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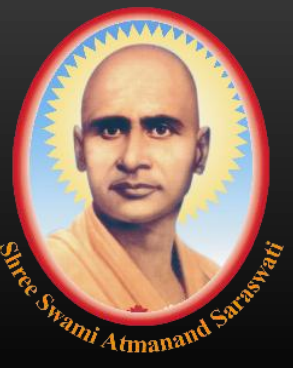

COMPUTER AIDED MANUFACTURING (2171903)

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CHAPTER 01: COMPUTER AIDED MANUFACTURING

- CAM CONCEPTS
- OBJECTIVES & SCOPE
- NATURE & TYPE OF MANUFACTURING SYSTEM
- EVOLUTION OF CAM
- BENEFITS OF CAM
- ROLE OF MANAGEMENT IN CAM
- CONCEPT OF COMPUTER INTEGRATED MANUFACTURING
- IMPACT OF CIM ON PERSONNEL
- ROLE OF MANUFACTURING ENGINEERS
- CIM WHEEL TO UNDERSTAND BASIC FUNCTIONS

CAM CONCEPTS

- Computer Aided Manufacturing (CAM) has many meanings and interpretations.
- At one extreme, it refers to the use of **a computer to run Automatic Programmed Tool (APT) for programming Numerical Control Machines (CNC)**
- While, at the other extreme, It refers to **what technology forecasting predicts for the future- The Automation Factory.**
- The automatic factory is a computer integrated manufacturing systems that controls all phases of industrial enterprise like **Product Design, Process Planning, and Flow of Materials, Production Planning, Positioning of Materials, Automatic Production and Assembly and Testing, Automatic Warehousing and Shipping.**

CAM CONCEPTS (CONTINUE…)

- The common interpretation of CAM is not as ambitious as the automation factory.
- Most commonly it involves the utilization of CNC machines and Robots.
- Computer Numerical Control (CNC) machines are locally programmable machines with dedicated microcomputers.
- CNC Machines provides greater flexibility by allowing the machine to be controlled and programmed in the office instead of on the shop floor.
- Machine setup is transferred to the office, which thus increases machine operating and processing time.
- CNC allows machines to be integrated with other complementary technologies such as computer aided design and computer integrated manufacturing.

- CNC also serves ad the building block for Flexible manufacturing Systems (FMS).
- The generation of CNC part programs can be done as a component of the CAD process.
- The geometric database constructed in the computer by an interactive CAD system can be used to generate tool paths with a few extra commands.
- These minimize the total design-to-production time, increase engineering efficiency and improve quality.
- Checking of a CNC program is aided by animation of a tool path on a CAD system.
- This enables the part programmer to visualize tool motions.

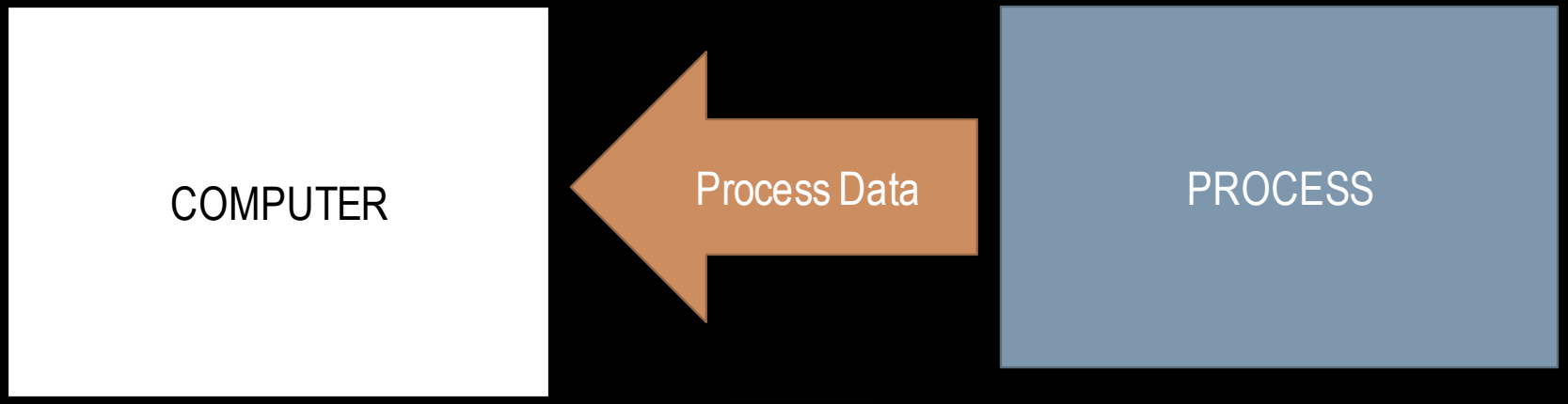
- Thus CAD integrates directly with CAM and can result in **increased productivity of both engineering and production personnel** by factors of up to an order of magnitude or more, while improving quality control and reducing the design to production time.
- "Computer Aided Manufacturing can be defined as the use of computer system to Plan, Manage and Control the operation of Manufacturing plant through either direct or indirect interface with the plant production resources"
- As per definition, the application of the computer aided manufacturing fall in to two broad categories:

