Manufacturing Engineering Technology Senior Projects Course

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Abstract

The primary emphasis of the manufacturing engineering technology projects course is to prepare senior students to face the challenge of solving real manufacturing problems in industry. Students work together in teams of three or four students. The team leader is responsible for arranging and conducting meetings of the group outside of the classroom time, and for meeting deadlines and completion of the project. Written and oral reports are made by the students. Each team works on an industrial manufacturing problem with an industry sponsor, therefore the projects are industry driven. Example projects are described.

INTRODUCTION

This paper focuses on the senior projects course as it is taught in the manufacturing engineering technology curriculum at Texas A&M University. TAC/ABET requires a capstone projects course in the final year of the baccalaureate program which draws together major elements of both design and manufacturing processes[1]. It should be project oriented and comprehensive in utilizing prior course work.

METHODOLOGY

The primary emphasis of the manufacturing engineering technology projects course is to prepare senior students to face the challenge of solving real manufacturing problems in industry. The scope of the project requires prerequisite knowledge from earlier courses. Students work together in teams of three or four students. The students choose their team members and elect a team leader. The team leader is responsible for arranging and conducting meetings of the group outside of the classroom time, and for meeting deadlines and completion of the project. Each team works on an industrial manufacturing problem with an industry sponsor. The teams select their own project. The selection is made from projects suggested by members of the Industrial Advisory Committee of the Manufacturing Engineering Technology program, by companies for which the students have worked during summers, by companies where relatives of the students work, or by alumni. The professor in charge of the course must approve any chosen project.

The mode of conducting the course is discussed next. During the first three to four weeks of the semester the students are introduced to the course, choose team members, elect a team leader, and select a project. Visits to project sponsors might be necessary during that time period. On the fourth week, the student teams submit a written Proposal and present the proposal orally to the whole class. During the 5th - 13th weeks, a progress report on the project is presented orally each week by the teams to the whole class and a brief (one-two paragraph) written report is submitted to the professor. No lectures are given by the professor. The mode of operation is as an advisor to the project, during the class period and outside of class. The class meets 1-2 hours once a week for the progress report sessions. The students also receive laboratory credit for this course; however, the teams meet independently to work on their projects. The teams visit their industrial sponsor and work on problem solutions, designs, analyses, reports, and on preparation of their presentations. Two major reports are required. Each team submits a written Mid-Term Report and makes an oral presentation of this report to the class. There is no final exam; however, a written Final Report is due the last class period and each team makes a final oral presentation of their project. This is generally during the 14th week of class. Sponsors are invited to attend the presentations. It has become a tradition for the students to “dress up” for their final presentation. They take this very seriously and exhibit professional behavior.

Since this course involves team effort, the final grade for this course is based mainly on team performance. The written Final Report and the team oral presentation of the Final Report constitutes 50% of the course grade. Besides team grades for the written reports and oral presentations, 30% of the final course grade is provided by individual student effort. This comes from an individual log kept by each student, an assessment of the individual student’s contribution to the project, and the student’s individual oral presentations during the semester.

EXAMPLE PROJECTS

Over the past seven years at least 30 different companies have furnished projects for the senior capstone course in the manufacturing engineering technology program at Texas A&M University. Some companies have supplied multiple projects.

Some past projects are listed below by project title:

1. Aircraft food tray design and manufacture
2. Aircraft skin modifications
3. Analytical test device manufacture
4. Dust/wood chip separation
5. Aircraft tail section material handling
6. Electronic component test facility layout
7. Truck trailer side material transfer
plates
8. Foundry mold clamping
9. Material handling and storage in business form production
10. Dust collection system in rice production
11. Gear turnover device in machining cell
12. Foundry mold separation
13. Shot blast cleaning of castings
14. Navy projectile load/unload material handling
15. Shrinking (freezing) of shafts for gear assembly
17. Gate and riser standardization
18. Injection mold die changing
19. Foundry ladle skimming
20. Babbit bearing cell layout
21. Waste paper collection and handling for bailing
22. Thickness measurement of battery
23. Solder masking
24. Material handling of shirts
25. Source loading in electronics production equipment
26. Maintenance plant layout
27. Gate valve plant layout
28. CMM cell design
29. Material handling of casting mold flasks
30. Material handling of tires for

16. Paperless factory system combustion in casting cupola

Each of these projects required the student teams to visit the industrial sponsor to discuss the problem, see the manufacturing processes involved, and to gather information. The students then propose solutions to the industrial problem. The projects are not “make work” projects. The students work on current, real industrial problems where a solution is needed and sought.

