

# **COMPUTER INTEGRATED MANUFACTURING**

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# Lecture Overview

- Definitions and Origin
- Key challenges
- Subsystems in computer-integrated manufacturing
- CIMOSA
- Development of CIM

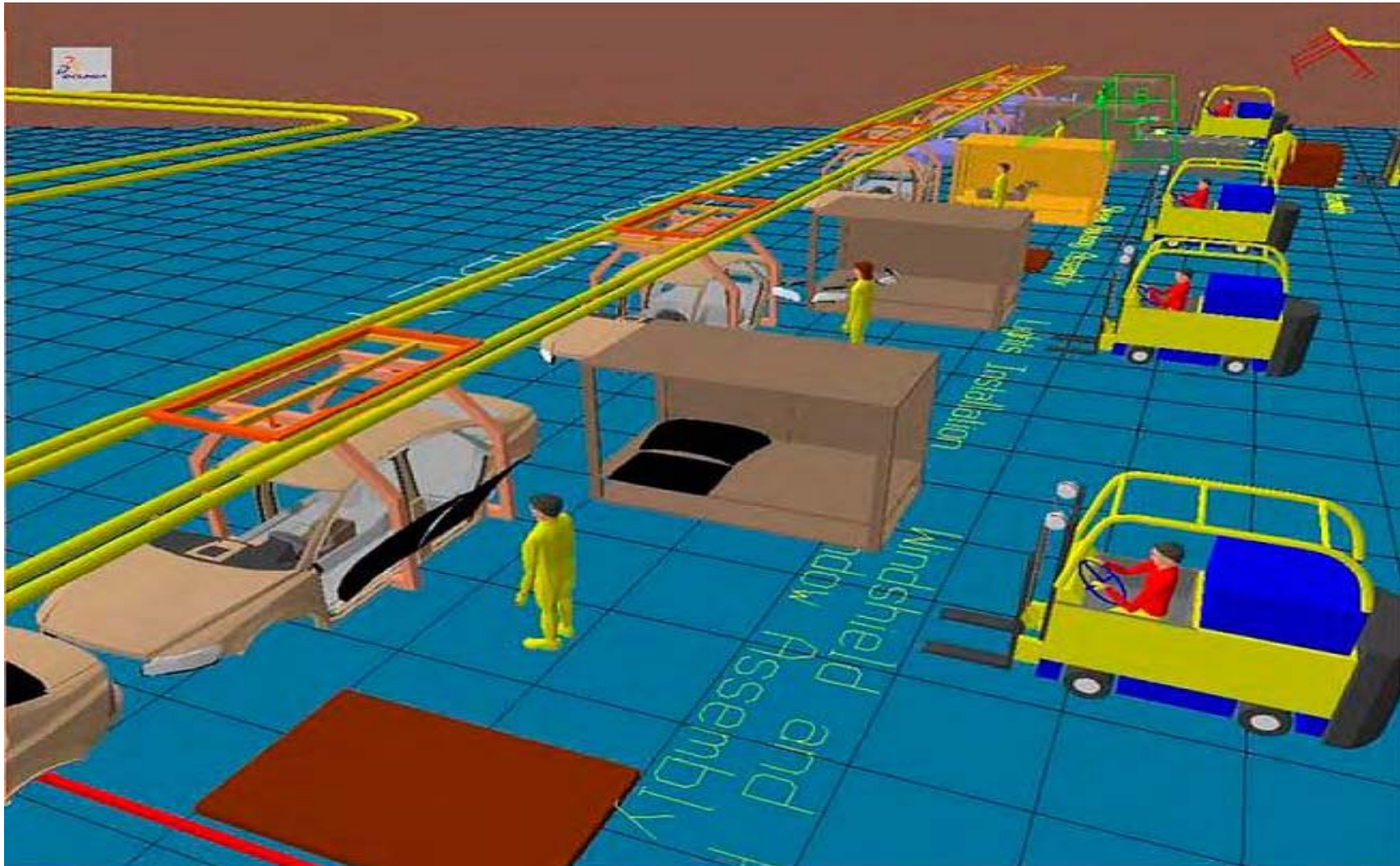
## Definition

- **Computer-integrated manufacturing (CIM)** is the manufacturing approach of using computers to control the entire production process
- This integration allows individual processes to exchange info with each other and initiate actions
- Through the computers integration, manufacturing can be faster and less error-prone, although 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*

