

## **AC 2007-2829: PROBLEM-SOLVING AND PROJECT-PLANNING BASED CURRICULAR ENHANCEMENT IN MANUFACTURING ENGINEERING TECHNOLOGY EDUCATION**

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# **Problem Solving and Project Planning Based Curricular Enhancement in Manufacturing Engineering Technology Education**

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## **Abstract**

The “lean” trend in business and industry is to expand capacity and quality while decreasing overall costs through continuous problem solving. More problems to solve, with fewer staff, places a premium on employees with problem solving skills. Universities excel at teaching technical topics and how to solve textbook problems within each technical discipline. However, little effort is directed to methods of problem solving for problems outside the textbook, even though this is becoming a major occupation of engineers in industry. Therefore it is important for engineering and technical programs to include more problem solving and project planning and management components in the curriculum. There are experts on structured methods of problem solving, some with extensive industry experience. These professionals can easily prove that a structured process will yield better solutions to problems than an off-the-wall approach, and that anyone’s problem solving skills can be improved. Similarly, most engineers spend much of their time involved in projects, but few have been trained in project planning and management by actually doing projects. Structured problem solving and project management are both skills that are learned more by actual practice than by textbook study. So it is necessary to incorporate significant project practice using both skills into curriculum as a part of normal course work.

This paper will discuss the strategies and processes of curriculum enhancement for our manufacturing program, and investigate and integrate more practical industry-related components into the manufacturing curriculum.

**Keywords:** Curriculum enhancement, problem solving, project planning

## **Introduction**

The College of Applied Science (CAS, the College) is the higher education home for Engineering Technology programs at the University of Cincinnati (UC). CAS’s mission is to provide high-quality, accessible, practical skills training, enriching education to students for industries. Since its inception in the middle of the nineteenth century, CAS has offered programs that focus on technologies. Early in the twentieth century, CAS developed a hands-on pedagogy to meet the growing demand for technically trained individuals. Later in the century, the focus shifted to design technologies to meet the needs of industry. Currently, design projects explore opportunities for innovation in Mechanical Engineering Technology (MET) and Manufacturing Engineering Technology (MfgET).

Now, the focus is once again shifting to meet the needs of manufacturing and similar industries. The engineering and engineering technology programs at UC are organized to work with business and industry to continuously improve their curriculum. Recent transformations in business paradigms require our institutions to understand the changing business and manufacturing environment and to make corresponding changes in the curriculum. Our industrial advisors recommend a curriculum that fosters problem solvers and project managers while promoting manufacturing innovation. To respond to their need, the college and MET department, with support from MET department's Industrial Advisory Board, propose to develop a project-based teaching and problem-based learning manufacturing curriculum providing hands on and creative thinking experience to MET department's students. Through the curriculum, innovative teaching pedagogies with enhanced use of project based teaching and problem based learning will be developed. Through this program, students will have a firm understanding of industry needs, develop skills to solve practical problems for the industry community, and grasp the knowledge of project planning and managing. The outcomes are to provide graduates who are well trained and are experienced at creative problem analysis, solving, planning and managing, for the manufacturing community. Understanding these techniques and gaining the experience outlined above is vital to the success of students who pursue a career in the manufacturing industry [1] [2].

### **Strategies for Enhancing Manufacturing Curriculum**

Our vision is to make the College the leading source of well-educated problem solvers and project managers for the manufacturing community. Our goal is to deliver graduates with exceptional skills at solving problems in an innovative way, planning and managing projects successfully from their first day of their employment.

Our strategy is to establish a structured problem solving system and integrate it into MET department students' classroom starting from their second year study in the College. Currently, we do teach students problem solving skills in the classroom. But it is on their senior year when they extensively used their previous technical knowledge to do projects [3]. The disadvantage is it is too late. Manufacturing program at the College is two-year Associate Program. Some students will graduate without the chance to obtain such training and leave the college without systematic problem solving skills. The problems are everywhere and exposed to students from anytime and angle. The earlier they obtain the training the better for their growth in the professional career or non-technical development. The enhanced manufacturing curriculum will include the following components:

1. Problem solving: The structured problem solving systems or methodologies have been investigated. Our own systematic problem solving methodology is being established. This could be offering a separate course for sophomores to introduce our own systematic problem solving methodology and process; the trained faculty will lead the course. We are also considering an extensive workshop on problem solving training with an international or national problem solving expert lead and organize the workshop. The audience will be sophomores or freshmen, depending on their co-op schedule. A third option is to integrate our problem solving methodology into one or two sophomore courses as a part of these two courses. The faculty advisers and/or engineers from

industry will provide general direction for the courses, while the students will have to use an established problem solving process to solve most of the problems on their own. They will be graded on their problem solving technique and steps as well as on their solutions.

