Tech 149: Unit 4 Lecture

Network Systems, Quality Systems, Manufacturing Planning, Control and Scheduling in CIM Environment

Network Systems in CIM

For Connectivity and Communications in:

- CAD/CAM, CAE, CAPP, and other sub-systems

- Departmental activities

- Plant-wide activities

- Company-wide activities

- Global activities

- Executive planning and managerial activities

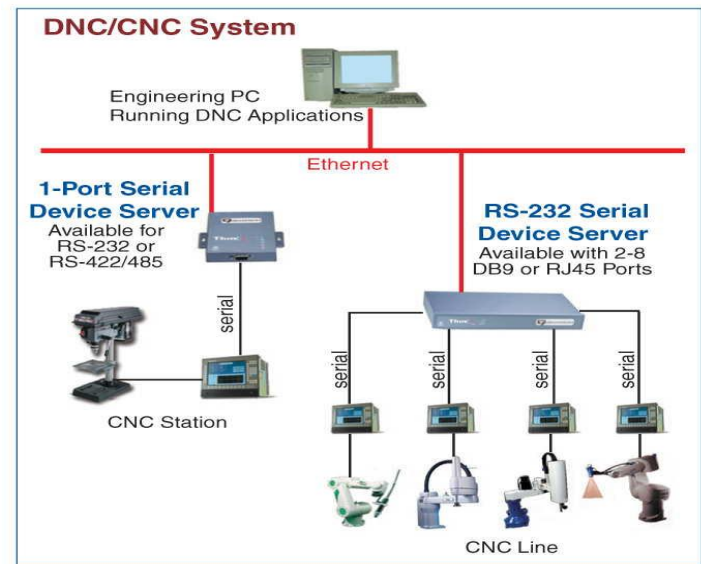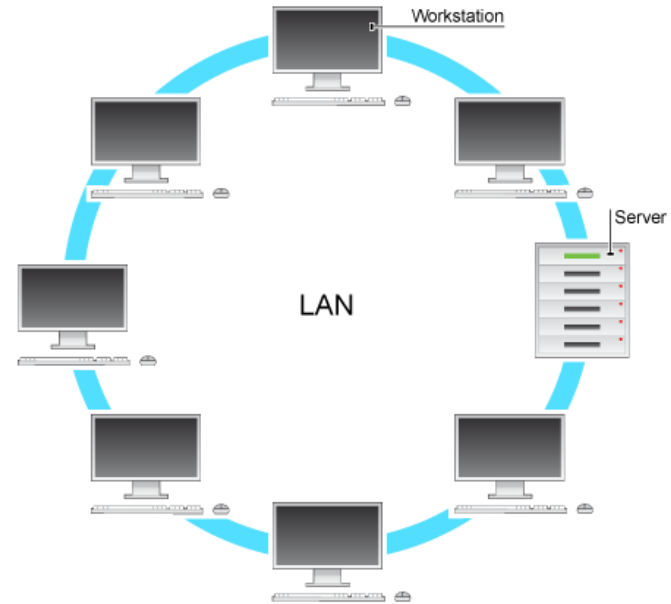# Types of CIM Network Systems