## Definition contd...

- **CIM** encompasses the entire range of product development and manufacturing activities with all the functions being carried out with the help of dedicated packages
- The data required for various functions are passed from one application to another in a seamless manner
- **CIM** use a common DB wherever feasible and communit-tech to integrate design, manufacturing and associated business
- **CIM** reduces the human component of manufacturing and thereby relieves the process of its slow, expensive and error-prone component

# ***Manufacturing Systems Integration Program***



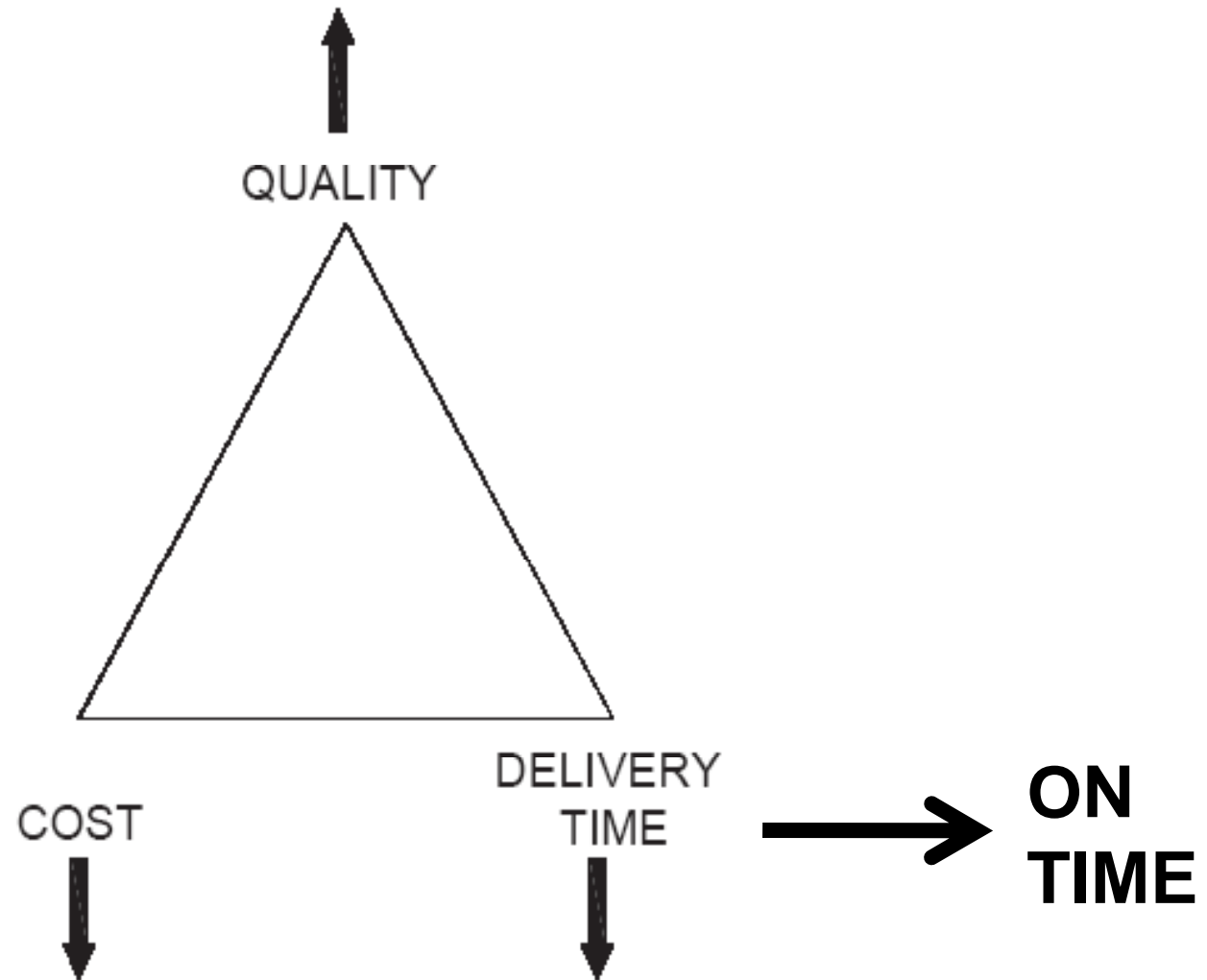
# Origin

- The term "**CIM**" 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.

