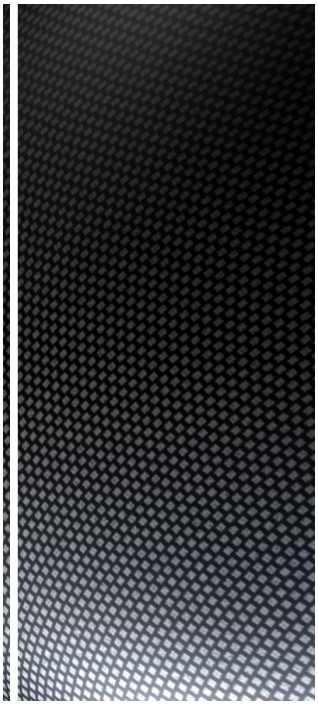
Automation (21-541)

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*

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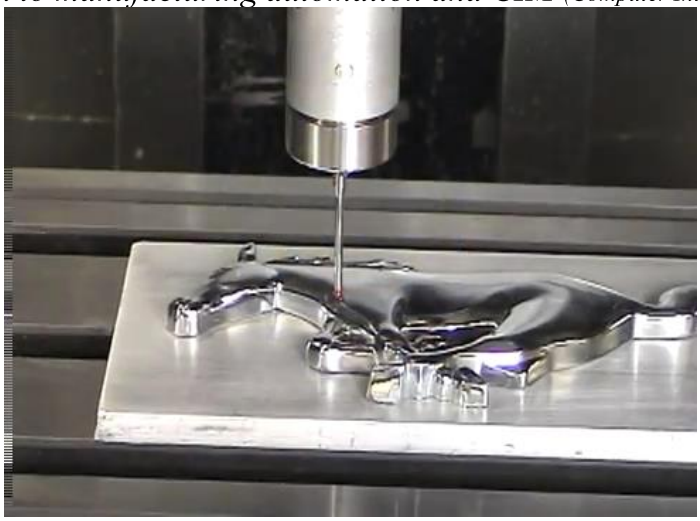

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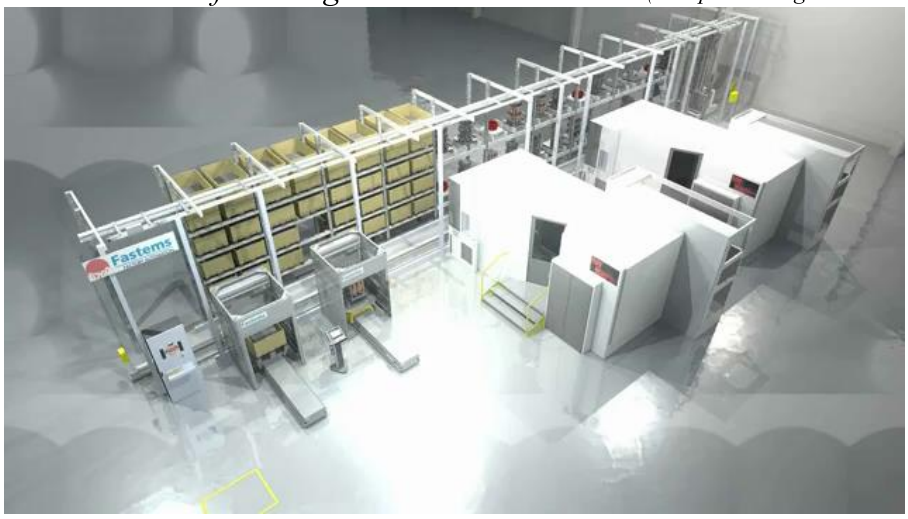

Automation engineer characteristics

- *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)

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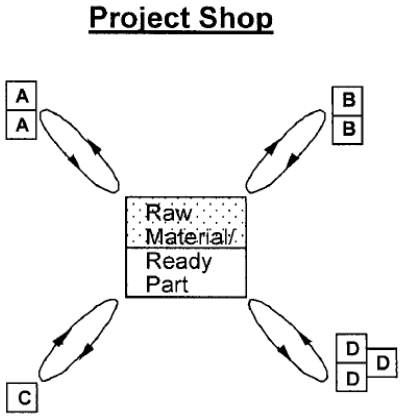
- *Computer Integrated Manufacturing (CIM) encompasses*
  - *The entire range of product development and manufacturing activities with all the functions being carried out*
  - *With the help of dedicated software packages.*
  - *The data required for various functions are passed from one application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

