Ch 23: Product Design and CAD/CAM/CIM in the Production System

Learning Objectives:

By the end of the lecture the student should be able to:

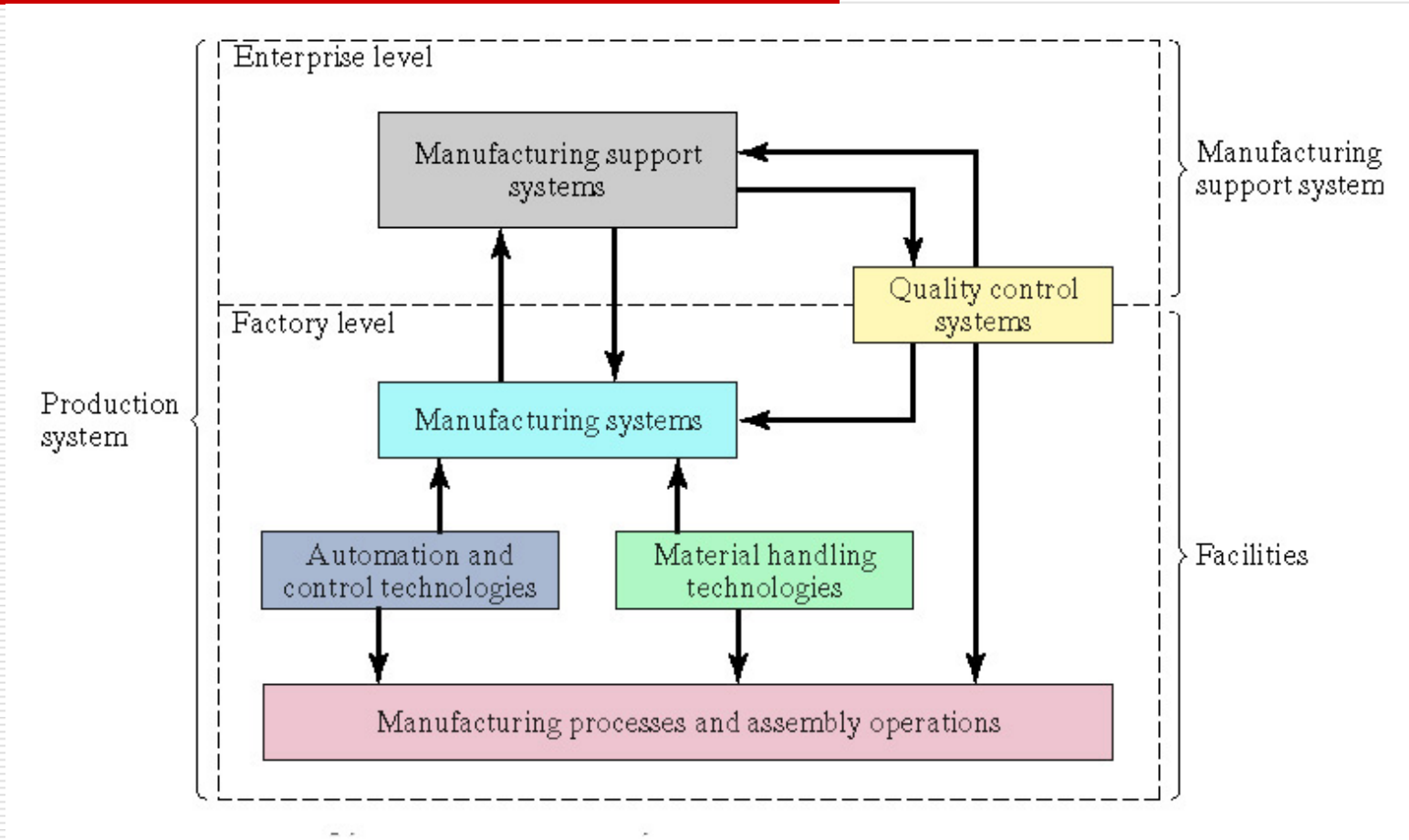
- Explain the six steps of design process
- Define and explain what Computer Aided Design is?
- Explain the influence of CAD on design process/product design.
- Define and explain what Computer Aided Manufacturing is?
- Explain CAM application into manufacturing planning and control.
- Define and explain what Computer Integrated Manufacturing is?
- Explain the scope of CAD, CAM, CIM.
- Outline computerized elements of CIM.
- Understand and explain the geometric modeling in MasterCam.

NOTE: Materials used to create this presentation were supplied from:

Lecture notes designed by 2008 Pearson Education Inc. Third Edition by Professor Mikell P. Groover

Lecture notes designed by Professor Darek Ceglarek, University of Wisconsin – Madison.