Local Area Network (LAN)
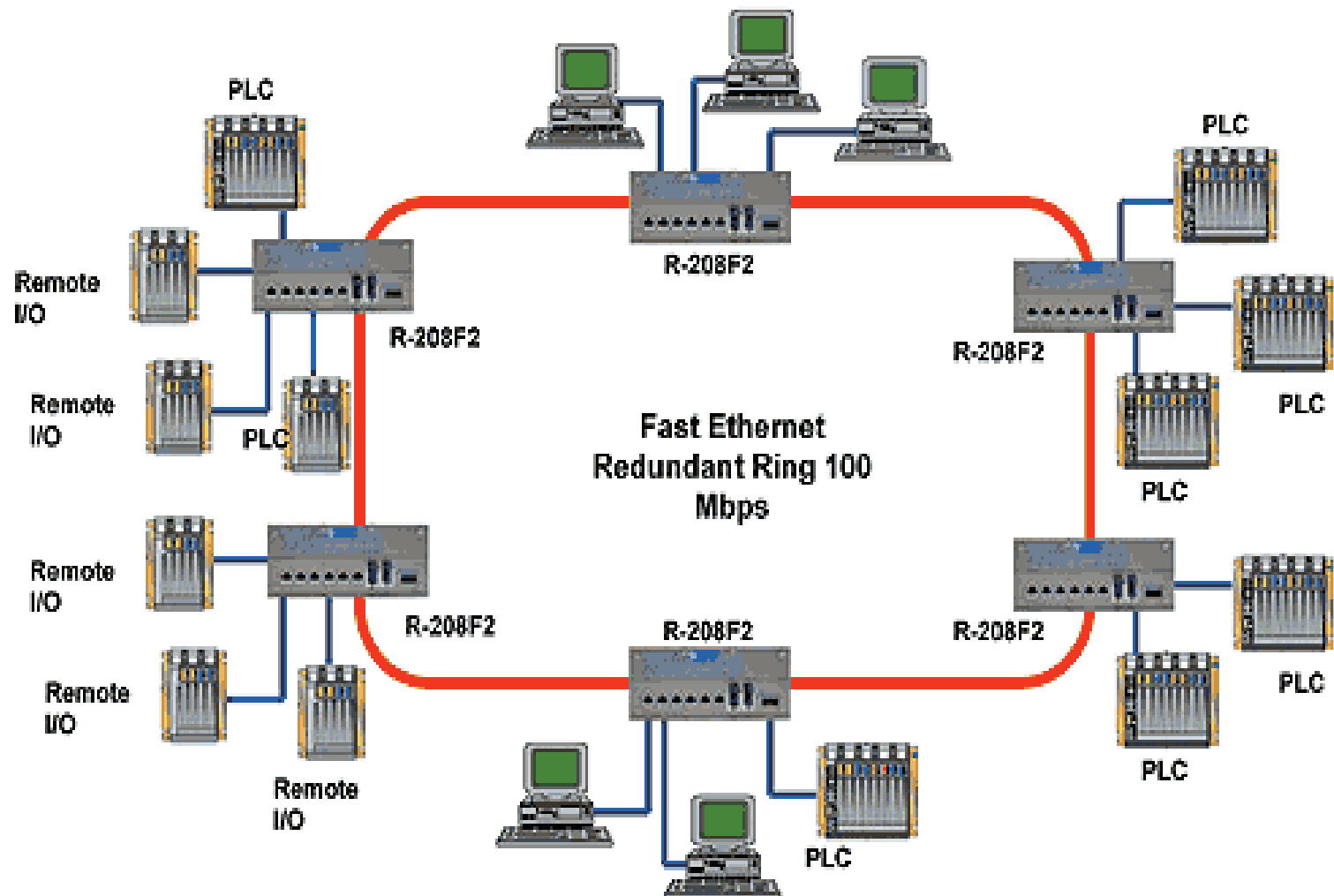Metropolitan Area Network (MAN)
Wide Area Network (WAN)

Local Area Network (LAN)

- A group of computers and associated devices that share a common communications line or wireless link to a server within a small geographic area such as an office building or home.

Sample Local Area Network

Chapter 9: Discrete Control Using PLCs and PCs

Sections:

1. Discrete Process Control
2. Ladder Logic Diagrams
3. Programmable Logic Controllers
4. Personal Computers and Programmable Automation Controllers

Logic Control

A switching system whose output at any moment is determined exclusively by the values of inputs

- No memory
- No operating characteristics that depend on time

Ladder Logic Diagrams

A diagram in which various logic elements and other components are displayed along horizontal rungs connected on either end to two vertical rails

- Types of elements and components:
  1. Contacts - logical inputs (usually), e.g., limit switches, photo-detector
  2. Loads - outputs, e.g., motors, lights, alarms, solenoids
  3. Timers - to specify length of delay
  4. Counters - to count pulses received