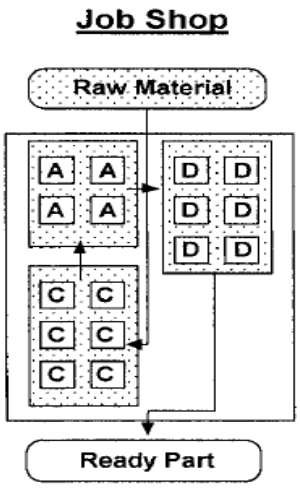
Project shop

- *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.*



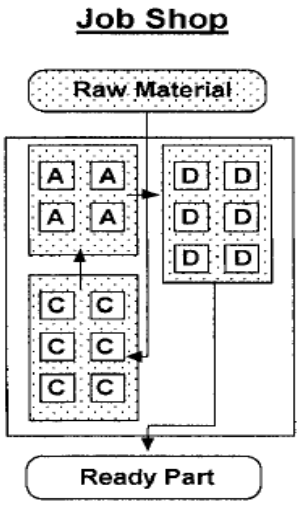
Job shop

- *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.*



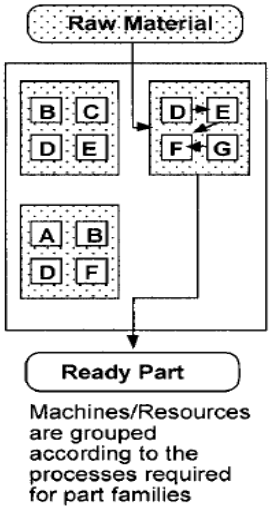
Job shop

- *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

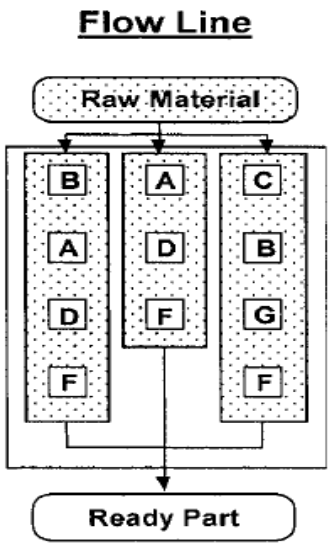
- *Characteristics*
  - *The equipment or machinery is grouped according to the process combinations that occur in families of parts*
  - *Each cell contains machines that can produce a certain family of parts*
  - *Intra-cellular material flow can be performed either automatically or manually*



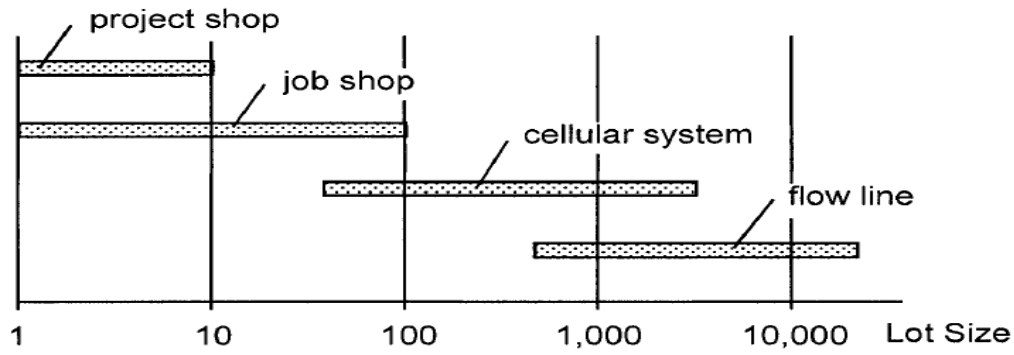
Machines/Resources are grouped according to the processes required for part families

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



Manufacturing Systems

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

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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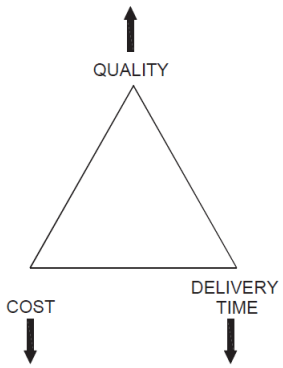
Automation & CIM

- *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)*



Automation & CIM (Continued…)

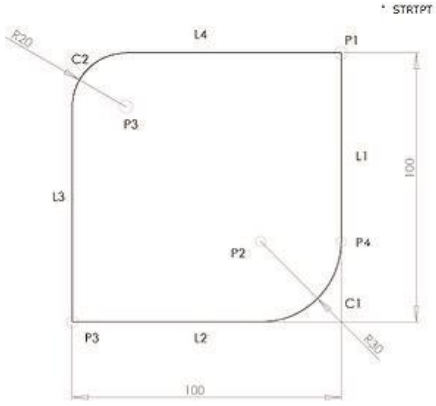
- *Advantages of Automated Manufacturing:*
  - *Improved work flow*
  - *Reduced handling*
  - *Simplification of production*
  - *Reduced lead time*
  - *Increased moral in workers (after a wise implementation)*
  - *More responsive to quality, and other problems*

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 = POINT / 50, 50, 0*
- *P2 = POINT / 20, -20, 0*
- *C1 = CIRCLE / CENTER, P2, RADIUS, 30*
- *P3 = POINT / -50, -50, 0*
- *…*
- *SPINDL / 3000, CW*
- *FEDRAT / 100, 0*
- *…*
- *GOFWD / C1, TANTO, L2*
- *GOFWD / L2, 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…)*