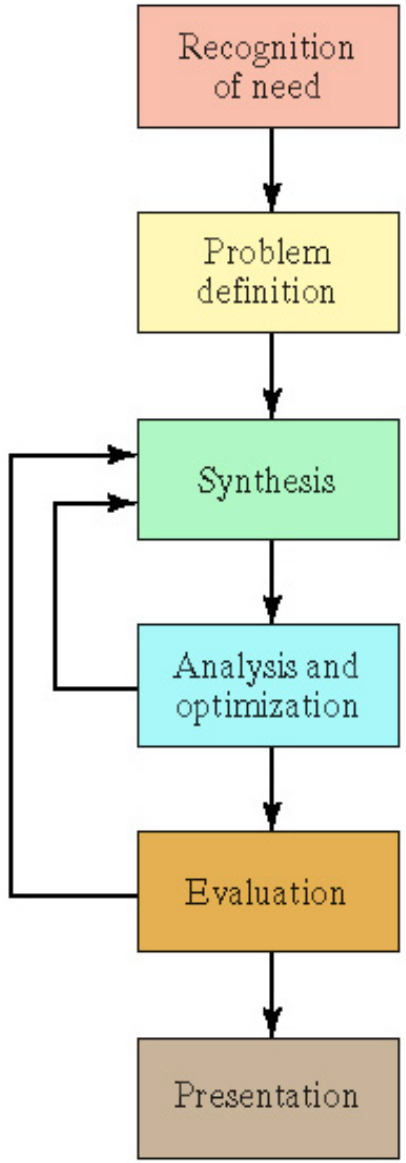
Manufacturing Support Systems in the Production System



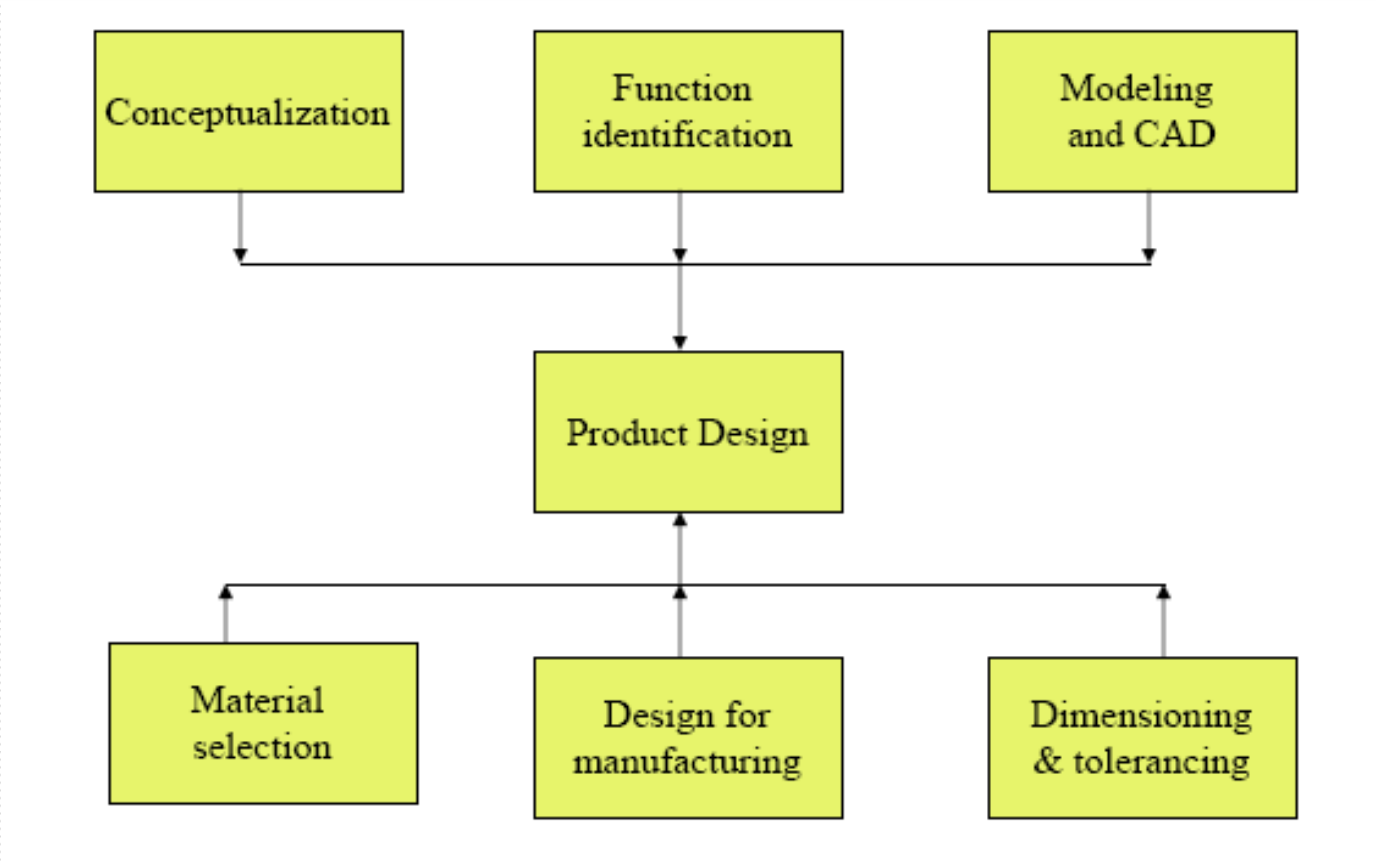
Design Process

The general process of design is characterized as an iterative process consisting of six phases:

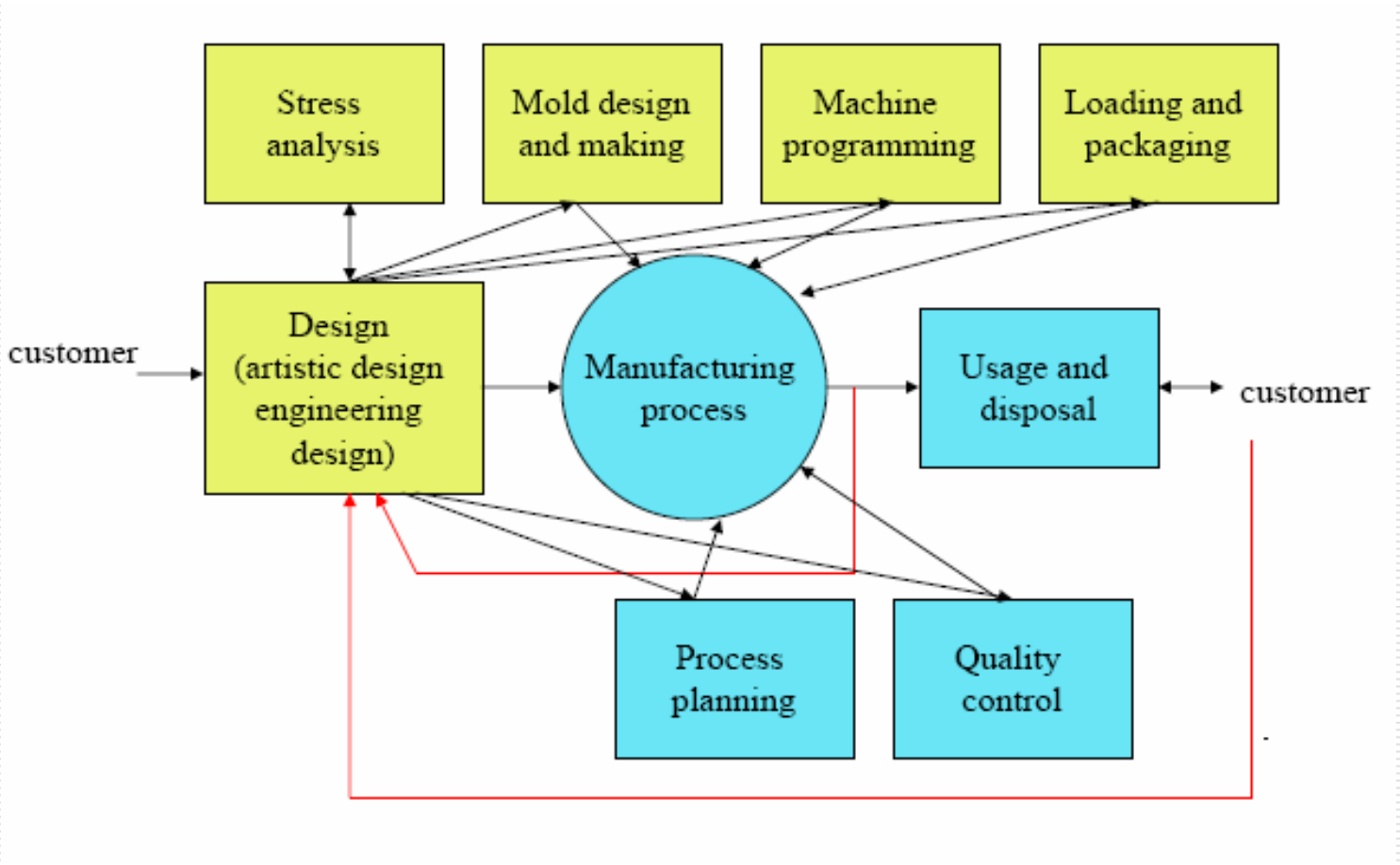
1. Recognition of need - someone recognizes the need that can be satisfied by a new design
2. Problem definition - specification of the item
3. Synthesis - creation and conceptualization
4. Analysis and optimization - the concept is analyzed and redesigned
5. Evaluation - compare design against original specification
6. Presentation - documenting the design (e.g., drawings)