Ladder Logic Diagram and Symbols
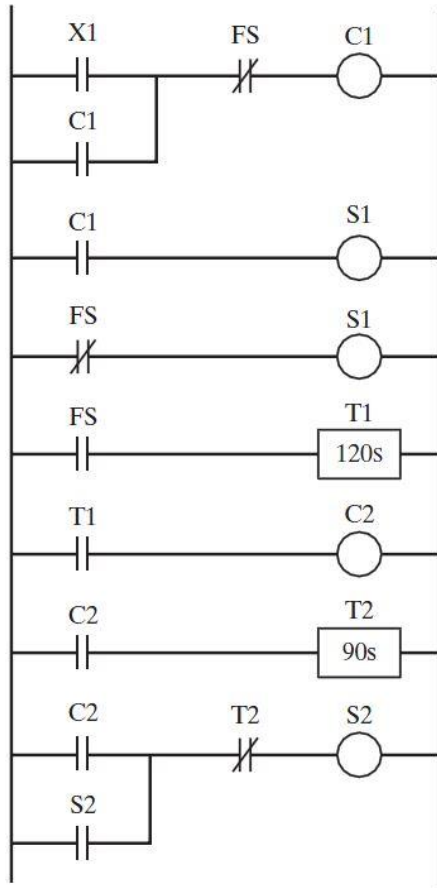
Ladder symbol	Hardware component
(a) ——⊣⊢——	Normally open contacts (switch, relay, other ON/OFF devices)
(b) ——⊣/⊢——	Normally closed contacts (switch, relay, etc.)
(c) ——◯——	Output loads (motor, lamp, solenoid, alarm, etc.)
(d) —[TMR 3s]—	Timer
(e) —[CTR]—	Counter

Programmable Logic Controller (PLC)

A microcomputer-based controller that uses stored instructions in programmable memory to implement logic, sequencing, timing, counting, and arithmetic functions through digital or analog modules, for controlling machines and processes
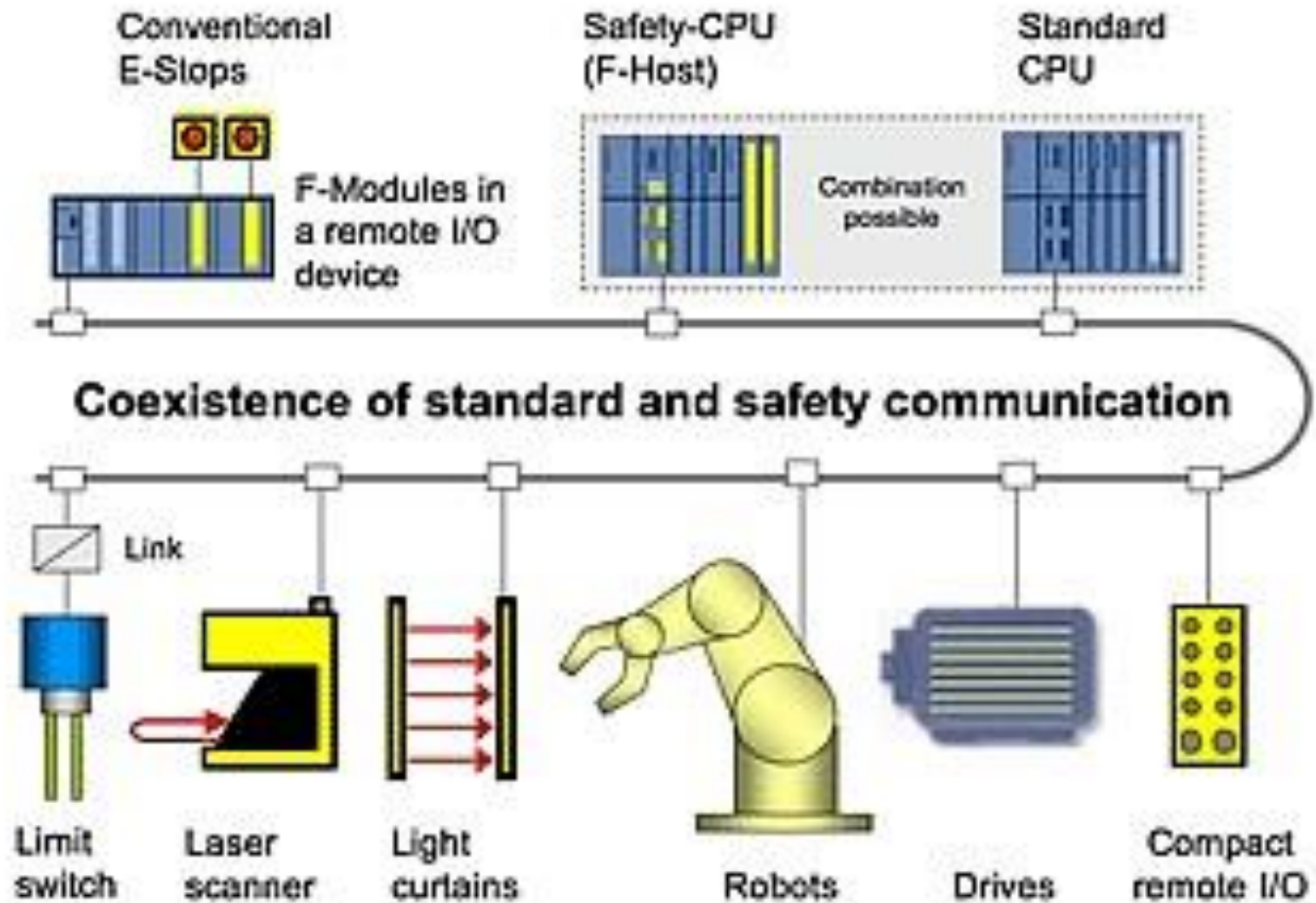
- Applications in both process industries and discrete manufacturing

