ME 345: AUTOMATION AND MANUFACTURING METHODS Fall 2011

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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, discrete event system models, and computer simulation. Strong emphasis is given on hands-on laboratory experience, with a lecture component covering fundamental concepts and supporting the laboratory exercises and projects. Includes lab. 4 credits. Prereq: ENG EK156.

Texts:

1. **Computer-Integrated Design & Manufacturing,** Singh

2. *** The Team Learning** Assistant Workbook: Deacon Carr, Herman, Zarotney Keldsen, Miller, Arkinstall Wakefield. Note: special BU rate for on-line version (used books don't provide web access to Team software). See Hmk 1 for registration/purchase details. Need ASAP.

3. *** The Goal** : E. M. Goldratt, North River Press

*** Start Reading immediately**

Objectives:

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

Grading:

1.	Lab (pre-lab and lab performance, lab report)	22%
2.	Final Project	19%
3.	Homework	15%
4.	Quizzes (2)	14%
4.	Final	24%
5.	Manufacturing Presentation	6%

Manufacturing Presentation: Each student will pick a topic and make a 12 minute presentation. The topic should be related to modern manufacturing practices and problems. **The student 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. **Your research should be more then a survey of whats available on the web**.

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's presentation, where you are expected to deliver real criticism, but in a constructive fashion.

Grading: you will be graded by your peers in terms of a) quality of presentation 30%, b) technical quality 40%, and c) depth of presentation 30%. Presentations will begin Friday, October 10. There will typically be two presentations each Friday and one each Monday that we meet for class.

Note, if you want, you can go over a draft of your presentation with me before your presentation to get some feedback.

MN345 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, and in some cases, three, although 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 Friday before the lab. Students missing the pre-lab for labs involving safety issues (in **BOLD**) will **not** be able to perform those labs without permission from the lab supervisor.

Grading for the labs will consist of: pre-lab write up = 20%, lab write up = 60%, post-lab oral = 20% (given when the lab report is handed in).

GROUP A	GROUP B
Lab 1: Design: Theory, and Application *	
LAB 2: Intro to CAD/CAM Milling	**LAB 3: Intro to CAD/CAM Lathe**
LAB 4: Manufacturing of Milled/Turned Parts	
LAB 5: Introduction to Robotics*	**LAB 6: Introduction to OpenCIM***
LAB 7: Statistical Process Control	Lab 8: Vision
LAB 9: Assembly	Lab 10: PLC*
Lab 11: Simulation	

Labs in **BOLD** involve safety issues, pre-lab attendance required. Labs with * have read assignments to be completed BEFORE the prelab session.

Team-work: A strong emphasis of the course is in learning team skills. Reading assignments in the TLA handbook are shown on the course-outline. **You should fill out the Team skills sheet (p 13) for the 3rd session.** Your team must also create a team contract (due session 9), and you will have a team evaluation and final evaluation using the team software.

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Course Outline Fall 2011

CLASS	DATE	DAY	TOPIC	READING*	NOTES
1	9-Sep	Fr	Course Introduction and **Pre-Lab 1: Design**	Chp. 1, 2.1	Pre-Lab & Video
2	12-Sep	Mo	Intro and Product Development, Cost Analysis 1	TLA Step1 Team Articles	.
3	16-Sep	Fr	**Pre-Lab 2/3: Mill/Lathe** Teamwork Exercise	Chap 5.1, 5.3	Due: ADMS/video questions
4	19-Sep	Mo	**Pre-Lab 2/3: Mill/Lathe** - How to make a presentation	Chap 13.1-13.5	Fill out TLA p 13. **Due:** Homework 1 (Team Exercise and design)
5	23-Sep	Fr	Machining		Manufacturing Presentation Outline,
6	26-Sep	Mo	Manufacturing Systems Analy. The GOAL: Class Discussion	Chap 6	**Due:** Homework 2 (The GOAL)
7	30-Sep	Fri	**Pre-Lab 4: CAM**		
8	3-Oct	Mo	SPC	Chap 8.1-8.4 TLA Step2	-**Team (Contract Due)** Schedule Project Meeting 1**: Project Outline
9	7-Oct	Fr	**Pre-Lab 5/6: Robotics /OpenCIM**		**Due:** Homework 3 (Machining)
	10-Oct	Mo	NO CLASS – Columbus Day		
10	14-Oct	Fr	**Pre-Lab 5/6: Robotics /OpenCIM Vision lect.**	Chap 2.6 TLA Step3	Manufacturing Presentations Begin
11	17-Oct	Mo	Cell Phone Mfg Contest. Cost Analysis II & Prod. dynamics	Handout	**Due:** Homework 4 (SPC)
12	21-Oct	Fr	**Pre-Lab 7/8: SPC/Vision**		
13	24-Oct	Mo	Production System Dynamics -	Handout Chap 11	**Due:** Homework 5 (Cell Phone Questions)
14	28-Oct	Fr	**Pre-Lab 7/8: SPC/Vision**		Team Evaluation 1
15	31-Oct	Mo	Quiz1: Prod Analy/Goal/SPC / Beer Game	Chap 6.8	
16	4-Nov	Fr	**Pre-Lab 9/10: Assembly/PLC**		
17	7-Nov	Mo	Toyota Production System / PLC	Handout TLA Step4	**Due:** Hwk 6 (Beer Game)
18	11-Nov	Fr	**Pre-Lab 9/10: Assembly/PLC**		
19	14-Nov	Mo	Control and Robotics I		
20	18-Nov	Fr	**Pre-Lab 11: Simulation**	Chp 13.10	
21	21-Nov	Mo	Control II		Schedule Project Meeting 2**: Project Update, Eval due
	23-Nov	Wed	NO CLASS – Thanksgiving Break		
22	28-Nov	Mo			
23	2-Dec	Fr			**Due:** Homework 7 (Control)
24	5-Dec	Mo	Quiz2: control, Control III		
25	9-Dec	Fr	Project Presentations		
26	12-Dec	Mo	Summary	TLA Step5	**Final Team Evaluation**
			Final Exam Tues 12/20		

