Facilities Planning

- Facilities Planning
  - Facilities Location
    - Location wrt customers, suppliers, and other facilities
  - Facilities Design
  - Structural Design
    - Building and Services
  - Layout Design
    - Equipment, machinery, and furnishings
    - Planning & design of production, support, and personnel areas
  - Handling System Design
    - Materials, personnel, equipment, and information handling systems
    - Mechanism by which all interactions required by the layout are satisfied

Facility Layout

- Developing a facilities layout is a critical step in the facilities planning process.
- Facilities Planner must be CREATIVE and COMPREHENSIVE in generating layout alternatives.
Facility Layout

- Which comes FIRST, the material handling system or the facilities layout?
- Layout is effected by:
  - Centralized vs. Decentralized Storage of WIP, Tooling, & Supplies
  - Fixed Path vs. Variable Path Handling
  - Unit Load Size
  - Degree of Automation
  - Type and Level of Inventory and Control of Materials

What if centralized WIP storage?
Facility Layout

Handling less is BEST -- Number of times material is handled
   Not necessarily the handling distance

Layout or MHS First? -- BOTH
   Sequential approach that considers a number of alternative
   handling systems and the corresponding layout alternatives.

- Layout Types
  - Product layout
  - Group layout
  - Fixed layout
  - Process layout
Layout Applications

- Layout of Specific Functions
  - Manufacturing
  - Receiving and Shipping
  - Storage and Warehousing
  - Office Planning
    » Personnel requirements
    » Make use of traditional layout approaches
    » Often an emotional issue
  - Facility Services
    » Specification of what services are required where
    » Integration of the facility services into the overall facility plan
- Nonmanufacturing Applications
  » Can adapt traditional techniques to these applications and apply a systematic approach

Manufacturing

- Facilities Planning for manufacturing should be a major part of corporate strategic planning.

- Emphasis on improved quality, decreased inventories, and increased productivity encourages the design of manufacturing facilities that are integrated, flexible, and controlled.
Manufacturing

- Layout and Handling System affected by
  - Product mix and design
  - Processing and materials technology
  - Handling, storage, and control technology
  - Production volumes, schedules, and routings
  - Management philosophies

<table>
<thead>
<tr>
<th>Classification</th>
<th>Requirements</th>
<th>Layout Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Shop</td>
<td>Low Volume / High Variety</td>
<td>Process or group</td>
</tr>
<tr>
<td>Mass Production</td>
<td>High Volume / Low Variety</td>
<td>Product</td>
</tr>
<tr>
<td>Batch Production</td>
<td>Med. Volume / Med. Variety</td>
<td>Any layout type</td>
</tr>
</tbody>
</table>

Manufacturing Systems

- Transfer Lines
  - Series material flow from one workstation to the next
    » Production rate governed by slowest operation
    » High volume applications
    » High level of automation
    » Inventory buffers can be used between workstations to compensate for some variations between workstations
  - Facilities planning for transfer lines is relatively simple
    » Processing equipment is arranged according to processing sequence
    » Typically, straight line or rectangular flow paths are used
Manufacturing Systems

- **Flexible Manufacturing Systems**
  - Network of workstations
  - Accommodates various processing sequences
  - Flexibility achieved by material handling system and general purpose machines
  - Designed for small batch (low to medium volume) and high variety
  - Justified on economies of scope

- **Components**
  - Processing equipment
  - Material handling equipment
  - Computer control equipment

Flexible Manufacturing System

- Design requirements for an FMS material handling system:
  - Random, independent movement of palletized workparts between workstations. (AGVs, cart-on-track system)
  - Temporary storage of workparts.
  - Convenient access for loading and unloading.
  - Compatible with computer control.
  - Provision for future expansion.
  - Adherence to all applicable industrial codes.
  - Access to machine tools.
  - Operation in shop environment.
Flexible Manufacturing System

- Designed for responsiveness to change; therefore, the FMS and the material handling system must be able to adapt to changes in
  - processing technology
  - processing sequences
  - production volumes
  - product sizes
  - product mixes

Modular Manufacturing System

- Integration of independent production units and modular material handling system.
- Designing modular, expandable systems is very challenging.
- Modular manufacturing system is characterized by
  - Standardized handling and storage components
  - Independent production units
  - Flexible material delivery system
  - Centralized work-in-process storage
  - High degree of control
Modular Design Concepts

- Facility Relayouts can be caused by:
  - Changes in the design of an existing product or in the product set to be produced.
  - Changes in the production sequences or in the processing equipment.
  - Changes in the production quantities and schedules, which prompt capacity changes.
  - Changes in organizational structure or management philosophy.

