to seek or continue employment in northeastern Indiana where it deeply affected with economic downturn and where the new initiatives are into sustainability. Many companies in northeastern Indiana require graduates with the skills provided by this degree. MET and IET graduates have been placed in occupations similar to those in which MFET graduates would work with companies in the northeast Indiana area such as: International Truck, ITT (Aerospace-Communications), Central Soya, General Electric, General Motors, Dana Corporation, Superior Essex, Fort Wayne Metals, Alcoa, Group Dekko, BAE Systems, DePuy, Zimmer, Biomet, and 39 other manufacturing companies as shown by the survey conducted by the department in April 2007.

Bibliography