Product Design Components



Example: making a plastic spoon

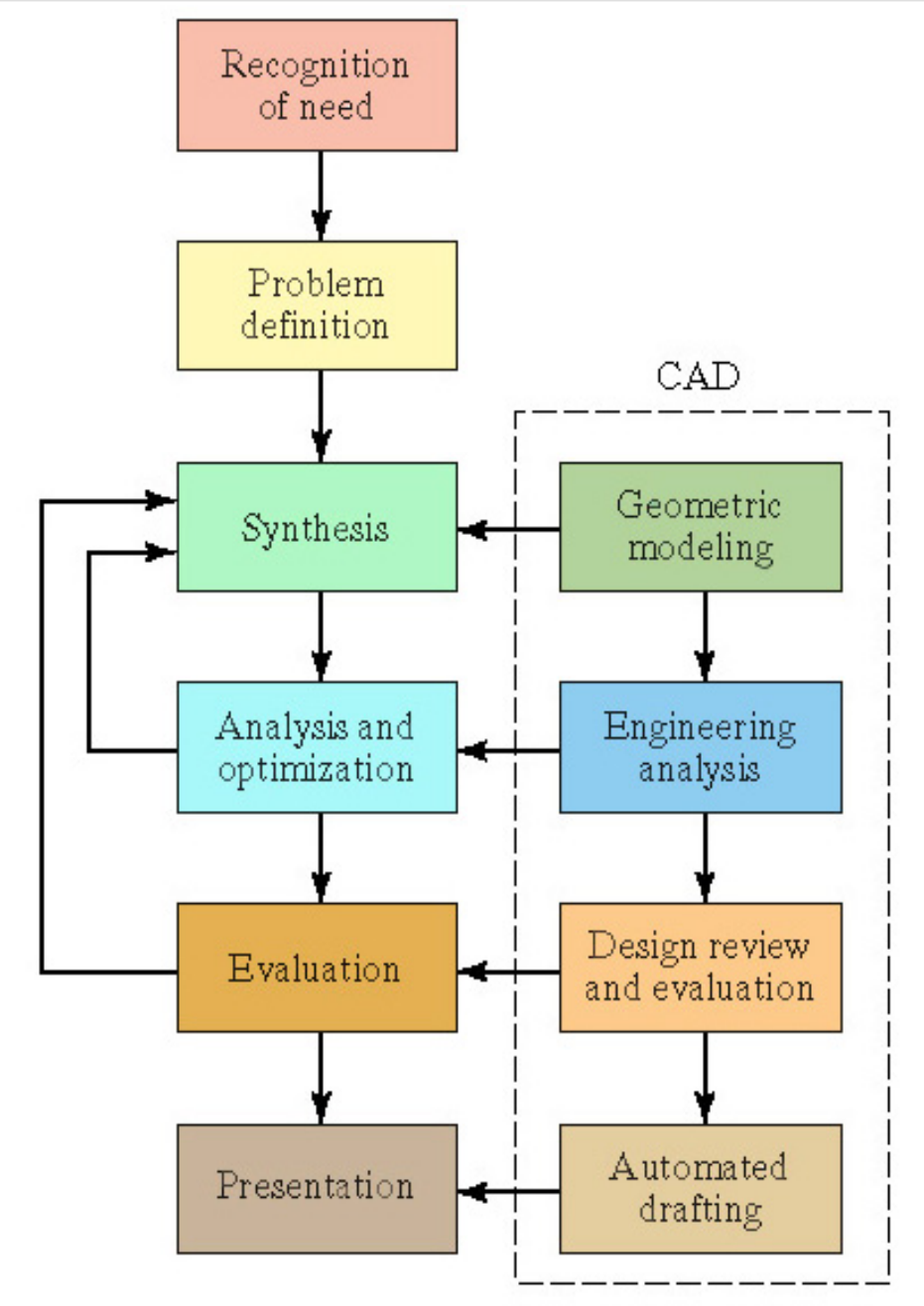


Computer-Aided Design (CAD)

- Any design activity that involves the effective use of the computer to create, modify, analyze, or document an engineering design
- Commonly associated with the use of an interactive computer graphics system, referred to as a CAD system
- The term CAD/CAM is also used if the computer system supports manufacturing applications as well as design applications

Reasons for Using a CAD System

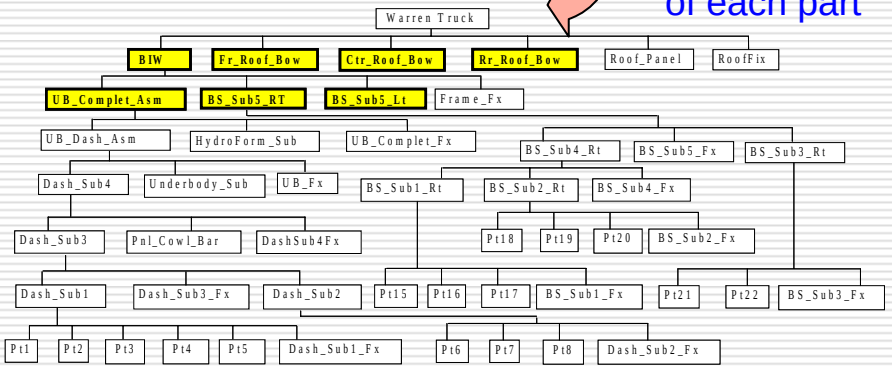
- To increase the productivity of the designer
- To expand the available geometric forms in design - wider range of mathematically defined shapes possible
- To improve the quality of the design - more engineering analysis possible, consideration of more alternatives
- To improve design documentation - better drawings than with manual drafting
- To create a manufacturing database - creation of the design documentation also creates manufacturing data
- To promote design standardization - use of design rules to limit the number of hole sizes, fasteners, etc.


Recognition of need
Problem definition
CAD
Synthesis
Geometric modeling
Analysis and optimization
Engineering analysis
Evaluation
Design review and evaluation
Presentation
Automated drafting

Example: Computer Aided Design (CAD) From Customer Need to Product Design

Market analysis, R&D

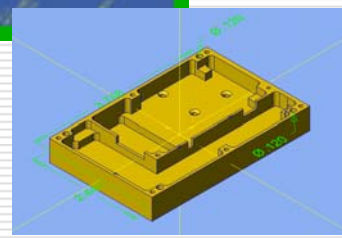
Convert customer need to function of each part



Convert to design specification

Computer Aided Design (CAD)

