Plan for the following lectures

- Lecture 1: Course outline and project
- Lecture 2: Product, process and schedule design I.
- Lecture 3: Product, process and schedule design II.
- Lecture 4: Product, process and schedule design III.
- Lecture 5: Flow, space and activity relationships I.

**Project proposals! → September 20**

- Lecture 6: **Quiz #1 → September 26**
Plan of the lecture

- Introduction (Chapter 1)
  - Facilities planning defined
  - Objectives of facilities planning
  - Continuous facilities planning
  - Significance of facilities planning

- Product, process and schedule design (Chapter 2)
Facilities planning defined

- Facilities planning determines how an activity’s tangible assets best support the activity's objective.

- Facilities planning:
  - Facilities location
  - Facilities design
    - Facilities systems design
    - Layout design
    - Handling systems design

- Facilities planning combines the efforts to determine location of a facility and design of it
Facilities location

• The placement of the facility

• Factors:
  ◦ Closeness (to the market, to the raw materials, to the suppliers, to other facilities, to the competitors)
  ◦ Geographical area (zoning, transportation access, labor, demographics, climate, environmental considerations)

• Fixed and recurring costs
Facilities design

- Facility systems design
- Layout design
- Handling system design
Facility systems design

- Structural systems, enclosure systems, atmospheric systems, electrical and lighting systems, communication system, life safety systems, sanitation system, etc.
- What systems are required
- Where they are required
- Integrating the systems into the overall facility
Layout design

- Layout for production areas and production-related and support areas
- Consists of all equipment, machinery and furnishing within the building envelope
- Determination of:
  - Block layout - relative locations and sizes of the planning departments
  - Detailed layout - exact location of all equipment and storage areas
Handling system design

- The mechanisms needed to satisfy the required facility interactions
- It consists of materials, personnel, information and equipment-handling systems required to support production
- Receiving, storing, retrieval, transporting, packaging and shipping, postal system, personnel transit system
• Which comes first, the material handling system or the facility layout?

BOTH!

• The layout and the handling system should be designed simultaneously
Objectives of Facilities Planning

- Improve customer satisfaction
- Maximize speed
- Reduce costs
- Integrate the supply chain
- Support the organization’s vision
- Effectively utilize resources
- Maximize return on investment (ROI)
- Maximize return on assets (ROA)
- Be easy to adapt and to maintain
- Provide safety for employees
Objectives of Facilities Planning

- Four main issues when designing a facility:
  - Customers
  - Internal efficiency
  - Work environment
  - Integration into the supply chain
Objectives of Facilities Planning

To Satisfy the Customers

- Technology
- Government
- Suppliers and Vendors
- Environment

Optimize the relationships within the organization

Optimize the relationships with the outside factors
Main features of facilities

- **Flexibility**
  - Flexible facilities are able to handle a variety of requirements without being altered

- **Modularity**
  - Modular facilities include systems that cooperate efficiently over a wide range of operating rates

- **Upgradeability**
  - Upgraded facilities easily incorporate advances in equipment systems and technology

- **Adaptability**
  - Considering the
    - Calendar
    - Cycles
    - Peaks

- **Selective operability**
  - Understanding how each facility segment operates
  - Allows contingency plans to be put in place
Facilities planning as continuous activity

- Constant reevaluation and replanning of facilities, and continuous improvement
- Why replanning facilities?
  - Economic considerations
  - Employee health and safety
  - Energy conservation
  - Community considerations
  - Disabilities considerations
  - Fire protection
  - Pilferage
Significance of facilities planning

- Facilities planning is one of the core areas in industrial engineering field
- Can learning facilities planning contribute to the economy?
  - In 1999, $320.8 billion was spent on structures in the US
  - 93% for new structures
  - In average 8% of GNP is spent for new facilities each year (US)

<table>
<thead>
<tr>
<th>Industry</th>
<th>GNP Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>3.2</td>
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<tr>
<td>Mining</td>
<td>0.2</td>
</tr>
<tr>
<td>Railroad</td>
<td>0.2</td>
</tr>
<tr>
<td>Air and other transportation</td>
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<tr>
<td>Public utilities</td>
<td>1.6</td>
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<tr>
<td>Communication</td>
<td>1.0</td>
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<tr>
<td>Commercial and other</td>
<td>1.5</td>
</tr>
<tr>
<td>All industries</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Source: U.S. Bureau of Census.
Significance of facilities planning