2. Project planning and management: The project-based learning method will be used in the curriculum. Projects will be assigned to students in groups. Each of the groups will plan the development of the project, manage the progress of the project, divide the project to series of problems, solve the problems, and assemble the solution of the problems into the project for successful completion. Of particular interest will be the technique of responding to unforeseen obstacles.
3. Written communication: The student groups will periodically provide formal written reports to faculty advisers, such as weekly report and mid-term or final term report.
4. Oral communication/listening: The small group activities with similar projects will provide participants with opportunities to communicate among group members and among the different groups. The final oral presentation will provide students the opportunities to show their confidence and skills to the technical audience.
5. Teamwork/working effectively with others: group activities will present the students with opportunities to cooperate with each other, including planning the schedule and project activities.

Lessons learned through above components will be incorporated into the current manufacturing curriculum. Project successes will be incorporated in other MET courses. Eventually every college course will include project-based learning, problem solving and the tools of project planning. Structured problem solving will be taught throughout the curriculum.

The action steps will be three major phases:

- 1.) To work with manufacturing and other industry communities to fine tune these new curriculum requirements;
- 2.) To seek out professionals at other universities who have interests and/or experience in teaching similar subjects to identify existing material which we may incorporate in our course modifications;
- 3.) Through collaboration with experts in project management and structured problem solving, the college faculty and engineering managers in industry will create modified courses and lesson plans for a substantial number of courses. These courses include more project assignments, project planning and management, and using structured problem solving process, all within the scope of the individual course subject matter.

The Manufacturing faculty will then be charged to develop and implement the pilot program by modifying all appropriate courses to provide a maximum of project work and providing applications of structured problem solving and project planning.

### **Expected Outcomes**

Students will be trained to become problem solvers and project managers. Graduates who present better problem solving skills and project managing skills will stand out in the workforce. The MET department and the college will be known for producing problem solvers, creative thinkers, and project managers. Increased levels of community and industry involvement especially from manufacturing companies will take place at the College.

The assessment methodologies for the program outcome are being investigated and will be added to the program as part of the curriculum enhancement.

### **Industrial Partners and Support**

The college currently has a strong reputation in local industry for producing graduates who “hit the ground running” as a result of the co-op experience. The College also requires that each BS graduate must have completed a senior project as their capstone experience. Both co-oping and senior projects have brought the College many friends and partners in industry, such as Procter & Gamble, Milacron, GE Aircraft Engines, Cincinnati Machine, Cincinnati Incorporated, Eagle Manufacturing, Meyer Tools, Cinergy, Toyota Motor Manufacturing at Georgetown Kentucky, etc. They are eager to help the College bring our successful program to the next higher level. It is these industry friends who have helped the College set the goals for a new level of Manufacturing Engineering Technology education, and who stand ready to work beside us to keep the development of courses.

### **Conclusion and Discussion**

The new curriculum will be extensively used in the manufacturing courses. The problem based learning experience will be established. The project based teaching method will be developed. The manufacturing engineering technology program curriculum will be enhanced. The connection between the College and manufacturing community will be enhanced. The co-op opportunities for college students will be widened. Students who are well trained in problem solving, creative thinking, project planning and managing will be produced and delivered to the manufacturing community.

Following the success in the Manufacturing program the College will follow-up to implement structured problem solving methodology, lessons and experience learned in project planning and management in all other programs. The module can also be disseminated to other educational institutes ranging from elementary schools to the college.

The strategies and plan for enhancing manufacturing program is the response to the needs of our industrial partners and manufacturing community. The implementation of the plan is the work in progress. As more work is being done, more reflection and data will be reported in the additional papers.

### **Bibliography**

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