It is not possible to discuss all of the above completed projects in this paper. Only a few will be briefly presented as follows:

Aircraft Skin Modifications - The sponsor company reconditions aircraft. This project was to increase the productivity in replacing the rivets in the upper aluminum skin panels and to replace the panels if necessary. The project is depicted by Figure 1. The height from the ground to the top of the aircraft was about 30 feet. The students designed a movable work platform, a fixturing aid for making the replacement panels, and special hand tools for riveting on the skin panels.

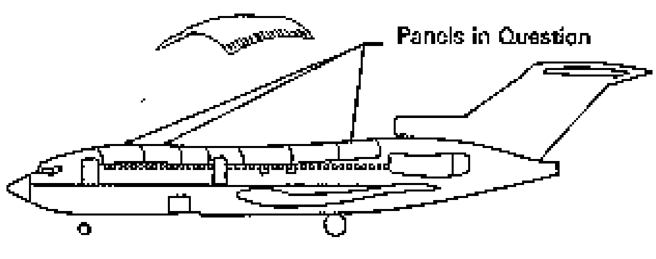

Figure 1. Aircraft Skin Modifications.

Aircraft Tail Section Material Handling - This sponsor company manufactured large tail sections for a aircraft manufacturer. As the tail section was built up in the vertical position it had to be picked up and moved from station to station. The students designed a movable platform on which the tail section was mounted such that it could be rolled into each station without having to remove the tail section. The weight of the completed tail section was about 2,000 pounds. Because of aisle restrictions the designed dolly required telescoping support arms which could be retracted during movement from work station to work station. Figures 2 and 3 depict the tail section and the designed dolly.

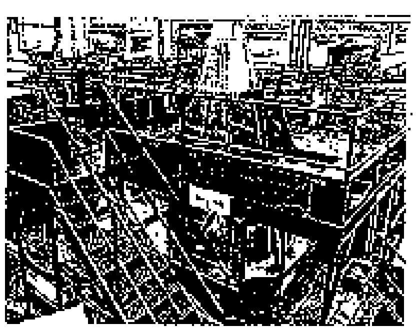

Figure 2. Aircraft Tail Section.

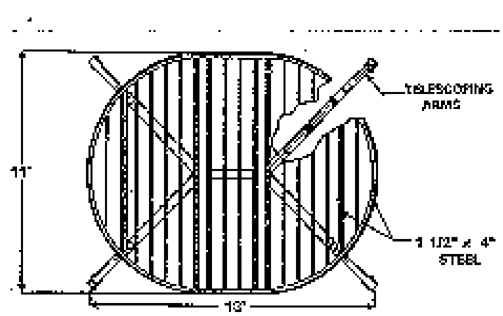

Figure 3. Material Handling Dolly

for Aircraft Tail Section.

Foundry Mold Clamping - This sponsor produced iron castings for its parent company. The customary method of securing the upper and lower halves of the mold flask was to employ steel wedges and one piece “C” clamps with the wedge pounded in place between the flask and the “C” clamp. A mallet was employed to secure the wedge in place; however, the pounding usually loosened other wedge/ “C” clamp assemblies already mounted. The student team designed a new “C” clamp having a cam locking mechanism which eliminated the need for the wedges. Figure 4 illustrates the new foundry mold clamp.