➢ Computer Monitoring and Control

➢ Manufacturing Support Application

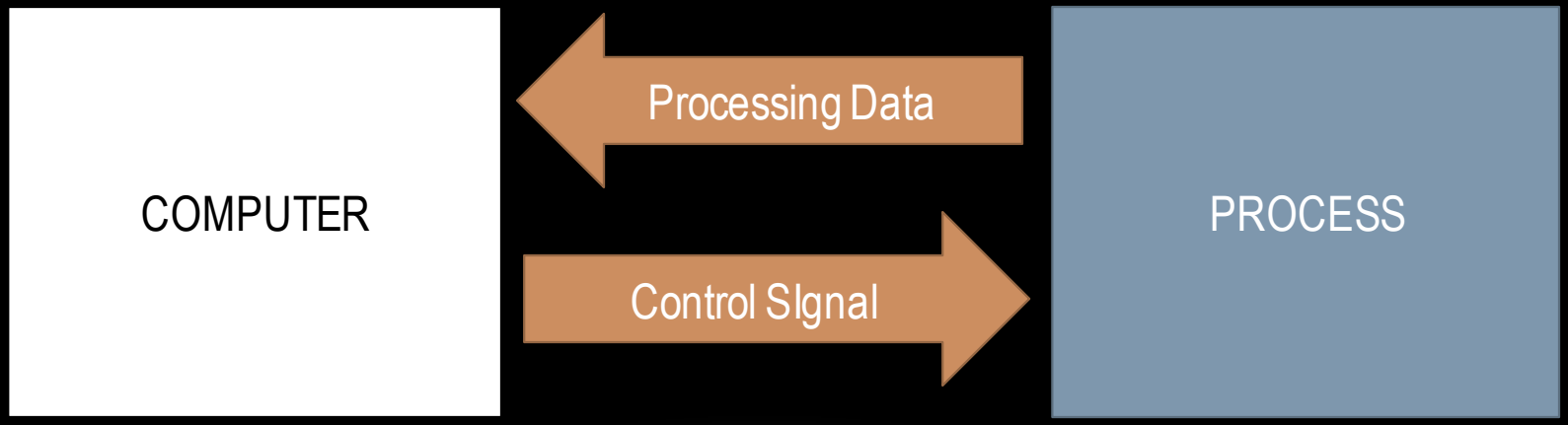
COMPUTER MONITORING AND CONTROL

- These are the direct applications in which the computer is connected directly to the manufacturing processes for the purpose of monitoring or controlling the process.



MANUFACTURING SUPPORT APPLICATION

- These are the indirect applications in which the computer is used in support of the production operation in the plant, but there is no direct interface between the computer and manufacturing process.



OBJECTIVE & SCOPE

- To increase productivity of Designer.
- To improve quality of design.
- To improve communication.
- To create a manufacturing database.
- To create and test tool paths and Optimize them.
- To help in production scheduling and MRP models.
- To have effective shop floor control

CAD & CAM USAGE INDUSTRY

- 1) Automotive industry
- 2) Aerospace and Aircraft Industry
- 3) Textile Industry
- 4) Medical Industry
- 5) Video gaming industry
- 6) Welding and Cutting Industry
- 7) Die Manufacturing Industry

NATURE OF MANUFACTURING/ PRODUCTION

- The term “manufacturing” covers a broad spectrum of activities.
- Metal working industries, process industries like chemical plants, oil refineries, food processing industries, electronic industries making microelectronic components, printed circuit boards, computers and entertainment electronic products etc. are examples of manufacturing industries.
- Manufacturing involves fabrication, assembly and testing in a majority of situations. However, in process industries operations are of a different nature.
- Types of Manufacturing are as below:

1. Continuous Process Production :

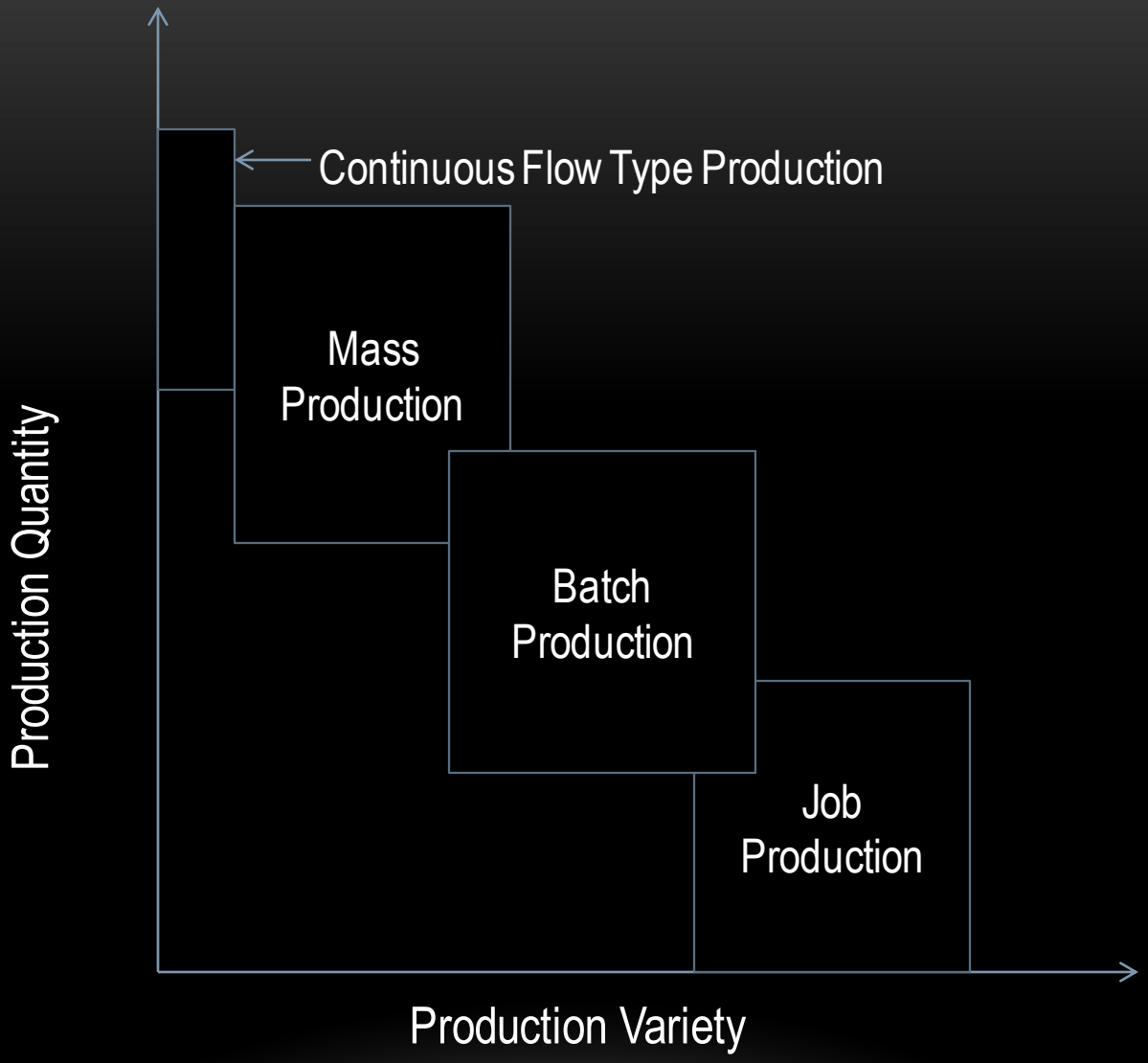
- Such type of product flows continuously in the manufacturing system, e.g. petroleum, cement, steel rolling, petrochemical and paper production etc.
- Equipment used here are only applicable for small group of similar products.