- The size of the investment in new facilities each year makes the field important
- **Adequate facilities planning is not being performed**
  - Existing facilities cannot adapt to changes easier
  - 20% to 50% of operating expenses are material handling cost
    - Facilities planning can reduce these costs by at least 10-30%.
    - If effective facilities planning were applied the annual manufacturing productivity in the US would increase 3 times!
- **There exists a significant opportunity for improvement of facilities planning process!**
Product, process and schedule design I.

- Chapter 2 of the textbook
  - Product design
  - Process design
  - Schedule design
Before we start developing alternative facility plans, we should have answers for the following questions:

1. **What** is to be produced?
2. **How** are the products to be produced?
3. **When** are the products to be produced?
4. **How much** of each product will be produced?
5. **For how long** will the product be produced?
6. **Where** will the products be produced?

Answer for the first 5 questions can be obtained from:
- Product design
- Process design
- Schedule design

Answer for the last question might be searched outside of the company - **global sourcing effect**
Answers to these questions will help develop the first part of your term projects!

- Market analysis
- Product design
- Suppliers and vendors selection
- Equipment and personnel requirements
- Location selection
- Plant layouts designs (using CAD) and selection of the best
- Materials handling
- Life cycle analysis of both product and facility
Product, process and schedule design

- **Product design:**
  - Product designers determine:
    - Product specifications (dimensions, material, packaging, etc.)

- **Process design:**
  - Process designers determine:
    - How the product will be produced

- **Schedule design:**
  - Production planners determine:
    - Production quantities
    - The schedules for the equipment

**WHERE DOES THE FACILITY PLANNER COME IN?**
- **Facility planner** is dependent on timely and accurate input from product, process and schedule designers.
- The need for close coordination among the four groups.
Product Design

- Determination of a product to be produced
- Detailed design of the product

Product Design – Product Determination

- Based on input from:
  - Marketing
  - Manufacturing
  - Finance
  - Etc.

- Most of the time final decisions are made by the top management
Product Design – Product Determination

• Uncertainty regarding the mission of the facility

• The occupants of the facility may change frequently or may never change at all
  ◦ If changes are likely – a high degree of flexibility and a very general space
  ◦ If a high degree of confidence about the products – the facility design should optimize the production of those products
Product Design – Detailed Design

- The detailed design of the product is influenced by aesthetics, function, materials and manufacturing considerations

- *Quality Function Deployment* - translation of the customers’ desires into product design, and subsequently into parts characteristics, process plans and production requirements.

- *Benchmarking* – used to identify the approach of the competition
Finally, detailed designs take place (CAD designs, prototypes, assembly designs, 2D drawings and dimension determinations)

**Concurrent Engineering** is a systematic way of enabling communication between all the related units during the product development

- The aim is to minimize the changes in design parameters once the design is finalized
- 70% of the manufacturing cost is set during the design phase
- Changing the design later in the process costs significantly more
Design phase determines the most of the costs associated with delivering a product. Typically, 70-80% of the cost of a product is fixed at the design stage.
Sequential development method

- Requirements
- Design
- Implementation
- Verification
- Maintenance

Concurrent development method

- Requirements
- Analysis & Design
- Implementation
- Deployment
- Initial Planning
- Evaluation
- Testing
Once the product design is completed, usually following documents are provided for the facilities planning process as inputs:

- *Exploded assembly drawing* – omits specifications and dimensions
- *Exploded parts photographs*
- *Component part drawing* - detailed
Figure 2.2   Exploded assembly drawing.
Figure 2.3 Exploded parts photograph.
Figure 2.4 Component part drawing of a plunger.

Note: 3" at end of stock is allowed for machine holding of stock.

Crosshatching shows portion of stock allowed for cutting.

Material
Aluminum bar stock
1.25" dia. = 12' length
Figure 2.5  Component part drawing of a seat.
Next lecture

- Process design
- Schedule design