- Changes in requirements for space, equipment, and people.

Modular Design Concepts

- Flexibility achieved by:
  - Modular office equipment
  - Modular workstations
  - Modular material handling equipment
  - General purpose production equipment
  - Expandability of the total system design
Modular Facilities

- Use of an interconnecting spine for material transport and movement of people.
- Standard size modules to allow functions to be interchanged if relationships change.
- Expand by extending the spine and adding modules -- creates minimal disruption to the existing facility.
- Alternative spine configurations: straight line, "T", or "X".

Modular Material Handling

- Plan flexible, standardized systems for handling, storing, and controlling material within the facility.
  - Build in flexibility.
  - Standardize methods: unit loads, equipment, etc.
  - Integrate into a system as opposed to separate pieces serving only part of the facility.
Handling and Storing Work-In-Process

- Issues
  - Centralized versus decentralized storage
  - Shop floor control and material tracking
  - Reduced WIP inventory levels
  - Controlled material movement to production areas
  - Reduced damage due to handling and storage
  - Automatic encoding of production data
  - "Just-in-time" production
  - Increasing levels of automation: CAE, CAD, CAM, MRP, RTIC, CAPP
  - Rapid tool changing for minimizing setups and reducing lot sizes

Handling and Storing WIP

- In-process handling includes movement of material, tooling, and supplies to and from production units, as well as handling at the workstation.

- In-process storage includes the storage of material, tooling, and supplies needed to support production. Typically, applies to material in a semifinished state of production.
Handling and Storing WIP

- Rules of Thumb
  - Handling less is best
  - Maintain physical control of materials
  - Eliminate, combine, and simplify
  - Moving and/or storing material incurs costs.
  - Pre-position material

- Design requirements for WIP handling system
  - Establish control requirements
  - Determine process flow methods
  - Establish inventory points and levels
  - Consider workplace layout
  - Determine load increment and container design
  - Evaluate WIP storage methods
  - Determine distribution method
  - Design control system

Handling and Storing WIP

- Processing time versus WIP time

<table>
<thead>
<tr>
<th>Time on Machine</th>
<th>Moving and Waiting</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>95%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In cut less than 30%</th>
<th>Positioning, loading, gauging, idle, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>70%</td>
<td>30%</td>
</tr>
</tbody>
</table>
Handling and Storing WIP

- Poor planning of WIP storage and control may result in these problems:
  - Materials are frequently lost
  - Materials are cannibalized from a different order
  - Large inventory discrepancies exist and are only discovered at audits
  - High material obsolescence costs
  - Crowded, unorganized conditions on manufacturing floor
  - Missed production schedules are the rule rather than the exception

Handling and Storing WIP

- Modular manufacturing and material handling techniques can aid WIP handling and storage.

**Conventional Approach**

- Neither case is modular -- if processing sequence changes, the facility layout must change
Centralized WIP Storage

- Provides the opportunity to use automated storage and retrieval
- Provides a controlled storage environment
- Can aid in creating modular systems

Material Control

- Types of control
  - Inventory control
  - Shop floor control
  - Quality control
  - Location control
  - Loss control
  - Position control
  - Fiscal control

- Material Tracking / Data Transmission
  - From the material/equipment interface
  - From the material itself
    » Bar Code
    » Optical Character Recognition
    » Magnetic Stripe
    » Smart Tag
    » ROM or PROM
Conclusion

- Depending on volume, variety, and value of products to be processed, different levels of automation, types of layouts, and material handling systems will be appropriate.