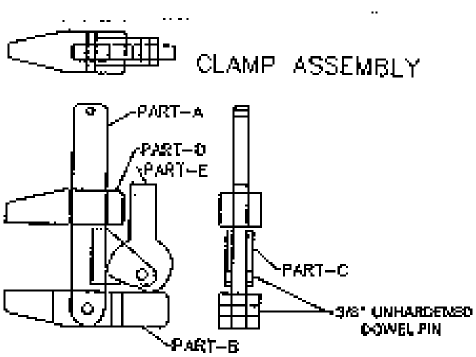

Figure 4. Foundry Mold Clamp.

Shrinking (Freezing) of Shafts for Gear Assembly - The project sponsor required a more efficient method of shrinking large shafts as part of the procedure of mounting gears on the shafts such that an interference fit occurred at room temperature. These shafts are generally 8" to 12" in diameter. The production method was to soak the shafts over night in a wooden box packed with dry ice. Figure 5 shows the solution designed by the students. It utilizes liquid nitrogen as the coolant. The student team established the materials required for the plumbing fixtures to withstand the low temperature of operation. This solution eliminated the need to soak the shafts overnight. The shrinking could be accomplished within the day shift.

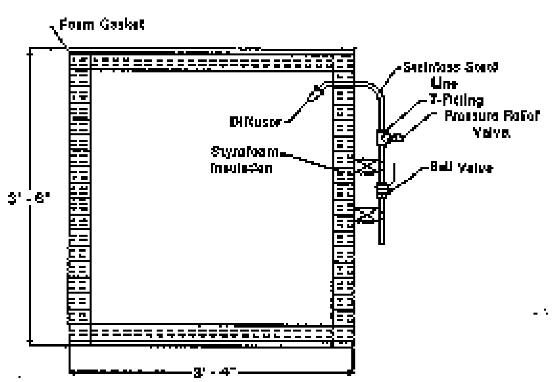

Figure 5. Shrinking of Shafts for Gear Assembly.

Injection Mold Die Changing - This sponsor produces injection molded rubber bushings. They desired a faster way of changing over the dies to make different parts. The dies required sitting in the press while the dies cooled and then the electrical connections were disconnected one at a time. The student's design utilized quick-disconnect electrical connectors containing multiple connections. The students designed a load/unload scheme such that the hot dies could be slid out of the way and the next die set slid into place. The design also included preheating of the die to be installed. Figure 6 shows this design. This solution greatly reduced the die changing time from 3.5-4.0 hours down to 0.5-1.0 hour.

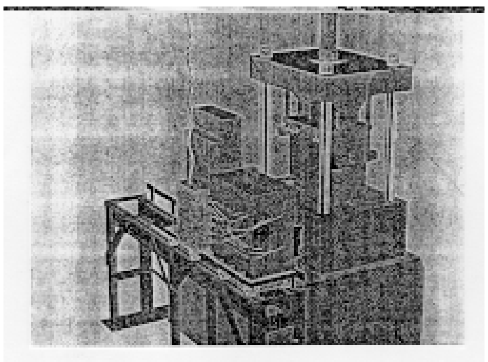

Figure 6. Injection Mold Die Changing.

Thickness Measurement of Battery Plates - This sponsor manufactures aircraft batteries. Battery plates are produced from a slurry ribbon which is cut into lengths. An improved method of measuring the slurry ribbon thickness was required. The production method was to employ a special micrometer to measure the ribbon thickness manually as the ribbon passed slowly from roller to roller. The students designed a powered slide holding a thickness measuring device which employed a laser system. This design is illustrated in Figure 7.

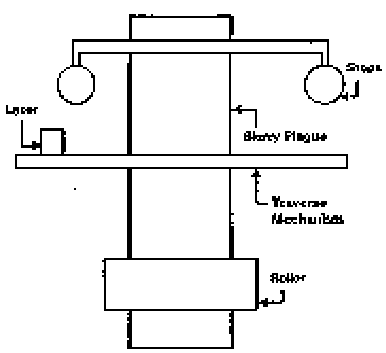

Figure 7. Thickness Measurement of Battery Plates.