- **2. Mass Production :**

- It includes the production of discrete unit at very high rate of speed.
- Discrete item production is used for goods such as auto mobiles, refrigerators, televisions, electronic component and so on.
- Mass production contains the character of continuous process production for discrete products.
- That's why mass production has realized enormous benefits from automation and mechanization.

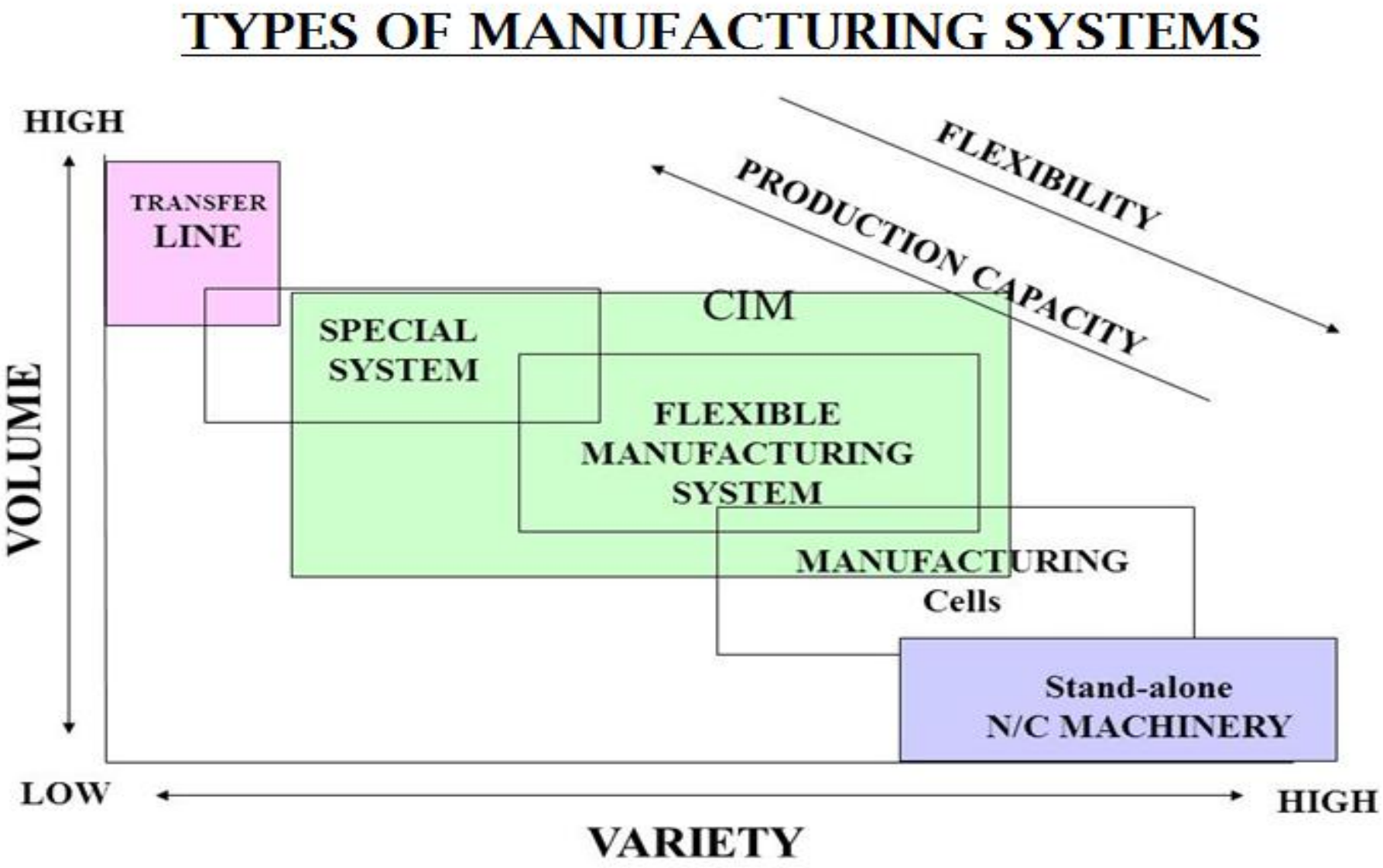
- **3. Batch Production :** Intermittent of Mass and Job Shop Production
- **4. Job Shop Production :**

- A manufacturing facility that produces a large number of different discrete items and requires different sequences among the production equipment's is called job shop.
- Scheduling and routine problems are the essential features of job shop.
- As a result automation has at best been restricted to individual component of job shop.
- But there have been few attempts in the field of total automation.



