ME345 A1: Automation and Manufacturing Methods

Fall 2013

Instructor and Class Information

Instructor: Peter A. Zink, pzink@bu.edu, 8-1631
Office, Hours: 730 Commonwealth Ave, EMA 209; Office hours by appointment.
Class Times, Location: Mon 2-4, GCB 203 & Wed 2-4, EMA 215
Course GTF: Eric Cristofalo, emc73@bu.edu
Lab Supervisor: Ryan Lacy, lacyr@bu.edu, 3-4274
ADMS Lab location, Hours: 730 Commonwealth Ave - EMA 215, 8-4 Monday-Thursday & 8-1 Friday
Prerequisites: EK156
Course Website: `http://learn.bu.edu`

Course Description:

An introduction to the major concepts and practices of modern manufacturing, including production system dynamics, process development, and computer-aided design and manufacturing techniques. Topics include numerically controlled machines, robotic control, real-time process control, computer vision, statistical process control, programmable logic control, production system design, and computer simulation. Strong emphasis is given to hands-on laboratory experience, with a lecture component covering fundamental concepts and supporting the laboratory exercises and projects. Includes lab. 4 credits.

Course Objectives

1. Introduce principles, methods, and hardware/software tools used in modern computerized design, automation, and manufacturing of discrete engineered parts.
2. Acquire practical experience in computer-aided design, process development, automation, & manufacturing through a series of laboratory exercises.
3. Understand the main principals & strategies involved in optimizing production system design & operations.
4. Use a team-based approach to design & manufacture a product using the ADMS flexible manufacturing cell.

Textbooks

- **The Goal:*, E. M. Goldratt, North River Press - Required
- *Fundamentals of Modern Manufacturing:*, Groover, 4th or 5th ed. - Required
- *The Machine that Changed the World:*, Womack et al, (any edition) - Suggested

Grading:

1. Lab (pre-lab, lab performance, lab report): [25%]
2. Homework [15%]
3. Quizzes (2) [15%]
4. Final Project [20%]
5. Manufacturing Presentation/Discussion [5%]
6. Final Exam [20%]

Manufacturing Discussions/Presentations:

A pair of students will pick a manufacturing process (specific or general) and identify 30 minutes of on-line video that illustrates the process. The topic should be related to modern manufacturing practices and problems. Each week, the class will watch (at home) two of the videos, and then in class, the students who chose the topic will present/lead a discussion about them, filling in any details that weren't covered in the videos, and connecting the process to the course.
The student pair needs to submit a 1 page outline of the topic by the second week of the course. Please check out the posters around the lab to get a feeling of what we are looking for and see me before hand to discuss your idea.
The objective of this assignment is to broaden your knowledge of state-of-the-art manufacturing practices, as well as to help you improve your presentation skills including answering questions (which are actually a compliment, since it indicates that you have created interest in the audience). You will also be asked to critique another student pair, where you are expected to deliver real criticism, but in a constructive fashion.
Grading: your presentation/discussion will be graded by your peers in terms of a) presentation quality 30

ADMS Labs:

Following is a list of labs indicating the order in which they will be done. The class will be divided into two groups: those labs on the same line will be conducted in parallel (where groups A and B switch the following week). Students are expected to work in teams of two, though each student must hand in a separate pre-lab and lab report reflecting their own work. After each lab, students will be asked oral questions and will be graded on their ability to answer questions related to written lab assignments they have submitted.
Pre-lab Attendance: Since many of the labs involve operating machines, you MUST attend the pre-lab lectures the Wednesday before the lab. Students missing the pre-lab for labs involving safety issues (in BOLD) will not be allowed to perform those labs and will get a zero for that lab. If you know you will miss a pre-lab, please see the lab instructor ahead of time.
Grading for the labs will consist of: pre-lab write up = 20%, lab write up = 60%, post-lab oral = 20%.

Table 1: ADMS Lab Order

Lab#	Title	Lab#	Title
1	Design, Theory, & Application*		
2	Intro to CAD/CAM Mill$^{\psi}$	3	Intro to CAD/CAM Lathe$^{\psi}$
4	Manufacture of Milled/Turned Parts$^{\psi}$		
5	Intro to Robotics*$^{\psi}$	6	Intro to Open CIM*$^{\psi}$
7	Statistical Process Control$^{\psi}$	8	Vision Systems
9	Assembly$^{\psi}$	10	PLC*
11	Simulation		

Notes: Labs with $^{\psi}$ involve safety issues, pre-lab attendance required to attend lab. Labs with * have specific reading assignments to be completed BEFORE the pre-lab session.