- Introduced around 1970

- Replaced hard-wired electromechanical relay panels

PLC Facts

- https://www.youtube.com/watch?v=iWgHqqunsyE

PLC Applications

Conventional E-Stops — F-Modules in a remote I/O device

Safety-CPU (F-Host) — Combination possible

Standard CPU

Coexistence of standard and safety communication

Link

Limit switch | Laser scanner | Light curtains | Robots | Drives | Compact remote I/O
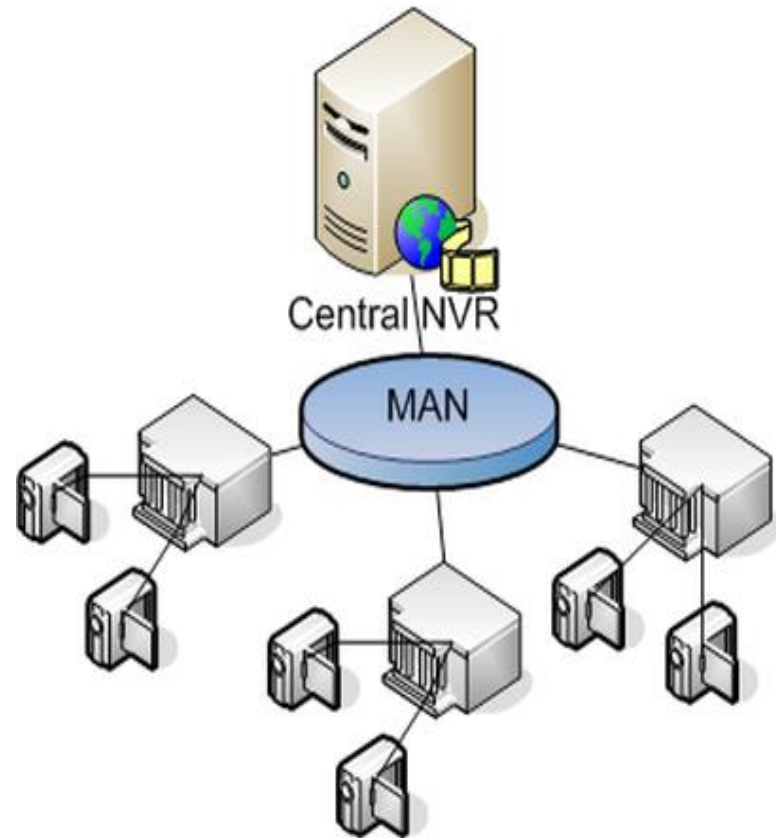
Metropolitan Area Network (MAN)