TYPES OF MANUFACTURING/ PRODUCTIONS

NATURE AND TYPE OF MANUFACTURING SYSTEMS



BENEFITS OF CAM

- Computer aided manufacture reduces manual labour. There is a misconception that the Indian labour is cheap.
- This is true in terms of per hour cost. But by world standards the Indian labour is less productive and hence are more costly compared to labour in other countries. Therefore the Indian products which involve manual labour need not necessarily be cheaper.
- Manual work lacks consistency whereas computer controlled or programmable equipment is always consistent as far as output and quality are concerned.
- There is less rejection and rework. Rejection if at all may be due to uncontrolled technological parameters like material variability, process changes, wear of tools etc.
- Product changes can be easily incorporated.
- Delivery of the products can be confidently assured.

- The manufacturing equipment can accept the CAD data directly.
- For example, a CNC machine control system can generate the manufacturing program using a CAD file with a limited number of instructions by the operator at the machine console itself.
- Similarly a rapid prototyping machine can produce a component directly from CAD data.
- The time elapsed between the conceptualization of a product and its realization and subsequent introduction to the market is called product development lead time.
- The lead time in manufacture is considerably reduced in computer aided manufacture.
- Computer aided manufacture helps-to achieve higher production rates with less labour.
- Cost savings can accrue due to increased manufacturing efficiency.

ROLE OF MANAGEMENT

- The basic objective of CAM is the complete integration of all functions of manufacturing.
- However, for the success of CAM, there has to be a greater integration of the human resources.
- This is possible only with the active involvement of the top management in integration of human resources.
- The strong commitment from the top management helps in the successful implementation of CAM.

EVOLUTION OF COMPUTER INTEGRATED MANUFACTURING

- Computer Integrated Manufacturing (CIM) is considered a natural evolution of the technology of CAD/CAM which by itself evolved by the integration of CAD and CAM.
- 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 these technologies. The manufacturing technology available during late 40's and early 50's could not meet the design and manufacturing challenges arising out of the need to develop sophisticated aircraft and satellite launch vehicles.
- This prompted the US Air Force to approach MIT to develop suitable control systems, drives and programming techniques for machine tools using electronic control.
- The first major innovation in machine control is the Numerical Control (NC), demonstrated at MIT in 1952. Early Numerical Control Systems were all basically hard wired systems, since these were built with discrete systems or with later first generation integrated chips. Early NC machines used paper tape as an input medium. Every NC machine was fitted with a tape reader to read paper tape and transfer the program to the memory of the machine tool block by block.
- Mainframe computers were used to control a group of NC machines by mid 60's.

➢This arrangement was then called Direct Numerical Control (DNC) as the computer bypassed the tape reader to transfer the program data to the machine controller. By late 60's mini computers were being commonly used to control NC machines.

➢At this stage NC became truly soft wired with the facilities of mass program storage, offline editing and software logic control and processing. This development is called Computer Numerical Control (CNC).

➢Since 70's, numerical controllers are being designed around microprocessors, resulting in compact CNC systems. A further development to this technology is the distributed numerical control (also called DNC) in which processing of NC program is carried out in different computers operating at different hierarchical levels - typically from mainframe host computers to plant computers to the machine controller.

➢Today the CNC systems are built around powerful 32 bit and 64 bit microprocessors. PC based systems are also becoming increasingly popular.
➢Manufacturing engineers also started using computers for such tasks like inventory control, demand forecasting, production planning and control etc.

- CNC technology was adapted in the development of co-ordinate measuring machine's (CMMs) which automated inspection. Robots were introduced to automate several tasks like machine loading, materials handling, welding, painting and assembly.

- All these developments led to the evolution of flexible manufacturing cells and flexible manufacturing systems in late 70's.

- Evolution of Computer Aided Design (CAD), on the other hand was to cater to the geometric modelling needs of auto mobile and aeronautical industries.
- The developments in computers, design workstations, graphic cards, display devices and graphic input and output devices during the last ten years have been phenomenal.

- This coupled with the development of operating system with graphic user interfaces and powerful interactive (user friendly) software packages for modelling, drafting, analysis and optimization provides the necessary tools to automate the design process.

