Automation (21-541)
Advanced Manufacturing Laboratory
Department of Industrial Engineering
Sharif University of Technology

Session # 2

Session Schedule

* Automation & CIM relation with enterprise information systems (ERP, Accounting, Inventory, marketing...)
* Automation and CIM development history
Introduction to manufacturing automation and CIM (Computer Integrated Manufacturing)

- Automation:
  - Set of all measures aiming at replacing human work through machines
    (e.g. automation is applied science)
  - The technology used for this purpose
    (e.g. this company has an automation department)

- Automation:
  - Replacement of human work through machines
    (e.g. the automatisation of the textile factory caused uproar of the workers)
  - Replacement of conscious activity by reflexes
    (e.g. drill of the sailors allows the automatisation of ship handling)

- Automation:
  - The use of computers and machines instead of people to do a job
Introduction to manufacturing automation and CIM (Computer Integrated Manufacturing)
Automation engineer characteristics

- Curiosity: I want to understand
- Learn-hungry: I learn fast – my knowledge is volatile
- Basic Physics: I can make a model of my world
- Mathematics: I know how to calculate
- Programming: I can structure
- Systematic Work: I can plan ...
- Initiative: I can try....

Introduction to manufacturing automation and CIM (Computer Integrated Manufacturing)
**Introduction to manufacturing automation and CIM (Computer Integrated Manufacturing)**

- **Computer Integrated Manufacturing (CIM) encompasses**
  - The entire range of *product development and manufacturing activities* with all the functions being carried out
  - With the help of dedicated *software packages*
  - The data required for various functions are passed from *one application software* to another in a *seamless* manner

- **CIM considers**
  - All activities from the *design of the product* to *customer support* in an *integrated* way,
  - Using various methods, means and techniques in order to achieve
    - Production improvement,
    - Cost reduction,
    - Fulfillment of scheduled delivery dates,
    - Quality improvement
    - Total flexibility in the manufacturing system.
Introduction to manufacturing automation and CIM (Computer Integrated Manufacturing)

- Types of manufacturing systems
  - Project shop
  - Job shop
  - Batch production system
  - Flow line

Project shop

- Characteristics
  - Product’s position remains fixed during manufacturing because of its size and/or weight
  - Materials, people, and machines are brought to the product as needed.
**Job shop**

- **Characteristics**
  - Machines with the same or similar material processing capabilities are grouped together
  - The machines are usually general-purpose machines, which can accommodate a large variety of part types
  - Material handling is very flexible in order to accommodate many different part types
  - Within each work center, a number of machines can be used for a particular operation.

**Job Shop**

- **Characteristics**
  - Each operation can be assigned to a machine, which yields the best quality or the best production rate
  - Machines can be evenly loaded
  - Machine breakdowns can be accommodated easily.
  - Requires making and implementing complex decisions in real time.
  - Parts spending a long time on the job shop
Batch production

- Characteristics
  - The equipment or machinery is grouped according to the process combinations that occur in families of parts.
  - Each cell contains machines that can produce a certain family of parts.
  - Intra-cellular material flow can be performed either automatically or manually.

Flow line

- Characteristics
  - Machines and other equipment are ordered according to the process sequences of the parts to be manufactured.
  - Only one part type is produced at a time.
  - The machines are linked by automated material handling devices, such as conveyors.
  - Lot size of each part is high enough to guarantee that the capacity of the equipment will be fully exploited and not wasted on the setups.
### Manufacturing Systems