Material Handling of Shirts - This sponsor produces silk-screened T-shirts and sweat shirts. Due to increased demand, the company expanded the floor space of its facility; however, city codes required that a fire wall exist between the new and old buildings. They needed a transport system which would move the completed product from one building to the adjoining building. The material handling had to be overhead out of the way and it had to pass through the fire wall. The students first thought of moving the shirts on hangers as was being done by hand. The students decided on a flat belt conveyor system with the shirts laying flat on the belt. The shirts are then mounted on hangers in the next building. The design is illustrated in Figure 8. This design incorporates a small sliding fire wall door and a collapsing conveyor section.

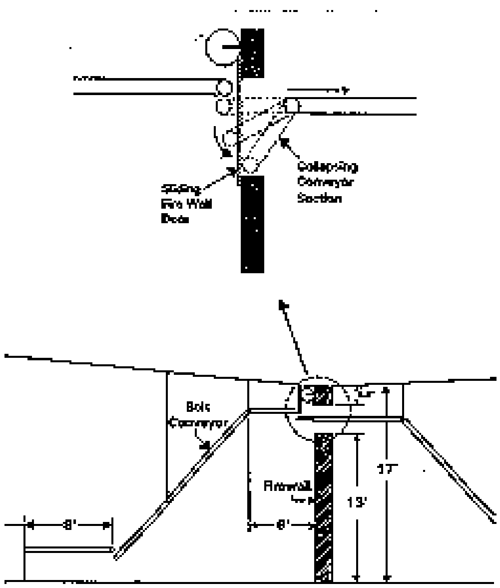

Figure 8. Shirt Material Handling.

Source Loading in Electronics Production Equipment - This company makes production equipment for producers of electronics chips and markets this equipment to the electronics chip manufacturers. In assembly of the production equipment the upper portion called the source is mounted (loaded) manually onto the lower portion. Because the source is heavy (about 80 pounds) it required two male employees to perform the loading, which at times resulted in damage to the equipment. The source loading is depicted in Figure 9. This production is conducted in a clean room environment. The students initially considered employing a robot; however, because of the confined space and the clean room environment, this concept was abandoned. Utilizing an existing overhead crane, the students designed a simple hook device which holds on to the handles on the source. The hook device is shown in Figure 10. This solution eliminated damage during assembly of the source, and also eliminated the requirement that the loading operation be conducted only by male employees.

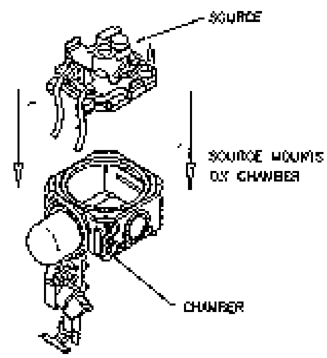

Figure 9. Source Loading in Electronics Chip Production Equipment.

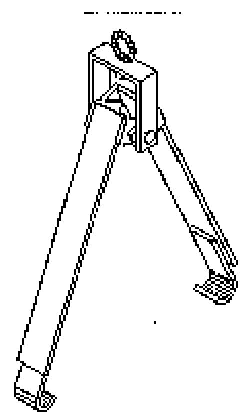

Figure 10. Source Loading Hook Device.

Maintenance Plant Layout - This sponsor required a new maintenance area in the plant due to expansion to meet production schedules. The current inadequate maintenance area had to be relocated to make room for new production equipment. The students surveyed the overall plant needs for maintenance, and designed a new maintenance area layout to accommodate the overall anticipated needs. The new layout utilized some existing work area, but also called for an expansion of the plant. The new maintenance area layout is illustrated in Figure 11. The overall cost of this expansion was estimated to be about $0.6 Million.