- A network that interconnects users with computer resources in a geographic area or region larger than that covered by a large local area network (LAN) but smaller than the area covered by a wide area network
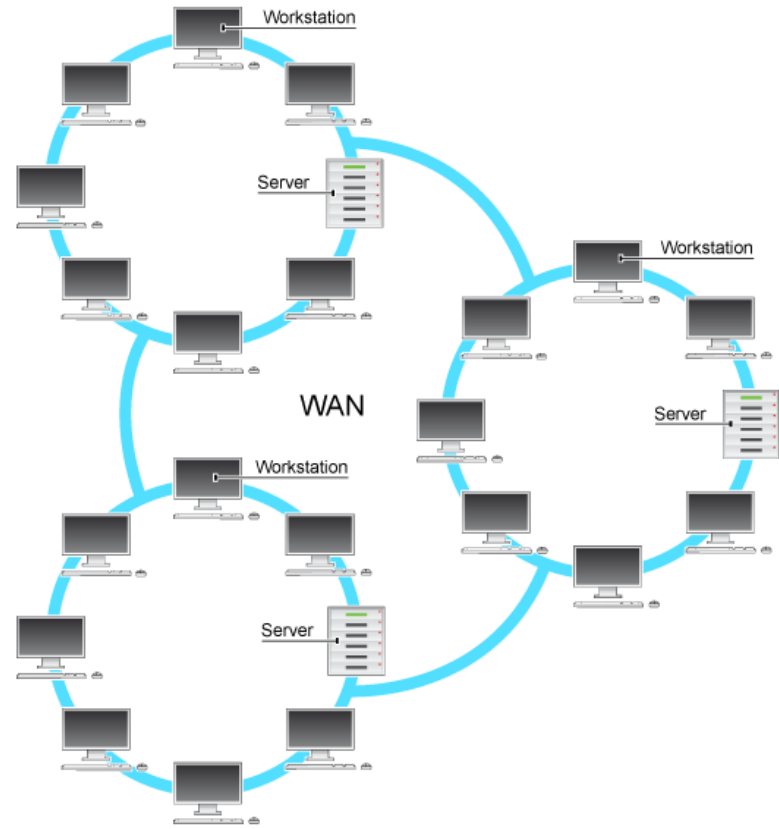
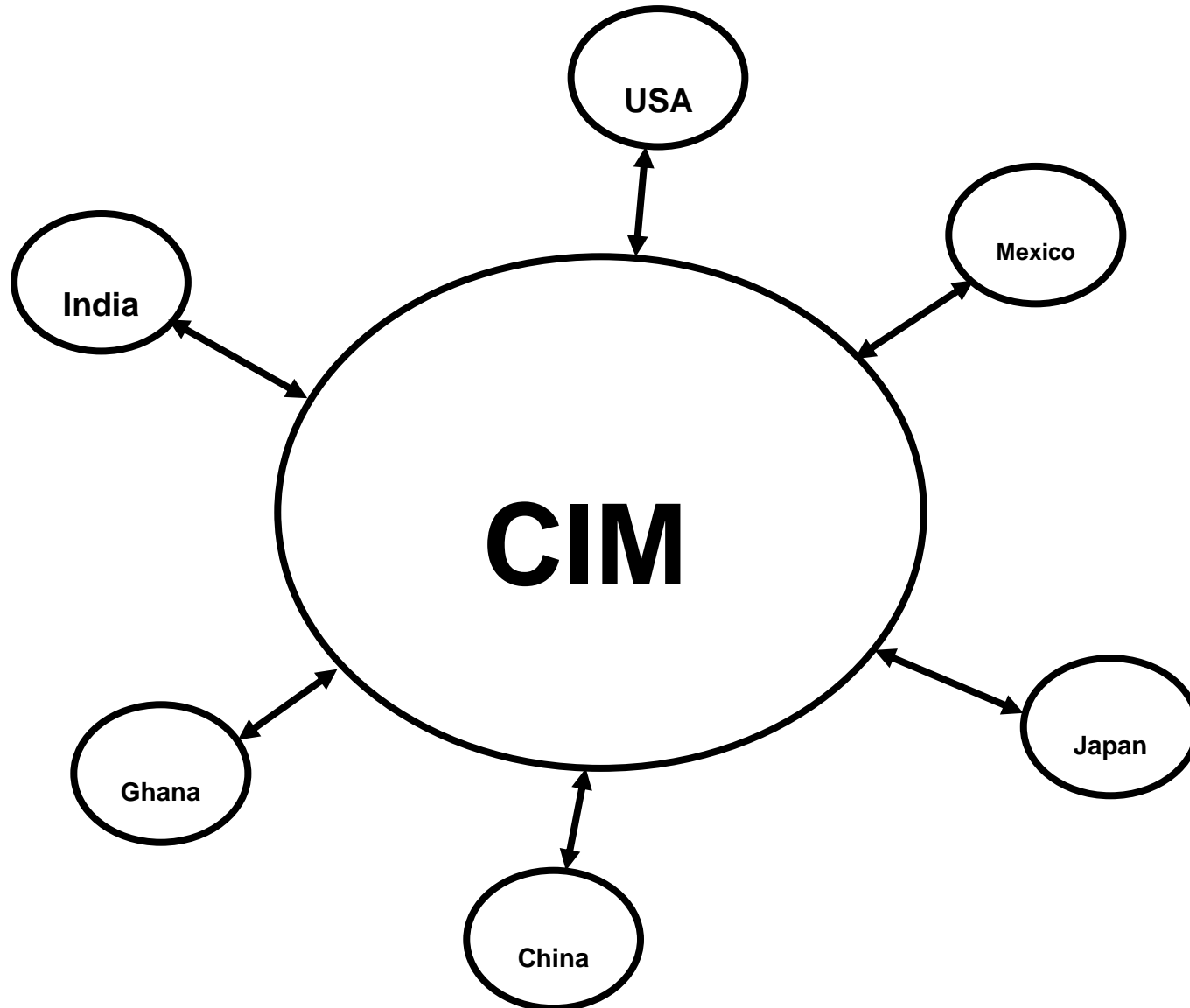# Sample Metropolitan Area Network