## Origin contd...

- **CIM** also encompasses the whole lot of enabling technologies including total quality management, business process reengineering, concurrent engineering, workflow automation, enterprise resource planning and flexible manufacturing
- A distinct feature of manufacturing today is *mass customization*
- This implies that though the products are manufactured in large quantities, products must incorporate customer-specific changes to satisfy the diverse requirements of the customers
- This requires extremely high flexibility in the manufacturing system.

# Challenges in Manufacturing





# Three Distinguished Components

- 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

# Definition

- **CIM** is an example of the implementation of info and common technologies in manufacturing
- **CIM** implies that there are at least two computers exchanging info, e.g. the controller of an arm robot and a micro-controller of a Computer Numerical Control(CNC) machine
- Some factors involved when considering a **CIM** implementation are the production volume, the experience of the company or personnel to make the integration, the level of the integration into the product itself and the integration of the production processes
- **CIM** is most useful where a high level of **ICT** is used in the company or facility, such as **CAD/CAM systems**

# Benefit from CIM

**Integration** of technologies brings following **benefits**:

1. Creation of a truly **interactive system** that enables manufacturing functions to communicate easily with other relevant functional units
2. Accurate data transferability among manufacturing plant or subcontracting facilities at implant or diverse locations
3. Faster responses to data-changes for manufacturing flexibility
4. Increased flexibility towards introduction of new products
- 5 Improved accuracy and quality in the manufacturing process (*continued*)

## **Benefit from CIM**

6. Improved quality of the products.
7. Control of data-flow among various units and maintenance of user-library for system-wide data.
8. Reduction of lead times which generates a competitive advantage.
9. Streamlined manufacturing flow from order to delivery.
10. Easier training and re-training facilities.

# Evolution of 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

# Digital Manufacturing

The idea of "digital manufacturing" was prominent the 1980s, when computer-integrated manufacturing was developed and promoted by machine tool manufacturers and the Computer and Automated Systems Association and Society of Manufacturing Engineers (CASA/SME).

"CIM is the integration of total manufacturing enterprise by using integrated systems and data communication coupled with new managerial philosophies that improve organizational and personnel efficiency."

# Key challenges - three major challenges

- **Integration of components from different suppliers:** when different machines, such as CNC, conveyors and robots, are using different communications protocols
- **Data integrity:** The higher the degree of automation, the more critical is the integrity of the data used to control the machine
  - While the CIM system saves on labor of operating the machines, it requires extra human labor in ensuring that there are proper safeguards for the control data signals
- **Process control:** Computers may be used to assist the human operators of manufacturing facility, but there must always be a competent engineer to handle circumstances which could not be foreseen by SW designers

# Subsystems in computer-integrated manufacturing

- **Computer-aided techniques:**
  - CAD (computer-aided design)
  - CAE (computer-aided engineering)
  - CAM (computer-aided manufacturing)
  - CAPP (computer-aided process planning)
  - CAQ (computer-aided quality assurance)
  - PPC (production planning and control)
  - ERP (enterprise resource planning)
  - A business system integrated by a common database.