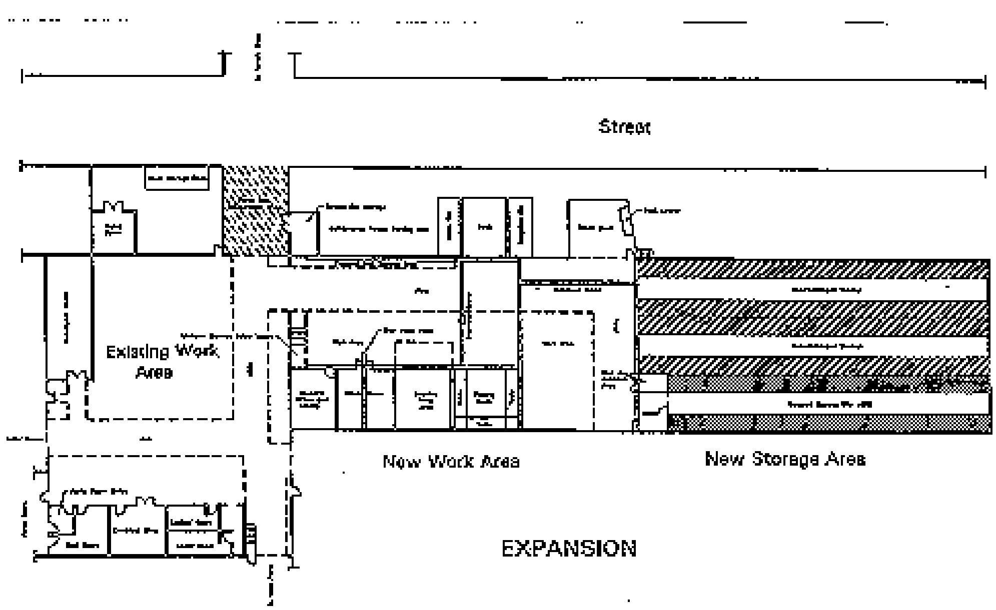

Figure 11. Maintenance Plant Layout.

Gate Valve Plant Layout - This sponsor needed to integrate a high-productivity machining center into their gate valve production facility to meet increased demand. The students reviewed the current plant layout and developed a new plant layout incorporating the new machining center, which features smooth flow line design. The new plant layout is illustrated in Figure 12.

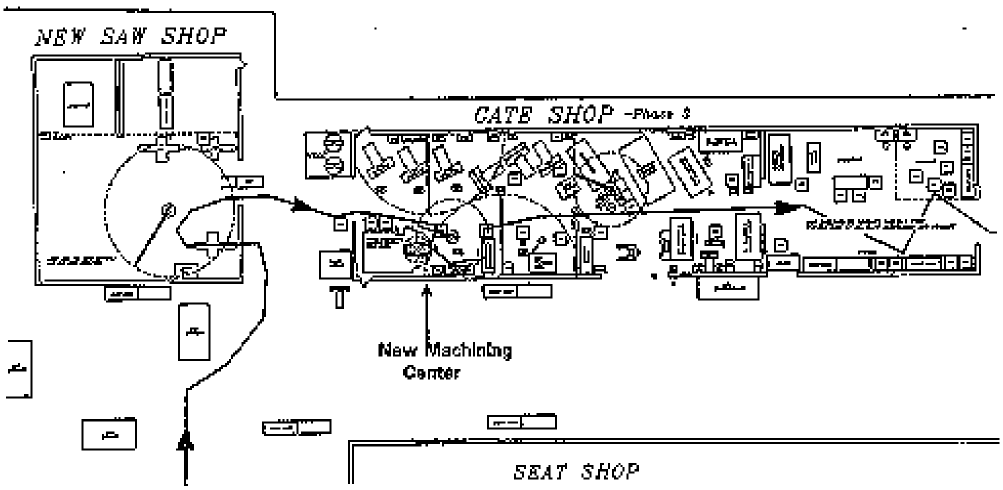

Figure 12. Gate Valve Plant Layout

CONCLUSIONS

This paper presented the methodology which is employed at Texas A&M University in the teaching of the senior capstone course in the manufacturing engineering technology curriculum, and presented some example manufacturing engineering technology projects. The students work on current, real industrial problems with a company sponsor. The students enjoy this course because they are working with a manufacturing company. This course enhances the professional development of the students.

REFERENCES

1. Criteria for Accrediting Programs in Engineering Technology, Technology Accreditation Commission/Accreditation Board for Engineering and Technology, Inc., New York, NY.

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