Tech 45: Unit 3

Green and Sustainable Manufacturing Facilities Design and Analysis: Workstation and Material Handling Equipment
Chapter 7

Ergonomics and Workstation Design Space Requirements
Workstation Design

- Safety and health considerations are now an integral part of workstation design
- The discipline of ergonomics is also referred to as human factors or human engineering
- Ergonomics is the science of preventing musculoskeletal injuries in the workplace
Workstation Design

- Ergonomic injuries are often described by the term "musculoskeletal disorders" or "MSDs"
- This term refers to a group of injuries and illnesses that affect the musculoskeletal system
- Ergonomic considerations include employee size, strength, reach, vision, cardiovascular capacities, cognition, survivability, and musculoskeletal injuries
Workstation Design

• The goal is to design the work or workstation so that the task fits the person rather than forcing the human body or psyche to fit the job

• Refer to Specific Allowances for Tech 045 project handouts for information on ergonomic considerations

• The height of the workbench and angle of the elbows and wrists must be considered to avoid carpal tunnel syndrome problem
Review of OSHA And NIOSH

• https://www.osha.gov/

• https://www.cdc.gov/niosh/

• http://www.sjsu.edu/people/samuel.obi/
Workstation Design

• A workstation design is normally a top view of the workstation, including the equipment, materials, and operator space.
• A workstation design must include the following information:

  ✓ Worktable, machines, and facilities
  ✓ Incoming materials including quantity and packaging
  ✓ Outgoing material or finished product
  ✓ Operator’s space and access to equipment
  ✓ Location of waste and rejects
  ✓ Fixture and tools
  ✓ Scale of drawing
Ergonomics & Principles of Motion Economy

Principle 1
Hand motions (should be eliminated as much as possible, combine motions to eliminate others, make motions as short as possible, reduce force, keep both hands equally busy, use mirror image moves, do not use hand as a holding device, locate frequently used tools and materials closer to the point of use)
Ergonomics & Principles of Motion Economy

**Principle 2**
Basic motion types (encourage ballistic motions; eliminate controlled motions)

**Principle 3**
Location of parts and tools (have a fixed place for all parts and tools and have everything as close to the point of use as possible)
Ergonomics & Principles of Motion Economy

**Principle 4**
Freeing the hands from as much work as possible (provide other means, such as fixture, for holding the work)

**Principle 5**
Gravity (free power; use it)

**Principle 6**
Operator safety and health considerations
Space Determination

• Space determination starts with the workstation design
• Length X width of each workstation = its square footage
• Total or sum of all square footage X 150% (or 200%) = space for all workstations + aisles + work in process + miscellaneous extra room
• This space does not include restrooms, lunch rooms, first aid, tool rooms, maintenance, offices, stores, warehouse, shipping, or receiving
## Space Determination Spreadsheet

<table>
<thead>
<tr>
<th>Machine</th>
<th>Length</th>
<th>X</th>
<th>width</th>
<th>Sq Ft</th>
<th>X Stations</th>
<th>No of</th>
<th>Total square Ft</th>
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<td>10</td>
<td>X</td>
<td>5</td>
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<td>4</td>
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<td>X</td>
<td>20</td>
<td>800</td>
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</table>

**Total Square Feet**

4660

X 150 % = 6990
Chapter 10

Material Handling
Material Handling Defined

1) All movement of materials in a manufacturing environment (broad definition)

2) The art of and science involving moving, packaging, and storing of substances in any form (American Society of Mechanical Engineers)

3) The function of moving the right material to the right place, at the right time, in the right amount, in sequence, and in the right position or condition to minimize production cost (specific definition)
About Material Handling

• On the average, material handling accounts for 50% of the total operations cost

• Non-powered material handling equipment such as gravity chutes, rollers, hand carts, and hand jacks can be very cost efficient and should always be considered
Goal of Material Handling

The primary goal of material handling is to reduce unit costs.

Adequate space must be developed for material handling equipment.