Part design specifications, Group Technology



Design Principles for quality and productivity

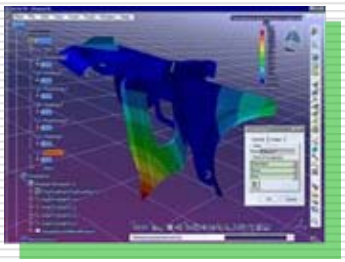
DFMA

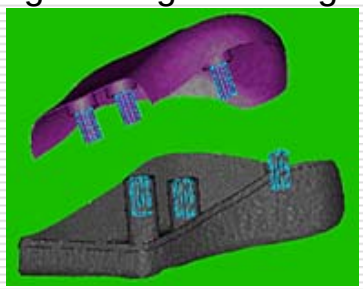
AXIOM

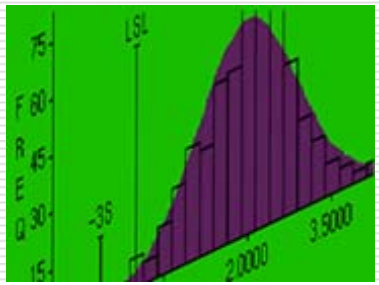
QFD

FMEA

Engineering Modeling







Stress, strength analysis

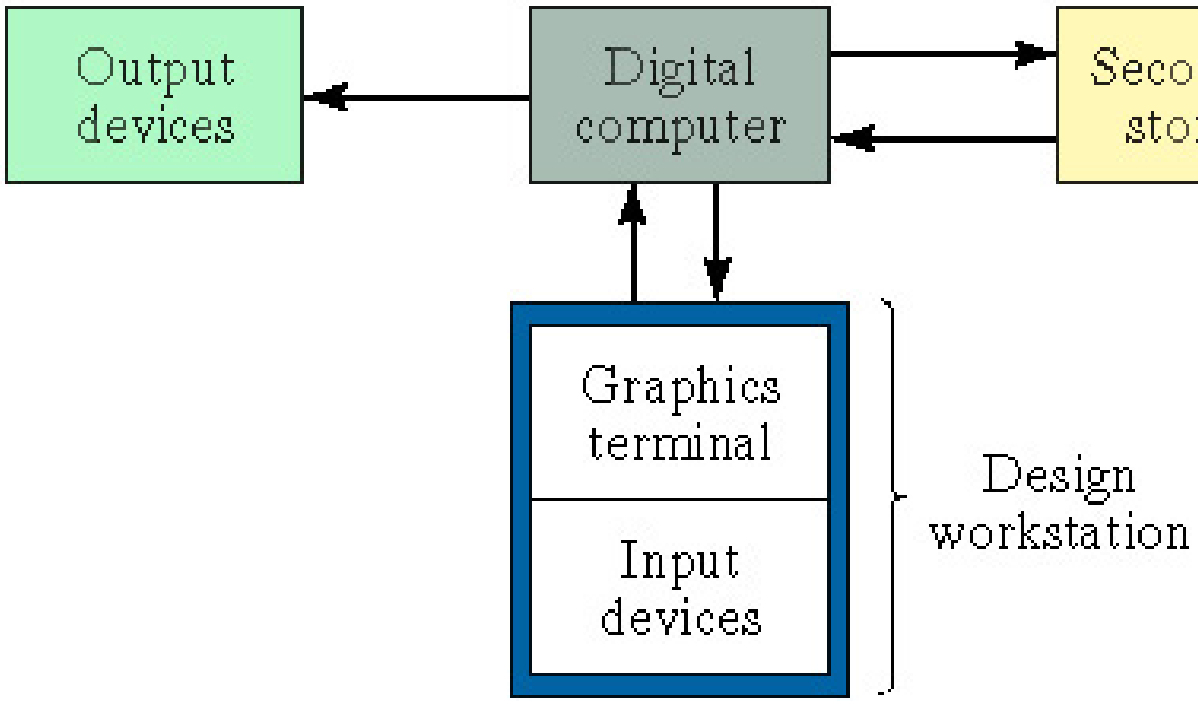
Curve, surface model

Product variation model

How a CAD System is Used in Product Design
(Steps 3 – 6 in Design Process)

- Geometric modeling
  - CAD system develops a mathematical description of the geometry of an object, called a geometric model
- Engineering analysis
  - Mass properties, interference checking for assemblies, finite element modeling, kinematic analysis for mechanisms
- Design evaluation and review
  - Automatic dimensioning, error checking, animation
- Automated drafting
  - Preparation of engineering drawings quickly