Quizzes and Exams:

Exams will be given roughly at the midway point and near end of the semester. Quizzes will be given periodically at the beginning of class. Both will be based on lectures, student presentations/discussions, articles given out in class, and other media

Team-work:

A strong emphasis of the course is in learning team skills. Reading assignments will be handed out in class. You will fill out a Team Skills Sheet before the 3rd class session. Your team must also create a Team Contract (due class session 9), and you will have a preliminary and final Team Evaluation using team assessment forms.

General Class Policies

- Assignments are due *at the beginning of class* on the due date. Late work will be reduced by a factor of 50% of the original possible score per day it is late.
- It is your responsibility to check with the instructor or GTF to make sure that all quizzes and assignments have been recorded correctly, and that you are not missing any points on the grade sheet on blackboard. After two weeks from the time the assignment is returned there will be no change in grades.
- Except in cases of extreme emergency, making up of missed exams/quizzes will be permitted only with approval BEFORE the regularly scheduled date/time.
- Students must follow the BU Academic Conduct Code, which can be found at: `http://www.bu.edu/academics/files/2011/08/AcademicConductCode.pdf`. Any violation of this conduct code will be reported to the College of Engineering Academic Conduct Committee.

Course Project:

One objective of the course project is to design and manufacture a product using the flexible manufacturing system in the ADMS laboratory. A variety of different issues will be addressed in this project including: design of the product and its parts, development of manufacturing strategy and processes, CIM control, scheduling and cost estimation.

Description: Each team will design, manufacture, and race small RC cars. Teams will be required to design two distinct car bodies, optimize a manufacturing plan and manufacture a minimum of 10 car bodies (5 of each design). Students will get to keep their own car, but each team must also provide an additional car must be assembled and left for the lab. The students in your weekly lab period are your team, and when you are done with the week's lab assignment, you should plan to work on your project.
Each team will compete using their own car on a race course to test the maneuverability of their teams design. Students will be graded not only on their manufacturing plan, but also on the performance and design of their teams car.

Each team will be provided the following materials:

- Stock plastic blocks to use for 10 car bodies/chassis
- Drive train for two cars (motor, capacitors, circuitry, etc)
- 1 diameter bar stock for making wheels, and shaft material
- Tire treads and material for shafts.

Notes: The project statement is intentionally open-ended. The goal is to make this project reflect situations that you will encounter in industry. In many cases, you will find that customers are quite vague as to what they want. This is quite likely a different experience than you have had to date in your engineering classes, where homework assignments have followed specific course material. Learning how to fill in the gaps on your own, based on your general engineering background and your own intuition and drive is an important objective of the project.

Teams and Peer-Evaluation: This semester we have approximately 7 teams of 4 members each. To assist in team management, you will evaluate the performance of yourself and your team members twice during the term, and the composite evaluation will be used in determining part of your grade.

Customer Meetings: You will meet at least twice with the potential customer to update them of your plans and progress. Note, the customer is looking not only for a statement of you're intentions, but also wants to be convinced that you can deliver the finished product. As such, they are looking for the details and analysis of issues, trade-offs, and capabilities that will make your proposal convincing. An interim progress report is required (see class schedule). Both the initial and interim meetings should include a PowerPoint presentation for the customer. A final team presentation will be given the last week of class, where each member will report on their work and the team presents the prototypes to the customer. 5 For your first meeting, we are looking for you to outline what you feel are the critical issues, objectives, work plan (both whos addressing which issues and a time-line). Each of the team members should present the outline of issues they will be addressing. We are looking to see that you really understand the complexity of the issues you need to address. Before the meeting, it is suggested you touch base with the course instructor to make sure you are on the right path.

Your team must design the product and manufacturing processes with minimal outside help, i.e. please do not go to any of the machinists fishing for conceptual design solutions. In particular, you should own the process of making your parts and should not have outsiders make them for you. Give yourselves plenty of time to discover and resolve issues. We note that all teams in the past have under-estimated the amount of effort required to develop specific manufacturing processes as well as develop a manufacturing strategy.

Project Grading: 25% of each individuals project grade will come from the assessment by your team members, 25% by your individual performance as evaluated by the course instructors, and 50% based on the teams overall performance. Each team will submit a formal final report as well as make a final presentation. All team members should participate in the presentation, and each team members contribution to the final report should be identified.

Besides implementing the manufacturing system, the team should address the following issues:

1. What design options do you want to present to the customer?
2. What are the critical processing issues? What are the specific process designs for the parts? These are major issues that all previous teams have significantly underestimated how difficult it is to develop.
3. Given the available machines, how do you optimize production capabilities?
4. How can you deal with variations in demand?
5. What is your cost proposal (taking into account different volume levels) that you are willing to quote to the customer? Were looking for a real analysis.
6. How would you redesign the manufacturing cell to achieve lower cost operation?