Safety must be of primary concern in operating material handling equipment.
Twenty Principles of Material Handling

1) Planning principle
2) System principle
3) Material flow principle
4) Work simplification principle
5) Gravity principle
6) Maximizing building cube principle

7) Unit size principle
8) Mechanization principle
9) Automation principle
10) Equipment selection principle
11) Standardization principle
12) Adaptability principle
13) Dead weight principle
14) Utilization principle
15) Maintenance principle
16) Obsolescence principle
17) Control principle
18) Capacity principle
19) Performance principle
20) Safety principle
Chapter 11

Material Handling Equipment
Four groups of material handling equipment

- Fixed-path or point-to-point equipment
- Fixed-area material handling equipment
- Variable-path variable area equipment
- Auxiliary tools and equipment
Receiving & Moving Dock
Material Handling Equipment

• Hand carts: Two-wheeled hand truck, pallet hand hack (or pallet truck-hydraulic lift), four-wheeled hand carts, and pallets
• Fork trucks
• Multipurpose equipment such as lifts and cranes
• Telescopic conveyor
• Weight scale
Stores Material Handling Equipment

- Narrow aisle trucks: Reach truck, straddle truck, side shifting lift trucks, maintenance carts, dollies and casters, maintenance tool crib, carousel storage and retrieval systems
- Kitting system
- Inventory control system
Fabrication Material Handling Equipment

- Shop containers
- Tubs and baskets
- Drop bottom tubs
- Drop side tubs or baskets
- Tilt stands
- V stands
- Scissor lifts or hydraulic lifts
- Dump hopper
Workstation Material Handling Devices

- Counterbalances
- Manipulators and lifting devices
- Vibratory feeders
- Waste disposal
- Walking beams
- Ball tables
- Powered round tables
- Jib cranes
- Vacuum or magnetic lifts
- Robots
Mobile Fabrication Equipment

- Slides and chutes
- Non-powered skate wheel and roller conveyors
- Lift conveyors
- Adjustable angle conveyors
- Magnetic conveyors
- Auger or screw conveyors
- Vibratory conveyors
- Monorail trolley conveyors
- Powered hand trucks
Assembly and Paint Material Handling Equipment

- Belt conveyors
- Powered roller conveyors
- Car-type conveyors
- Slat conveyors
- Tow conveyors
- Overhead trolley conveyors
- Powered and free conveyors
Packout Material Handling Equipment

- Box formers
- Automatic taping, gluing, and stapling
- Palletizers
- Pick and place robots
- Banding
- Stretch wrap
Warehousing Material Handling Equipment

- Picking carts and tractor-trailer picking carts
- Gravity flow bins
- Clamp trucks
- Rotary conveyor bins
- Vertical warehouse and picking cars
- Packing station
- Shipping containers
Applicable Green and Sustainability Design Principles

• **Principle 1:** Inherent Rather Than Circumstantial. Designers need to strive to ensure that all material and energy inputs and outputs are as inherently non-hazardous as possible.

• **Principle 2:** Prevention Instead of Treatment. It is better to prevent waste than to treat or clean up waste after it is formed.

• **Principle 3:** Design for Separation. Separation and purification operations should be designed to minimize energy consumption and materials use.
Applicable Green and Sustainability Design Principles

- **Principle 4**: Maximize Efficiency. Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency.

- **Principle 5**: Output-Pulled Versus Input-Pushed Products, processes, and systems should be “output pulled” rather than “input pushed” through the use of energy and materials.

- **Principle 6**: Conserve Complexity. Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition.

Principle 12: Renewable Rather Than Depleting. Material and energy inputs should be renewable rather than depleting.
Obi, Chapter 7

Manufacturing Materials and Material Handling Systems
## Three Forms of Materials

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Types of Manufacturing Materials

- Metals
  - Ferrous Metals
  - Nonferrous Metals
- Plastics
  - Thermoplastics
  - Thermosets
- Composites
- Ceramics
- Wood
Properties of Manufacturing Materials

• Mechanical Properties
• Chemical Properties
• Electrical Properties
• Physical Properties
• Manufacturing Properties
Shapes and Nature of Commercially Available Manufacturing Materials

- Bars
- Tubings
- Sheets, plates and foils
- Ingots
- Preforms
- Granules and powders
- Coils and reels
- Liquid materials
- Gaseous materials
Types of Material Handling Equipment

- Bulk Material Handling Equipment
- Workstation Material Handling Equipment
- Workstation-to-Workstation Material Handling Equipment
- Storage Material Handling Equipment
- Assembly and Paint Material Handling Systems