- CAD in fact owes its development to the APT (Automatically Programmed Tool) language project at MIT in early 50's. Several clones of APT were introduced in 80's to automatically develop NC codes from the geometric model of the component.

- Now, one can model, draft, analyse, simulate, modify, optimize and create the NC code to manufacture a component and simulate the machining operation sitting at a computer workstation.

- If we review the manufacturing scenario during 80's we will find that the manufacturing is characterized by a few islands of automation. In the case of design, the task is well automated. In the case of manufacture, CNC machines, DNC systems, FMC, FMS etc provide tightly controlled automation systems.

- Similarly computer control has been implemented in several areas like manufacturing resource planning, accounting, sales, marketing and purchase.

- Yet the full potential of computerization could not be obtained unless all the segments of manufacturing are integrated, permitting the transfer of data across various functional modules.

- This realization led to the concept of computer integrated manufacturing.

- Thus the implementation of CIM required the development of whole lot of computer technologies related to hardware and software.

CONCEPT OF COMPUTER INTEGRATED MANUFACTURING

- Computer-integrated manufacturing (CIM) is the manufacturing approach of using computers to control the entire production process.
- This integration allows individual processes to exchange information with each other and initiate actions.
- Although manufacturing can be faster and less error-prone by the integration of computers, the main advantage is the ability to create automated manufacturing processes.
- Typically CIM relies on closed-loop control processes, based on real-time input from sensors. It is also known as flexible design and manufacturing.

- Computer-integrated manufacturing is used in automotive, aviation, space, and ship building industries.
- The term "computer-integrated manufacturing" is both a method of manufacturing and the name of a computer-automated system in which individual engineering, production, marketing, and support functions of a manufacturing enterprise are organized.
- In a CIM system functional areas such as design, analysis, planning, purchasing, cost accounting, inventory control, and distribution are linked through the computer with factory floor functions such as materials handling and management, providing direct control and monitoring of all the operations.

As a method of manufacturing, three components distinguish CIM from other manufacturing methodologies:

- Means for data storage, retrieval, manipulation and presentation;
- Mechanisms for sensing state and modifying processes;
- Algorithms for uniting the data processing component with the sensor/modification component.

IMPACT OF CIM ON PERSONNEL

- The computer integrated manufacturing has affected all' the company personnel from the
- lowest rank operator to the CEO of a company.
- The impact of CIM on the workforce is more than that on the technology itself.
- 1. Downsizing of Workforce
- 2. Requirements of Change in Skill Sets-
- 3. Specialists Need to Generalize and Generalists Need to Specialize
- 4. Cultural Change in Management

ROLE OF MANUFACTURING ENGINEERS

- In CIM environment, the role of manufacturing engineers is versatile in nature.
- In ClM culture, there is a continuous upgradation and modification of the products, Therefore, there is a greater need for manufacturing engineers to interact closely with the design engineers.
- The manufacturing engineers need to understand design process, especially CAD tools.
- The manufacturing engineers also need to develop the certain degree of experty in the area of maintenance of their own machines.
- Therefore, they must understand the various systems of machine tools like : Hydraulic systems, Pneumatic systems, Electrical systems, Electronic systems and Computer systems.

- The study was conducted by the 'Society of Manufacturing Engineers (SME), in USA to predict the role of manufacturing engineers in 21st century.
- The findings of study are documented as **'Profile 21**'.
- The profile 21 predicts that the role of manufacturing engineers will change in 21st century due to following factors:

(i) Increased product variety and sophistication;

(ii) Globalization of manufacturing; and

(iii) Socio-economic changes.

Some of the findings of 'Profile 21'

- 1. Function as Integration Engineers
- 2. Function as Business Administrators
- 3. Function as Effective Team Leaders

Function as Integration Engineers

- The manufacturing engineers will function as integration engineers with the duties of coordinating people, information and technology.
- They must passes managerial, business, technical, scientific and mathematical skills.