# Subsystems in computer-integrated manufacturing

- **Computer-aided design (CAD)** also known as computer-aided design and drafting (CADD) is the use of computer technology for the process of design and design-documentation

CAD describes the process of drafting with a computer providing the user with input-tools for the purpose of streamlining design processes; drafting, documentation

CAD output is often in the form of electronic files for print or machining operations

# Subsystems in computer-integrated manufacturing

- Computer-aided engineering (CAE) is the broad usage of computer software to aid in engineering tasks  
It includes computer-aided design (CAD), computer-aided analysis (CAA), computer-integrated manufacturing (CIM), computer-aided manufacturing (CAM), material requirements planning (MRP), and computer-aided planning (CAP)
- Computer-aided process planning (CAPP) is the use of computer technology to aid in the process planning of a part or product, in manufacturing  
CAPP is the link between CAD and CAM in that it provides for the planning of the process to be used in producing a designed part

# Subsystems in computer-integrated manufacturing

- **Computer-aided manufacturing (CAM)** is the use of computer to control machine tools and related machinery in the manufacturing of work pieces

CAM may also refer to the use of a computer to assist in all operations of a manufacturing plant, including planning, management, transportation and storage

Primary purpose is to create a faster production process and components and tooling with more precise dimensions and material consistency, which in some cases, uses only the required amount of raw material while simultaneously reducing energy consumption

- **Computer-aided quality assurance (CAQ)** is the engineering application of computers and computer controlled machines for the definition and inspection of the quality of products

# Subsystems in computer-integrated manufacturing

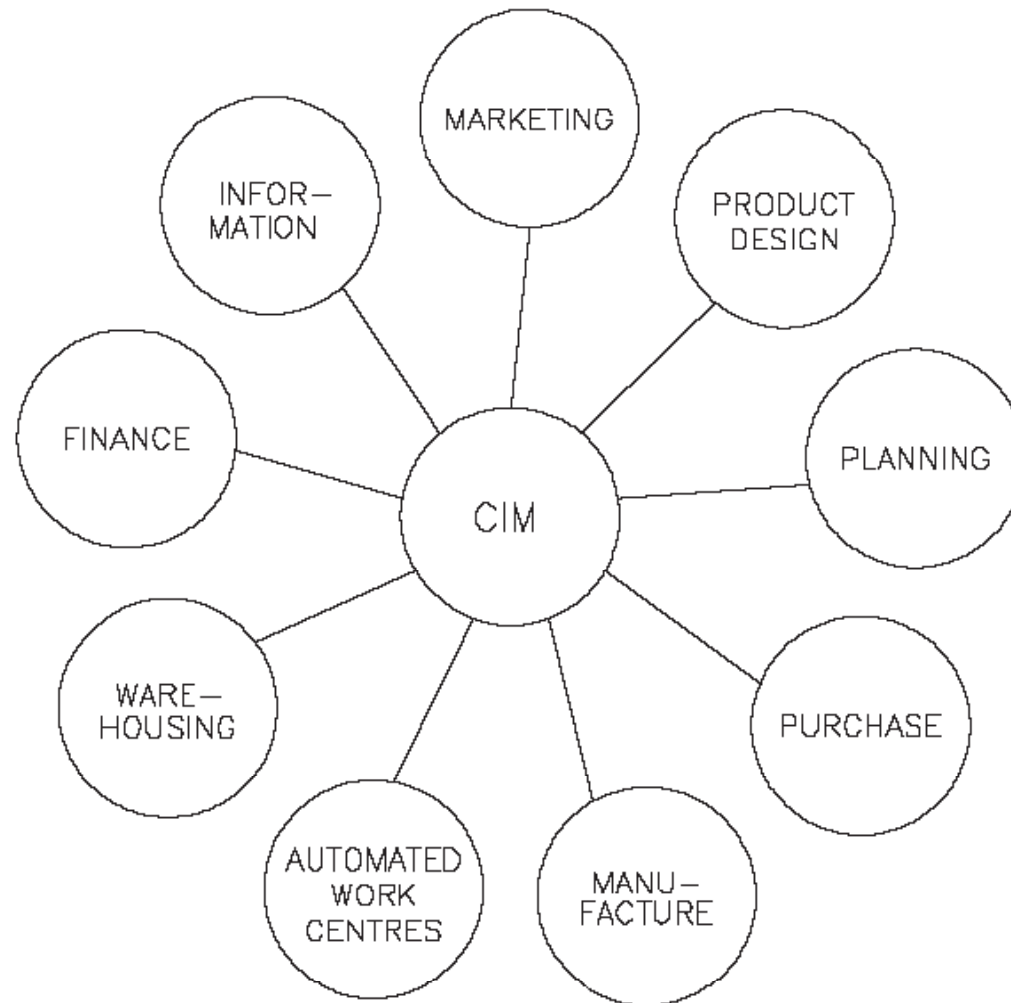
- **Project management software** is covering many types of Software including estimation and planning, scheduling, cost control and budget management, resource allocation, collaboration Software, communication, quality management and documentation which are used to deal with the **complexity of large projects**
- **Enterprise resource planning (ERP)** integrates internal and external management info across an entire organization, embracing finance/accounting, manufacturing, sales and service, customer relationship management
  - It automate this activity with an integrated Soft Ware (SW) application