#### Table

<table>
<thead>
<tr>
<th>Type</th>
<th>Job shop</th>
<th>Batch Production</th>
<th>Flow line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine allocation</td>
<td>same or similar material processing capabilities are grouped together</td>
<td>grouped according to the process combinations that occur in families of parts</td>
<td>ordered according to the process sequences of the parts to be manufactured</td>
</tr>
<tr>
<td>Machine Types</td>
<td>general-purpose machines</td>
<td>machines produce a certain family of parts</td>
<td></td>
</tr>
<tr>
<td>Material handling</td>
<td>flexible</td>
<td>intra-cellular material flow can be performed either automatically or manually</td>
<td>automated material handling devices,</td>
</tr>
<tr>
<td>Product Variety</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Product Quantity</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>WIP</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Material Flow</td>
<td>Complicated</td>
<td>material flow within the cell may differ for different parts of a part family</td>
<td>Smooth</td>
</tr>
<tr>
<td>Product type</td>
<td>specialized and customized</td>
<td>Family Part</td>
<td>One type of product</td>
</tr>
<tr>
<td>Labor</td>
<td>highly skilled</td>
<td>Medium</td>
<td>Not skill</td>
</tr>
</tbody>
</table>
Automation and CIM development history

- **Fixed automation**
  - Uses mechanical, electrical, pneumatic and hydraulic systems
  - Is widely used in automobile manufacturing

- **Fixed automation examples**
  - Single spindle automatic lathe
  - Multi spindle automatic lathe
  - Transfer lines

- **Fixed automation limitations**
  - It is designed for a particular product
  - Any product change will require extensive modifications to the automation system.

Automation and CIM development history (continue ...)

- **Programmable automation**
  - Electrically controlled systems
  - Programs were stored in punched cards and punched tapes

- **Programmable automation examples**
  - Electrical programmed controlled milling machines
  - Hydraulically operated Automatic lathes with programmable control drum
  - Sequencing machines with punched card control /plug board control
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**Automation & CIM**

- The advances in automation have enabled industries to develop
  “Islands of automation”

- Islands of automation examples are:
  - Flexible manufacturing cells
  - Robotized work cells
  - Flexible inspection cells

- CIM tries to achieve the consolidation and integration of these islands of automation.
Automation & CIM (Continued...)

- Consolidation and integration of “Islands of automation” requires:
  - Sharing of information among different applications or sections of a factory (Collaboration)
  - Accessing incompatible and heterogeneous data and devices (Interoperability)

![Diagram]

Advantages of Automated Manufacturing:

- Improved work flow
- Reduced handling
- Simplification of production
- Reduced lead time
- Increased moral in workers (after a wise implementation)
- More responsive to quality, and other problems
**CIM history**

- Computer-Aided Design (CAD) & Computer-Aided Manufacturing (CAM) were the first areas for “Automation islands integration”
- Massachusetts Institute of Technology (MIT, USA) is credited with pioneering the development in both CAD and CAM
- The need to meet the design and manufacturing requirements of aerospace industries after the Second World War necessitated the development CIM technologies.
- US Air Force approaches MIT to develop suitable control systems, drives and programming techniques for machine tools using electronic control

**CIM history (Continued...)**

- CAD in fact owes its development to the APT language project at MIT in early 50’s.
  - APT (Automatically Programmed Tool)
  - \( P1 = \text{POINT} / 50, 50, 0 \)
  - \( P2 = \text{POINT} / 20, -20, 0 \)
  - \( C1 = \text{CIRCLE} / \text{CENTER}, P2, \text{RADIUS}, 30 \)
  - \( P3 = \text{POINT} / -50, -50, 0 \)
  - ...
  - \( \text{SPINDL} / 3000, \text{CW} \)
  - \( \text{FEDRAT} / 100, 0 \)
  - ...
  - \( \text{GOFWD} / C1, \text{TANTO, L2} \)
  - \( \text{GOFWD} / L2, \text{PAST, L3} \)
CIM history (Continued...) 

- By 80’s, the automation in design was well progressed.
- In the case of manufacture, CNC machines, DNC systems, FMC, FMS ... provide tightly controlled automation systems
- Also computer control has been implemented in several areas like
  - Manufacturing resource planning
  - Accounting
  - Sales
  - Marketing
  - Purchase

CIM history (Continued...) 

- CIM scope within the enterprises:
  - Marketing
  - Product Design
  - Planning
  - Purchase
  - Manufacturing Engineering
  - Factory Automation Hardware
  - Warehousing
  - Logistics and Supply Chain Management
  - Finance
  - Information Management
CIM history (Continued...)