CAD System Hardware

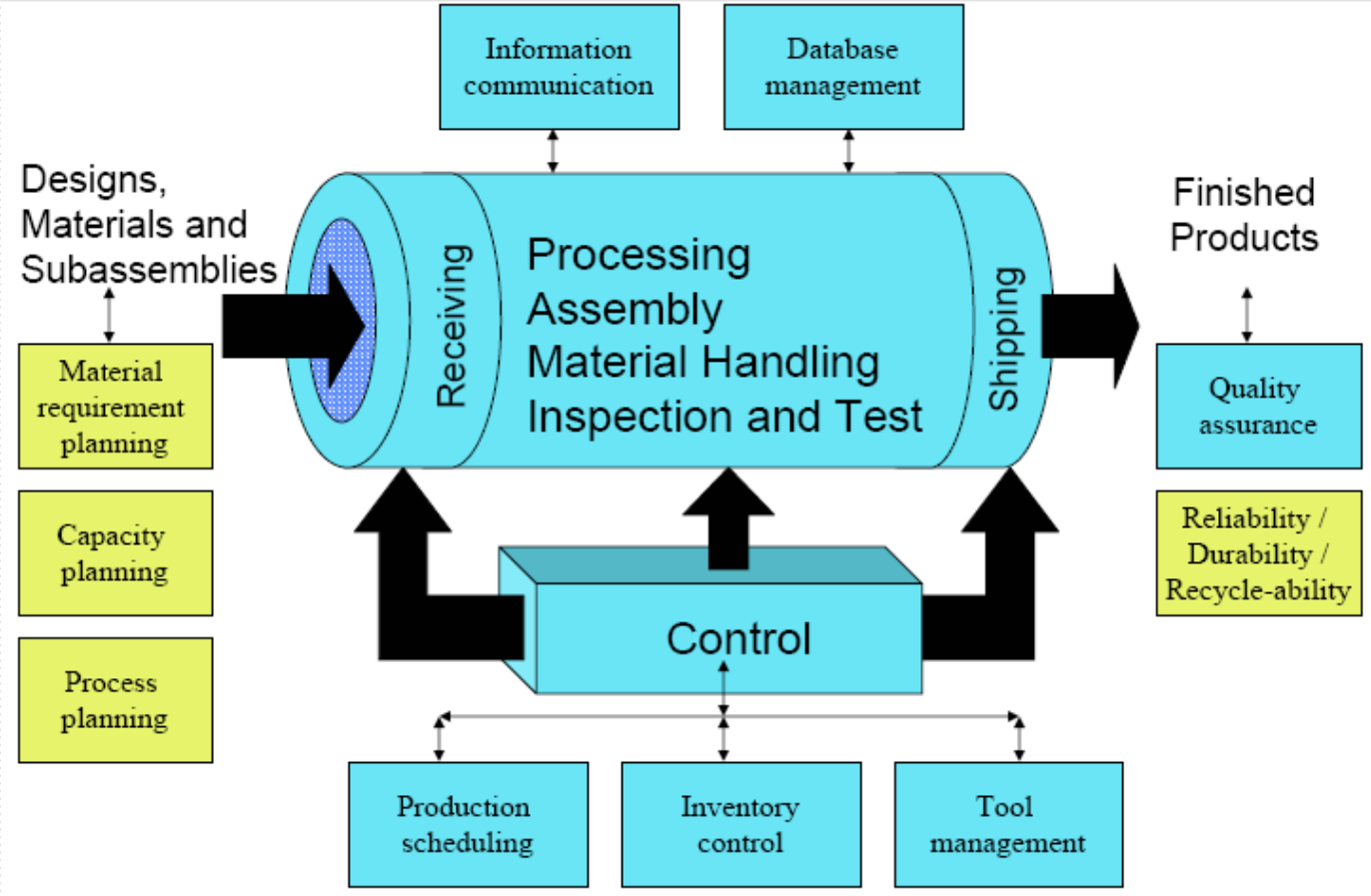


Computer Aided Manufacturing (CAM)

The effective use of computer technology in manufacturing planning and control

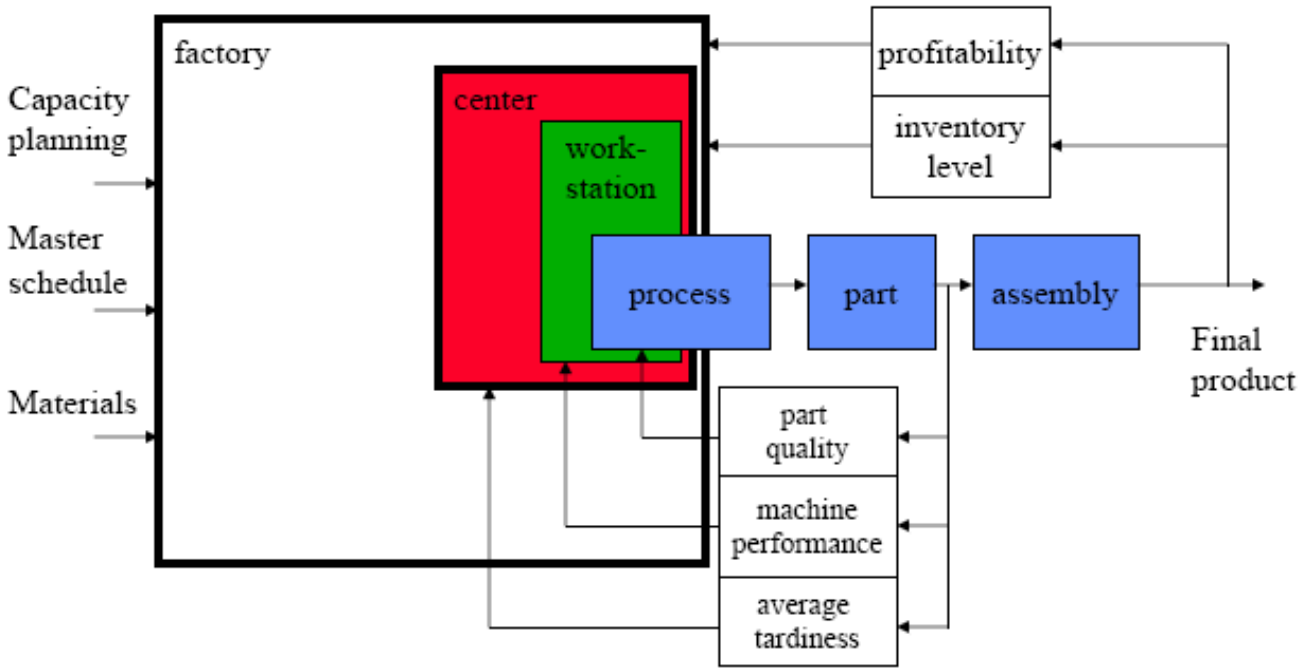
- Most closely associated with functions in manufacturing engineering, such as process planning and NC part programming
- CAM applications can be divided into two broad categories:
  1. Manufacturing planning
  2. Manufacturing control