Its purpose is to facilitate the flow of info between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders

# Nature and Role of the Elements of CIM System

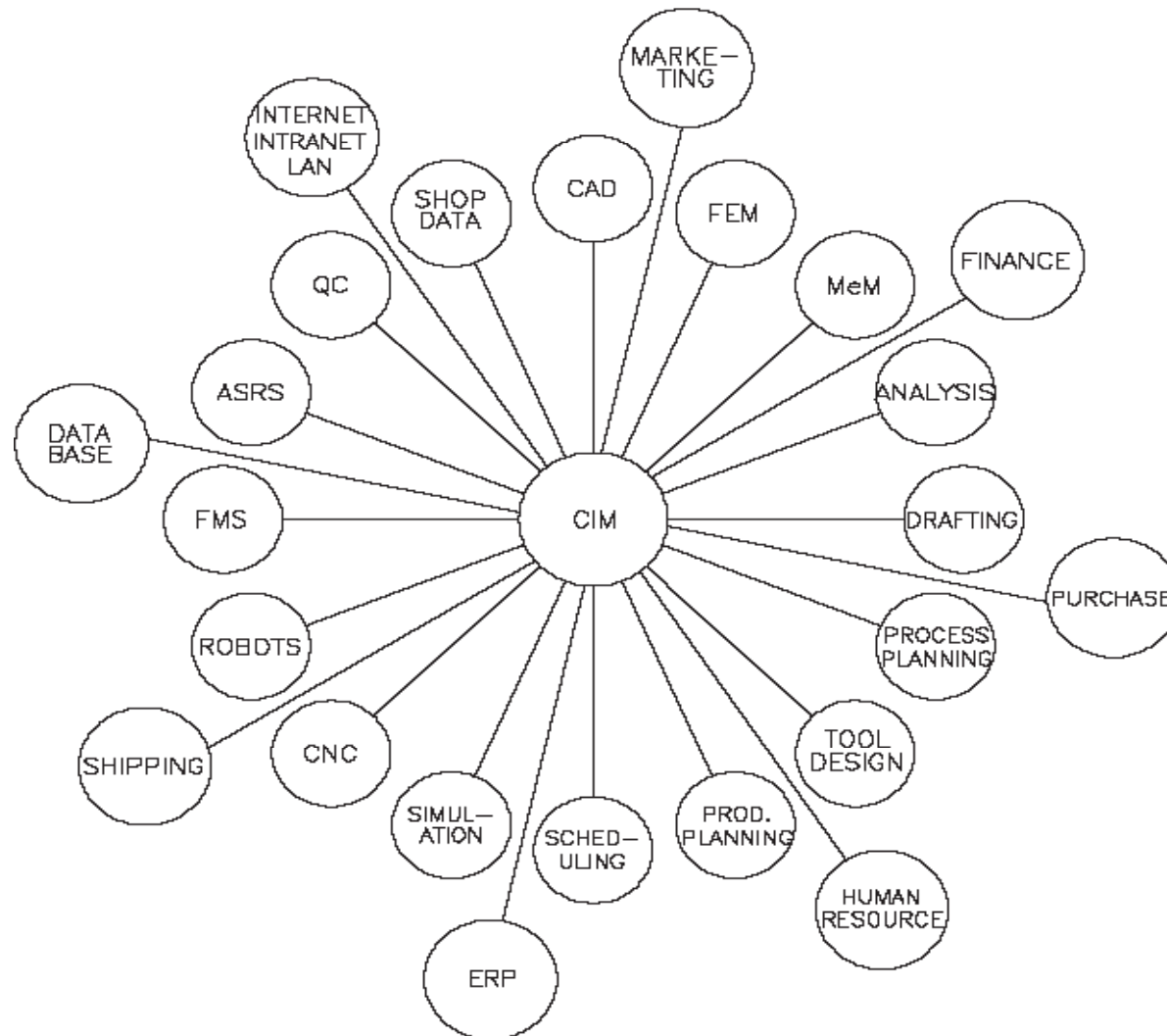
- Nine major elements of a CIM system are in next slide:
  - Marketing
  - Product Design
  - Planning & Purchase
  - Manufacturing Engineering
  - Factory Automation Hardware
  - Warehousing
  - Logistics and Supply Chain Management
  - Finance
  - Information Management