- All readings from *Computer-Integrated Design & Mfg by Singh*, unless otherwise noted
- ** Students are responsible for scheduling project meetings with Prof. Gevelber and Gerry Sheppard

Course Project: The objective of the course project is to design, develop the manufacturing process, and manufacture a product selected for the semester using 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, machining process development, CIM control, scheduling and cost estimation.

Project Statement: 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 and controller, but each team must also provide an additional car must be assembled and left for the lab.

Each team member will compete using their own car on a race course to test the maneuverability of their team's design. Students will be graded not only on their manufacturing plan, but also on the performance and design of their team's cars (looks count).

Each team will be provided the following materials:

- Ten (10) 3"x1.5"x1.25" blocks of PE to use for bodies
- Drivetrain of car (motor, capacitors, circuitry, etc)
- 1" diameter bar stock for making wheels, and shaft material
- Tire treads (but you must make the wheels), and material for shafts.
- Mounting plate for steering mechanism

Comment: 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, and if it's really a new product for a company, there might be very little information on hand to guide the development effort. 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 wits and drive is an important objective of the project.

Additional Details:

To assist in team management, we will utilize the team tools from the Center for Team Learning at the School of Management. In particular, 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.

You will meet with the potential customer to update them of your plans and progress. Note, the customer is looking not only for a statement of what your going to do, but also wants to be convinced that you can deliver the goods. As such, they are looking for the details and analysis of issues, trade-offs, and capabilities that will make them believe your proposal. An interim progress report is also required (see class schedule). Both the initial and interim meetings should be made using a power point presentation that is left with 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.

For your first meeting, we are looking for you to outline what you feel are the critical issues, objectives, work plan (both who's addressing which issues and 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 instructors to make sure you are on the right path.

Your team must design the product and manufacturing processes with minimal outside help, i.e. don't go to Bob Sjostrom or Gerry Sheppard fishing for solutions. In particular, you own making your parts and should not have outsiders make them for you. In addition, your team must anticipate and deal with problems that will undoubtedly arise over the course of the project. Since you probably have not dealt with many of the complexities of this project, you should give yourselves plenty of time to discover and resolve issues.

Project Grading:

25% of each individual's 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 team's 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 member's contribution to the final report should be identified.

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

a) What design options do you want to present to the customer?

b) 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.

c) Given the available machines, how do you optimize production capabilities?

d) How can you deal with variations in demand?

e) What is your cost proposal (taking into account different volume levels) that you are willing to quote to the customer? We're looking for a real analysis.

f) How would you redesign your cell to achieve lower cost operation?

A few observations for this terms project:

This terms project is quite challenging, in that there are a lot of design issues that should be addressed. Besides the physical design, be sure and address the design for assembly (DFA) and design for manufacture (DFM) issues.

An important technique to make sure that you are aware of the real issues is to prototype your design. Besides providing a physical part to discuss options with your customer, it will allow your design and manufacturing team to explore the critical production 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.

- All teams must complete a team contract. Critical issues include how much effort you expect each member to contribute (hrs/wk), as well as how the team might handle those members that don't meet their commitments.

- How much time does the whole team want to devote to the project, and when do you need to start? How do you keep the pace of the project up to avoid all nighters at the end of the course?

- All teams should ID two critical actors: **team leader**-someone who has a view of the big picture, and calls attention to the team when new priorities or direction needs to be established. **Team organizer**-someone who keeps a record of what has been decided, organizes meetings, keeps tabs on who's doing what.

- How do you manage an open ended problem in terms of time commitment, especially when you haven't done anything like it before?

- Might consider getting something "in the bag" (ie something simple), before you try to build a Lamborghini. Helps discover where the problems are.

- I'm more interested in substance rather then filler, especially in terms of cost analysis, production analysis, and presentations.

- Everyone should participate in presentations, and it should be clear what your contribution to the project was.