

The University of Michigan
Department of Mechanical Engineering

ME483/MFG502 Manufacturing System Design

COURSE CONTENT

Winter 2009

Course Description:

An introduction to the procedures and methodologies for designing manufacturing systems. Topics covered include: paradigms of manufacturing; building blocks of manufacturing systems; numerical control and robotics; task allocation and line balancing; system configurations; performance of manufacturing systems including quality, productivity and responsiveness; economic models and optimization of manufacturing systems; launch and reconfiguration of manufacturing systems; Lean manufacturing.

1. Introduction (3 hours)

- a. Importance of manufacturing
- b. Types of industry
- c. Manufacturing System performance
 - i. Cost (fixed cost, variable cost)
 - ii. Productivity (system efficiency, system availability)
 - iii. Quality
 - iv. Responsiveness
 - v. Safety
- d. Paradigms of manufacturing
 - i. Craft
 - ii. Mass production
 - iii. Lean
 - iv. Flexible
 - v. Mass customization
 - vi. Reconfigurable Manufacturing
- e. Exercises

2. Building Blocks of Manufacturing Systems (3 hours)

- a. Types of manufacturing processes.
 - i. Machining
 - ii. Assembly
 - iii. Welding and Joining
 - iv. Forming
 - v. Special processes: EDM, ECM, etc.
- b. Components of Manufacturing Systems
 - i. Processing Machines (workstations)
 - ii. Material Handling

- iii. Fixtures
- iv. Pallets
- v. Buffers
- vi. controls
- vii. Measurement and inspection
- c. Examples manufacturing systems
 - i. Engine block machining
 - ii. Automobile body assembly
 - iii. Stamping
 - iv. Aircraft final assembly
 - v. Computer assembly
 - vi. Painting processes

3. Computer Numerical Control (1.5 hours)

- a. CNC system architecture
- b. G-Code
- c. Controllers
- d. Interpolators
- e. Exercises

4. Robotics (1.5 hours)

- a. Types of robotics
- b. Robot motion
- c. Robot applications
 - i. Welding
 - ii. Painting
 - iii. Material handling
 - iv. Fixturing
- d. Exercises

5. Procedure in manufacturing system design (4.5 hours)

- a. From machines to systems
 - i. Station level design issues: fixturing
 - ii. Layout vs. volume and variety
 - iii. Configurations: Serial, Parallel, and Hybrid
- b. Product to process planning
- c. Exercises
- d. Task allocation and sequencing
- e. Line balancing
- f. Exercises

6. System Productivity (3 hours)

- a. Machine level performance
 - i. Component failures
 - ii. Failure Mode Effect Analysis
 - iii. Reliability Analysis

- b. Reliability vs productivity
- c. Productivity analysis
 - i. Productivity of serial and parallel configurations
 - ii. Productivity of general mfg systems
 - iii. Role of buffers
 - iv. Bottleneck analysis and theory of constraints
- d. Impact of Material Handling systems on productivity
- e. Exercises

7. Quality of manufacturing systems (3 hours)

- a. Sources of variability
- b. Propagation of quality variation in Mfg Systems
 - i. Descriptive statistics
 - ii. Addition of Variance
- c. Impact of Configuration on Quality
- d. Process stability
- e. Tolerance and Process Capability
 - i. Cp, Cpk, Cpm
- f. Exercises

8. Responsiveness (1.5 hours)

- a. Just in-time
- b. Convertibility
 - i. Quick die change
- c. Scalability

9. Cost of manufacturing system (3 hours)

- a. Cost of manufacturing systems
 - i. Investment cost
 - ii. Operations cost
- b. Life cycle economics
- c. Exercises

10. System Selection (1.5 hours)

- a. Criteria
- b. Trade-off analysis
- c. Analytic Hierarchy Process

11. Manufacturing System Launch (3 hours)

- a. Ramp-up issues
- b. Variation Reduction
 - i. Assembly example
 - ii. Machining example

12. Reconfiguration of Manufacturing System (3 hours)

- a. Needs for system reconfiguration

- b. Principles of Reconfiguration
- c. Examples of Reconfiguration
 - i. Machines
 - ii. Cells
 - iii. Systems

13. Lean Manufacturing (6 hours)

- a. Toyota production system
 - i. JIT, Pull, Flow
- b. Lean cell design as example of manufacturing system design

TEXTBOOK: Course Notes.

COURSE GRADE:

On-campus students:

Homework – 20%
Class Participation – 5%
Term Project – 15%
Exam 1 – 30%
Exam 2 – 30%

Off-campus students:

Homework – 20%
Term Project – 20%
Exam 1 – 30%
Exam 2 – 30%

LECTURES: M, W 8:30 – 10:00 a.m.

INSTRUCTOR: Prof. Kannatey-Asibu, Jr. (asibu@umich.edu)

Office Hours: M 4:00 – 5:30 p.m.
W 1:30 - 3:00 p.m.
Or by appointment

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Office Hours: TBA or by appointment

All reading assignment must be completed ahead of time.

No make-up exams