# Subsystems in computer-integrated manufacturing



**Major Elements of a CIM System**

# Subsystems in computer-integrated manufacturing



**Various Activities in CIM**

# Subsystems in computer-integrated manufacturing

- **Devices and equipment required:**
  - CNC, Computer numerical controlled machine tools
  - DNC, Direct numerical control machine tools
  - PLCs, Programmable logic controllers
  - Robotics
  - Computers
  - Software
  - Controllers
  - Networks
  - Interfacing
  - Monitoring equipment



# Subsystems in computer-integrated manufacturing

- **Technologies:**
  - FMS, (flexible manufacturing system)
  - ASRS, automated storage and retrieval system
  - AGV, automated guided vehicle
  - Robotics
  - Automated conveyor systems
- **Others:**
  - Lean manufacturing

# CIMOSA

- **CIMOSA** -Computer Integrated Manufacturing Open System Architecture is the enterprise modeling framework, which aims to support the enterprise integration of machines, computers and people

Its framework is based on the system life cycle concept, and offers a modeling language, methodology and supporting technology to support these goals

- is a 1990s European proposal for an open system architecture for CIM developed by the AMICE Consortium as a series of ESPRIT projects

**The goal of CIMOSA was "to help companies to manage change and integrate their facilities and operations to face world wide competition"**

# CIMOSA

- **CIMOSA** provides a solution for business integration with four types of products:
  - The CIMOSA Enterprise Modeling Framework providing a reference architecture for enterprise architecture
  - CIMOSA IIS,
    - a standard for physical and application integration.
  - CIMOSA Systems Life Cycle,
    - is a life cycle model for CIM development and deployment.
  - Inputs to standardization, basics for international standard development.

# CIMOSA Architecture

- The main focus of **CIMOSA** has been to construct:
  - a framework for enterprise modeling, a reference architecture
  - an enterprise modeling language
  - an integrating infrastructure for model performance supported by
  - a common terminology

# CIMOSA Architecture

- **CIMOSA** aims at integrating enterprise operations by means of efficient information exchange within the enterprise
- **CIMOSA** models enterprises using **four** perspectives:
  - the **function view** describes the functional structure required to satisfy the objectives of an enterprise and related control structures;
  - the **information view** describes the information required by each function;
  - the **resource view** describes the resources and their relations to functional and control structures; and
  - the **organization view** describes the responsibilities assigned to individuals for functional and control structures

# Development of CIM

- CIM is an integration process leading to the integration of the manufacturing enterprise
- Dictated by the needs of the individual enterprise, this process usually starts with the need to interchange information between the some of the so called “**islands of automation**”

# Development of CIM

- Flexible manufacturing cells, automatic storage and retrieval systems, CAD/CAM based design etc. are the examples of islands of automation i.e. a sort of computer based automation achieved completely in a limited sphere of activity of an enterprise
- This involves data exchange among computers, NC machines, robots, gantry systems etc.
  - Therefore the integration process has started bottom up
  - The interconnection of physical systems was the first requirement to be recognized and fulfilled.

# Development of CIM