Manufacturing Planning



Manufacturing Control

- There are many levels of manufacturing control, each serve for a specific function



Quality Control: An Example

Optical CMM - Measurement/Vision Station

CAD/CAM

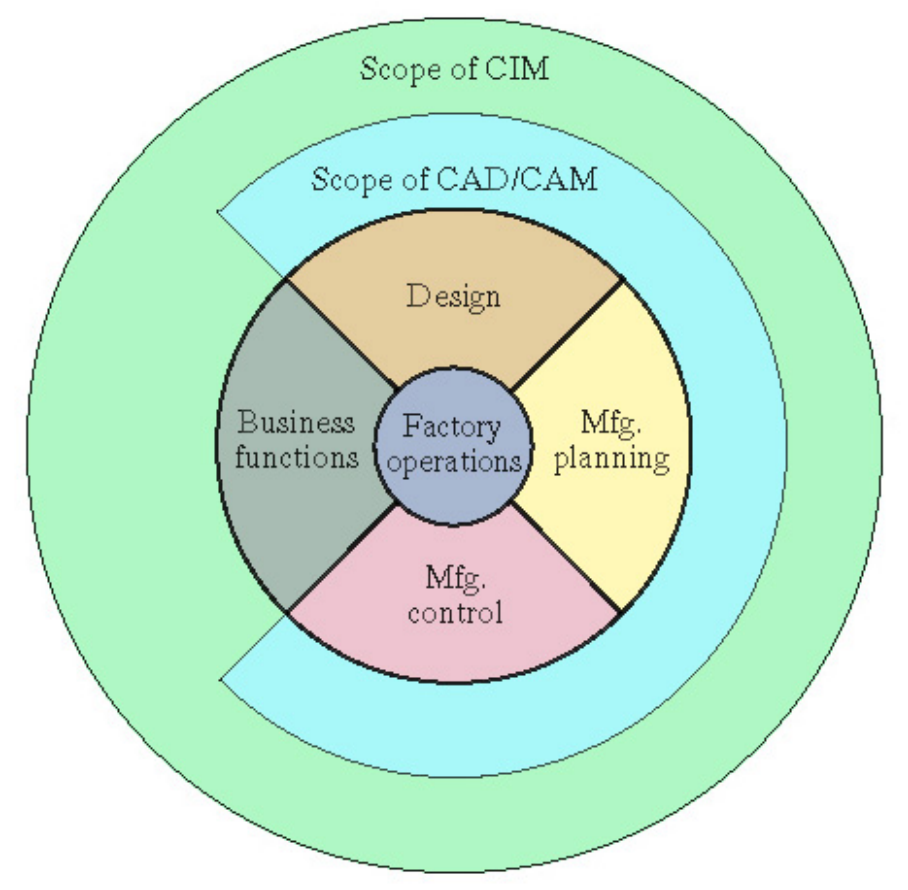
- Concerned with the engineering functions in both design and manufacturing
- Denotes an integration of design and manufacturing activities by means of computer systems
  - Goal is to not only automate certain phases of design and certain phases of manufacturing, but to also automate the transition from design to manufacturing
  - In the ideal CAD/CAM system, the product design specification residing in the CAD data base would be automatically converted into the process plan for making the product

Terms: "Over the wall design"; "Concurrent Engineering"

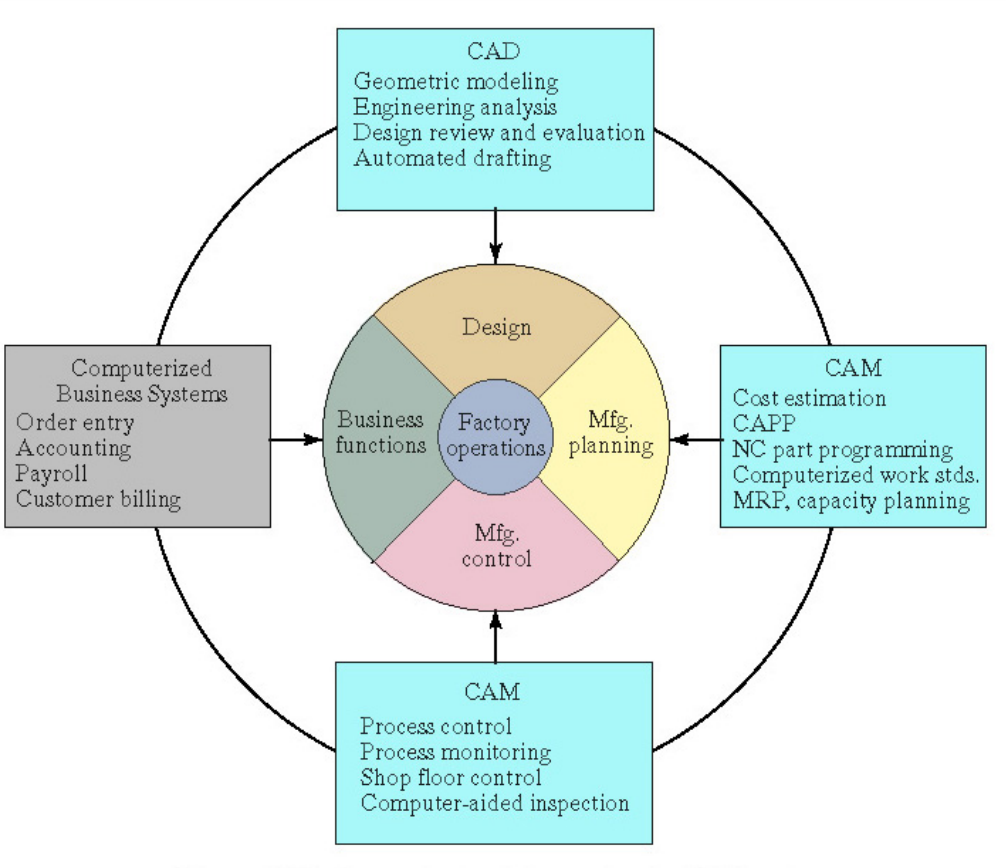
Computer Integrated Manufacturing (CIM)