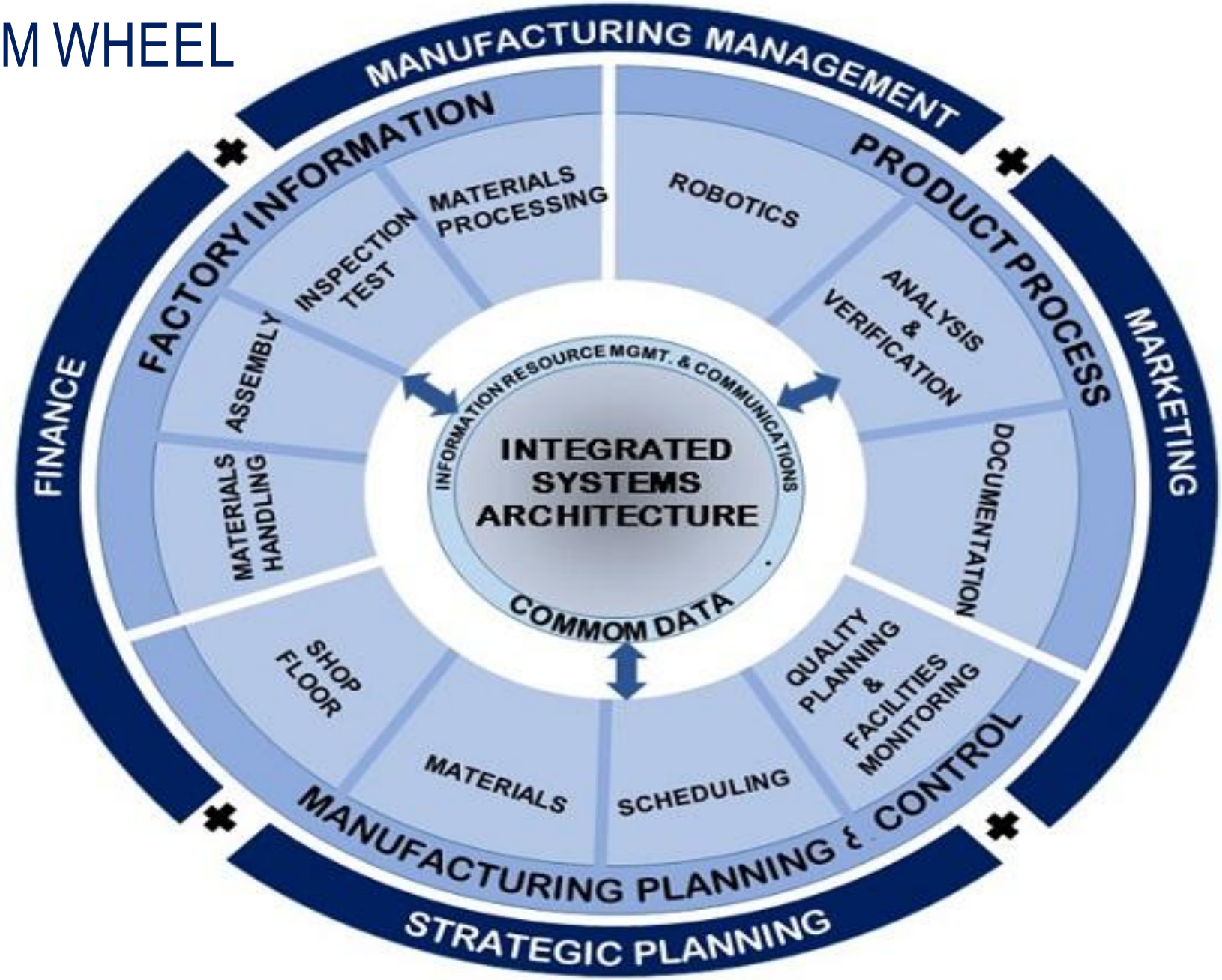
Function as Business Administrators

- The manufacturing engineers will function as business administrator for their unit.
- They will carry out planning of logistics, work flow, and human resources.

Function as Effective Team Leaders

- The profile 21 predicts that manufacturing engineers will need to have man management skills and technical skills.
- They will have to function as an effective team leaders.

CIM WHEEL


MANUFACTURING MANAGEMENT
PRODUCT PROCESS
MARKETING
CONTROL
MANUFACTURING PLANNING &
STRATEGIC PLANNING
FINANCE
FACTORY INFORMATION
ROBOTICS
MATERIALS PROCESSING
INSPECTION TEST
ASSEMBLY
MATERIALS HANDLING
ANALYSIS & VERIFICATION
DOCUMENTATION
QUALITY PLANNING & FACILITIES MONITORING
SCHEDULING
MATERIALS
SHOP FLOOR
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INTEGRATED SYSTEMS ARCHITECTURE
COMMOM DATA

THANK YOU

- Any Questions?