CHAPTER 1
Fundamental Principles of Facilities Planning and Design

- Definitions
- Significance
- Objectives
- Scientific Method
- Types of Math Models in Facilities Planning
- Facilities Planning Process
- Manufacturing Concepts
- Types of Factory Layouts
- Break-Even Point Analysis
- Manufacturing Processes
Definitions

Facility
Something created to serve a particular function

Location
Placement of a facility in such a way that it will satisfy specified requirements concerning customers, suppliers, and other facilities with which it interacts

Components
1. Structure (building and services)
2. Layout (equipment, machinery, furnishings)
3. Handling system (mechanism for interactions in the layout)

Facility Planning
• Facilities location (where?)
• Facilities design (what & how?)

Facilities Design
• Structural design
• Layout design
• Handling system design

Layout Design
1. Facility layout
2. Plant layout (emphasis on factory layout)
**Plant Layout** embraces the physical arrangement of industrial facilities. This arrangement (ether installed or planned) includes the *space* needed for:

1. Operating equipment and personnel
2. Material movement
3. Storage
4. Indirect laborers
5. Supporting activities or services

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**Significance of Facilities Planning**

**Table 1.1**

<table>
<thead>
<tr>
<th>Industry</th>
<th>Percentage GNP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>3.2</td>
</tr>
<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>
<td>0.3</td>
</tr>
<tr>
<td>Public utilities</td>
<td>1.6</td>
</tr>
<tr>
<td>Communications</td>
<td>1.0</td>
</tr>
<tr>
<td>Commercial and other</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>All industry (total)</strong></td>
<td><strong>8.0</strong></td>
</tr>
</tbody>
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Objectives of Facilities Planning

- Objectives of Facilities Location
- Objectives of Facilities Design

Objectives of Facilities Location
Minimize components of deliver-to-customer costs that depend on location

Objectives of Facilities Design
- Flexibility
- Capital Minimization
- Material Handling
- Integration
- Safety & Workers Satisfaction
OPERATIONS RESEARCH APPROACH
FUNDAMENTAL STEPS

• Problem Definition
• System Identification
• Model Formulation
• Solution Procedure
• Solution Validation
• Implementation

TYPES OF MATH MODELS IN F.P.

• Location & Allocation
• Warehouse layout
• Conveyor
• Storage
Engineering Design

- Define problem
- Analyze
- Generate alternatives
- Evaluate
- Select plan
- Implement
Facilities Planning Process

- Define objectives
- Identify primary & support activities
- Determine interaction between activities
- Determine space requirements
- Generate alternative facilities plans
- Evaluate alternatives
- Select plan
- Implement
- Maintain & adapt
- Redefine objectives of the facility

Manufacturing Systems Concepts

- Product Design
- Process Planning
- Production Operations
- **Material Handling**
- **Facilities Layout**
- Production Planning & Control
1. The fixed-position layout is a layout where the material or major component remains in a fixed place to which tools, machinery, men and other pieces of material are brought.

2. The product layout (or production line) places one operation immediately adjacent to the next; the equipment needed is arranged according to the operational sequence.

3. In the process layout all operations of same process or type are grouped together; equipment performing a common function is grouped together.

4. The cellular layout is based on the grouping of parts to form families based on common machining requirements (and other aspects, such as shapes, material composition, tooling requirements, etc.).
**Fixed-Position**: material or major component remains in a fixed location

**Product (production line)**: low number of part types and high production volume

**Process (job-shop)**: high number of part types and low production volume

**Cellular (group technology)**: medium number of part types and medium production volume

See Figures 1.10-1.13, textbook, pp. 18-20
Layout by Process

Raw Material

Completed Part

Layout by Product

Raw Material

Completed Part
Group Technology

Cell 1

Cell 2

Cell 3

Break-Even Point Analysis

Total Cost $ vs. Production Volume

Revenue vs. Production Volume

Product Layout

Process Layout
As an illustration, let $1,800,000 and $1,200,000 be the fixed cost for the production and process layouts, respectively. Similarly, let $220 and $300 be the variable costs for the two layouts, respectively. Assume that the selling price per unit is equal to $380.

(a) Find the level of production at which the two layouts are identical from a cost point of view.

\[(F + vQ)_{\text{product}} = (F + vQ)_{\text{process}}\]

\[Q = \frac{600,000}{80} = 7,500\]

(b) For each layout find the level of production at which the production of the item starts being profitable.

\[Q_{\text{product}} = \frac{1,800,000}{(380-220)} = 11,250\]

\[Q_{\text{process}} = \frac{1,200,000}{(380-300)} = 15,000\]

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**Manufacturing Processes**

- Processes for changing the shape of material
- Processes for machining parts to a fixed dimension
- Processes for obtaining a surface finish
- Processes for changing physical properties
- Plastic processing