TEACHING AN ADVANCED PROCESSES COURSE USING AN INDUSTRY PROJECT

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A semester-long course in advanced manufacturing processes can barely scratch the surface in teaching students the many emerging technologies. An alternative approach to such a course has the students learning a single process very well, thus "learning what is takes to learn" a new process. This knowledge can then be applied to any process encountered. Senior students in Miami University's Manufacturing Engineering program were given the opportunity to work with a local business while learning specific processes. In preparation for implementation of a new computer aided process planning (CAPP) system, the business required development of standardized practices for several advanced processes.

Background

The Miami University, School of Applied Science has an ABET accredited Bachelor of Science program in Manufacturing Engineering. Approximately one hundred and forty students are enrolled in the program. The students take a three-course progressive sequence in manufacturing processes. Basic processes are introduced in the sophomore year, with following courses expanding upon the basics, introducing advanced processes, and teaching other pertinent engineering topics.

In the Advanced Manufacturing Processes II course, senior-level students are expected to apply process tooling and quality knowledge gained in previous courses to the planning of component manufacture and assembly of a product. A few new processes are introduced to the students through use of standard lectures. The design exercise traditionally employed in the class involves use of teams which develop different aspects of planning which must coordinate with each other to ensure a viable set of plans for the overall product.

There are several drawbacks to this traditional method of instruction. Laboratory facilities are not available to give the students hands-on experience with the advanced processes that they are studying. Selection of the technologies to include in the course was an issue as the actual needs of the department's students were dependent on the industry in which they obtained a job upon graduation. The students in the course tended to gain only a cursory knowledge of several advanced technologies. The process plans prepared in the course project were at a relatively high level. In addition, all aspects of the process planning for the design project are performed in a paper-based mode and in relative isolation when considering the impact and links of process planning beyond the process selection.

An alternate approach to the course was explored to address these drawbacks. It was decided that future employers would benefit if students "learned how to learn" a process in an actual industry environment. In addition, a computer-aided process planning approach would retain all

current process planning elements while broadening the scope and use of technology. An innovative partnership was formed with General Electric Aircraft Engines in Evendale, OH to facilitate the course improvements.

Partnership with General Electric

General Electric Aircraft Engine (GEAE) in Evendale, Ohio was embarking a project to improve the consistency and content of detailed process planning/operator instructions across its multiple manufacturing locations. As a part of this project, best practices relative to critical processes were to be identified and standardized. The opportunity for standardization and development of new process planning corresponded with implementation of a new computer aided process planning (CAPP) system.

Miami University proposed to support the implementation of the CAPP system at GEAE with development of standardized/best practices for advanced process areas. A contract was awarded in the amount of $19,000 to fund effort in three phases, Requirements, Analysis & Development, and Implementation. How requirements for each phase of the contract were met is discussed briefly below. A more detailed discussion then follows relative to use of students in the Advanced Processes II course.

Phase I - Requirements

Manufacturing Engineering Department faculty member, Dr. Karen Schmahl, performed efforts for the Requirements Definition phase in the fall of 1996. The requirements for developing and implementing the CAPP system in special process areas were defined. The following tasks were accomplished:

- Review of processes considered for best practices analysis/standardization. Initial processes were identified in vacuum brazing, tig welding, electron beam welding and laser drilling areas.

- Determination of the magnitude of effort in each area. This analysis considered the types of equipment used in each process, the variety of operations performed using the equipment, and the number of process plans impacted.

- Review of the CAPP application on utilization of templates for standardized text.

- Identification of necessary resources for development of the standardized/best practices in selected process areas including appropriate GEAE personnel familiar with the processes, the users of the processes, and locations of pertinent data.

- Preparation of course material and notebooks containing process information.

Phase II - Analysis & Development

During the Spring Semester 1997, Dr. Schmahl directed student teams in the Advanced Manufacturing Processes class in the analysis of processes and development of standard templates. As a part of their course requirements, the student teams

- Collected information on application/methods of assigned processes.
- Aided GEAE special process teams in analysis for standardization/best practices for each process.
- Developed standardized text templates for utilization in the CS/CAPP application.

Phase III - Implementation

At the completion of the semester, Dr. Schmahl was to insure that the standardized texts for at least four GEAE special processes are satisfactory for GEAE use. Effort to completion included:

- Review the student developed templates with GEAE and revise as necessary for GEAE utilization.
- After concurrence/approvals put templates into the CS/CAPP implementation for utilization.