- Includes all of the engineering functions of CAD/CAM
- Also includes the firm's business functions that are related to manufacturing
- Ideal CIM system applies computer and communications technology to all of the operational functions and information processing functions in manufacturing
  - From order receipt,
  - Through design and production,
  - To product shipment

The Scope of CAD/CAM and CIM



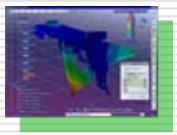
Computerized Elements of a CIM System

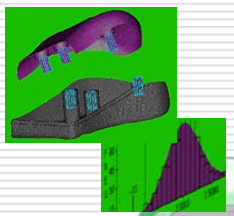


CAD/CAM in the Product Life Cycle

Market analysis, R&D

Engineering Modeling

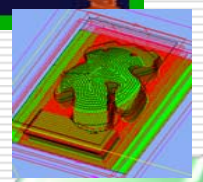




Computer Aided Design (CAD)

Product design GD&T

Process design GD&T



Computer Aided Manufacturing (CAM)

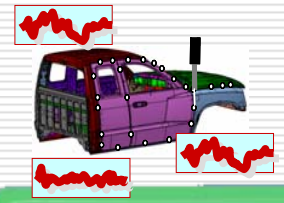
Prototyping

Rapid Prototyping

Production system

Cell, Quick Response Manufacturing

Quality control



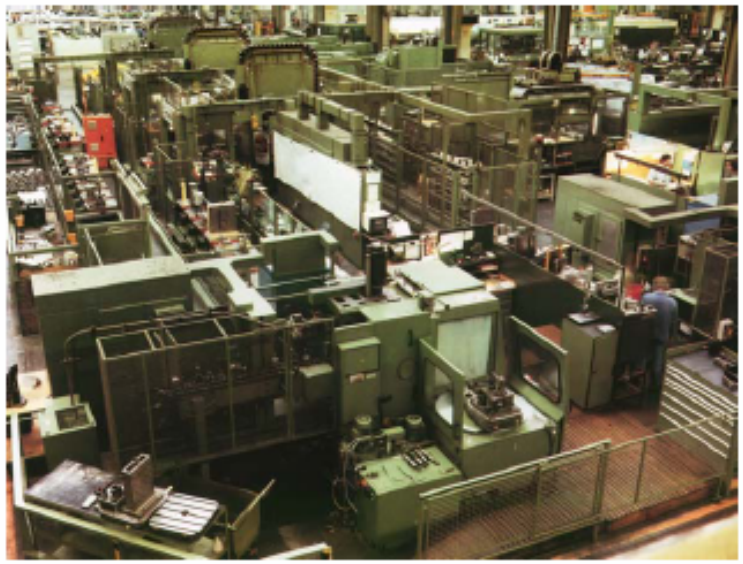
Statistic Process Control (SPC)

Field warranty service

Topics and related classes

Reality Check…

Systems Like This → Have to Wait for These



Acronyms and Abbreviations (Manager's Guide)

- AGV Automatically Guided Vehicle
- APT Automatically Programmed Tools
- AS/RS Automated Storage and Retrieval System
- BUE Built Up Edge
- CAD Computer Aided Design
- CAPP Computer Aided (or Assisted) Process Planning
- CIA Computer Integrated Assembly or Central Intelligence Agency
- CIM Computer Integrated Manufacturing
- CMM Coordinate Measuring Machine

Acronyms and Abbreviations (Manager's Guide)

- DFA(M or X) Design for Assembly (or Manufacture or Anything)
- DNC Direct (or Distributed) Numerical Control
- EDM Electrical Discharge Machining
- FMS (Flexible Manufacturing (or Machining) System
- GT Group Technology
- JIT Just in Time
- KBS Knowledge Based Systems
- LAN Local Area Network
- MAP Manufacturing Automation Protocol
- MRP Manufacturing Resource (or Requirements) Planning

Acronyms and Abbreviations (Manager's Guide)

- CNC (Computer) Numerical Control
- OC Curve Operating Characteristics Curve
- PC or PLC Personal Computer or Programmable (Logic)Controller
- QC(A) Quality Control (or Assurance)
- QTAT Quick Turn Around Time
- ROI Return on Investment
- SCARA Selective Compliance Assembly Robot Arm
- SPC Statistical Process Control
- TOP Technical and Office Protocol
- WIP Work In Process
- U & V and X - Z Open to suggestions