Integrating the GEAE project into the course

The basic objective of the Advanced Manufacturing Processes II course is for students to demonstrate an understanding of the manufacturing function and how the planning of production operations connects product development with production resources for making parts. Accomplishment of the basic objective was realized with the GEAE project where student teams identify best practices in a complex manufacturing process and prepare a proposal for standardization of the associated process planning. In the first week of class, students were introduced to the project and teams were formed. While the teams were allowed to be self-selected, each team was required to have a half day in which they could all travel together for site visits. Eight teams were established, two assigned to each process.

The goal of each team was to generate a set of guidelines for GEAE manufacturing engineers to use when preparing operator instructions for the process using the new CAPP system. The students were to prepare a standard template for use in the CAPP system to go with the guidelines for their assigned process.

A series of guest speakers from GEAE were brought to address the class at the beginning of the semester. The need for the project was established along with its importance to GEAE. At the end of a lecture on dealing with proprietary information, the students were asked to sign a confidentiality agreement. Laboratories were developed to introduce the students to the CAPP software.

The first assignment for the class was to conduct research and prepare a report on the subject process. Once the students were familiar with their process, visits to GEAE were arranged.

GEAE process technology leaders for each process demonstrated the technologies and answered questions. The students were given notebooks of actual operation sheets from various GEAE facilities.

The students were to analyze the process plans for commonality and “best practices”. The GEAE process leaders served as the technical resource for the students and several teams made numerous visits to the manufacturing facilities to see their process in use. In general, the steps used to arrive at the final deliverable were:

1. Evaluate current work instructions for a variety of parts.
2. Create an outline of general areas to be included in the process plan template.
3. Determine the steps that were common across all parts.
4. Arrive at a list of steps that contained part specific parameters.
5. Generate the process plan template through union of the outline, common steps and part specific steps.
6. Test the template by creating process plans for six parts.
7. Improve the process plan template using feedback form the analysis of the six process plans.

At the midpoint of the semester, the template was generated and presented in formal presentations to GEAE. Feedback was provided to the students by the GEAE process engineers and the CAPP implementation team.

After the midterm presentations, the two teams assigned to the same process were merged and required to identify the best in each of their templates to come up with a single “optimum” template. Graduate students from the Master’s program in Technical and Scientific Communication facilitated the merging of the teams and advised the students on areas of improvement for their templates.

Each individual was then responsible for developing a single process plan to test the template. The final package delivered by each team was a CAPP generated process plan template with instructions for its use and six plans completed using the template. Again formal presentations were made to the industry customer.

Benefits of the Project

The project as described above addresses many of the competency gaps identified by SME “Manufacturing Education Plan: Phase I Report.” Participation in the development of the project provided the students with opportunities to build their teamwork and project management skills. The project also emphasized the written and verbal skills used in communicating with industry and in making presentations. By working with industry on introducing the new CAPP technology, the students received a first-hand view of the change management process. Focusing on process planning requires emphasis on basic manufacturing and quality principles as well as the processes themselves. "Learning what it takes to learn" a new process prepares the students for continuous or lifelong learning.

Using the students in the GEAE project gave them valuable experience that could not be duplicated in a pure classroom environment. Upon completion of the project students demonstrated ability to:

- Research and understand a complex manufacturing process, then correctly apply the process to produce a family of parts.
- Develop a detailed set of process plans which meets technical, quality and procedural requirements of an industrial user.
- Gain an understanding of the broad view of the manufacturing function and how the planning of production operations connects product development with production resources for making parts.
- Understand the role of the manufacturing engineer in the design, development and improvement in the systems and processes for making parts.
- Understand the professional and ethical responsibility of the manufacturing engineer.
- Communicate technical topics effectively and understand team projects.

Concluding Remarks

In addition to the benefits obtained by the students, GEAE learned valuable lessons about the use of their new CAPP system and the process necessary to develop standardized planning using the system. Three of the four process plan templates developed by the students were deemed useable by GEAE. Dr. Schmahl developed a fourth template to fulfill the contract requirements.

The success of the project in the customer's eyes is shown with GEAE interest in continuing use of the Advanced Processes II students to further develop process planning templates. Now that the faculty and GEAE have gained some experience in using the teams, an expanded role is proposed for the students in the upcoming year. The students in 1998 will not only analyze the process and propose a template for the variant process planning system, but will also be asked to develop generative logic for future expansion of the system. Overall, a win-win relationship has been established between the Miami University Manufacturing Engineering program and General Electric Aircraft Engine.

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