Wide Area Network (WAN)

- A computer network that spans a large geographical area of two or more local-area networks. These computers are often connected through public networks, such as the telephone system, leased lines or satellites.
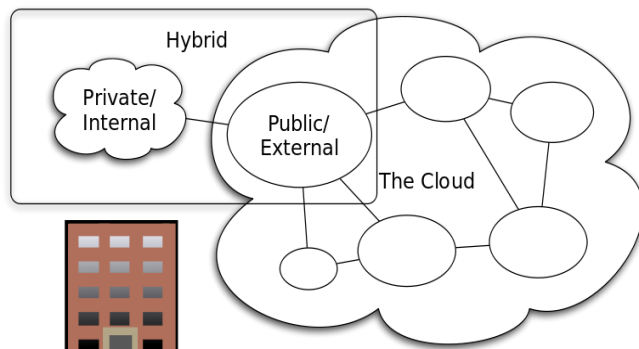
Sample Global CIM Network Systems

Cloud-Based Computer Networking

The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.

Hybrid

Private/Internal

Public/External

The Cloud

On Premises / Internal

Off Premises / Third Party

Cloud Computing Types

Benefits of Cloud-Based Network Systems

1. It allows companies to avoid upfront infrastructure costs, and focus on projects.
2. It allows enterprises to get their applications up and running faster.
3. It allows for improved system manageability and less maintenance.
4. It enables companies to more rapidly adjust resources to meet fluctuating and unpredictable business demand.

Chapter 25: Production Planning and Control

Sections:

1. Aggregate Production Planning and the Master Production Schedule

2. Material Requirements Planning

3. Capacity Planning

4. Shop Floor Control

5. Inventory Control

6. Manufacturing Resource Planning (MRP II)

7. Enterprise Resource Planning (ERP)

Production Planning and Control

- Concerned with the logistics problems in manufacturing:
  - Managing the details of what, when, and how many products to produce
  - And obtaining the raw materials, parts, and resources to produce them
- PPC solves these logistics problems by managing information
- PPC is the integrator in computer integrated manufacturing

Production Planning

- Concerned with:

  1. Deciding which products to make, how many of each, and when they should be completed

  2. Scheduling the delivery and/or production of the parts and products

  3. Planning the manpower and equipment resources needed to accomplish the production plan

Activities in Production Planning

- Aggregate production planning – planning the production output levels for major product lines
  - Must be coordinated with product design, production, marketing, and sales

- Master production planning – specific schedule (master production schedule) of the quantities of individual models in each major product line

- Material requirements planning (MRP) – detailed schedule of raw materials and parts production for models in master schedule

- Capacity planning – planning labor and equipment resources to achieve the master schedule

Production Control

- Concerned with determining whether the necessary resources to implement the production plan have been provided
    - If not, it attempts to take corrective action to address the deficiencies
- Major topics in production control:
    - Shop floor control
    - Inventory control
    - Manufacturing resource planning
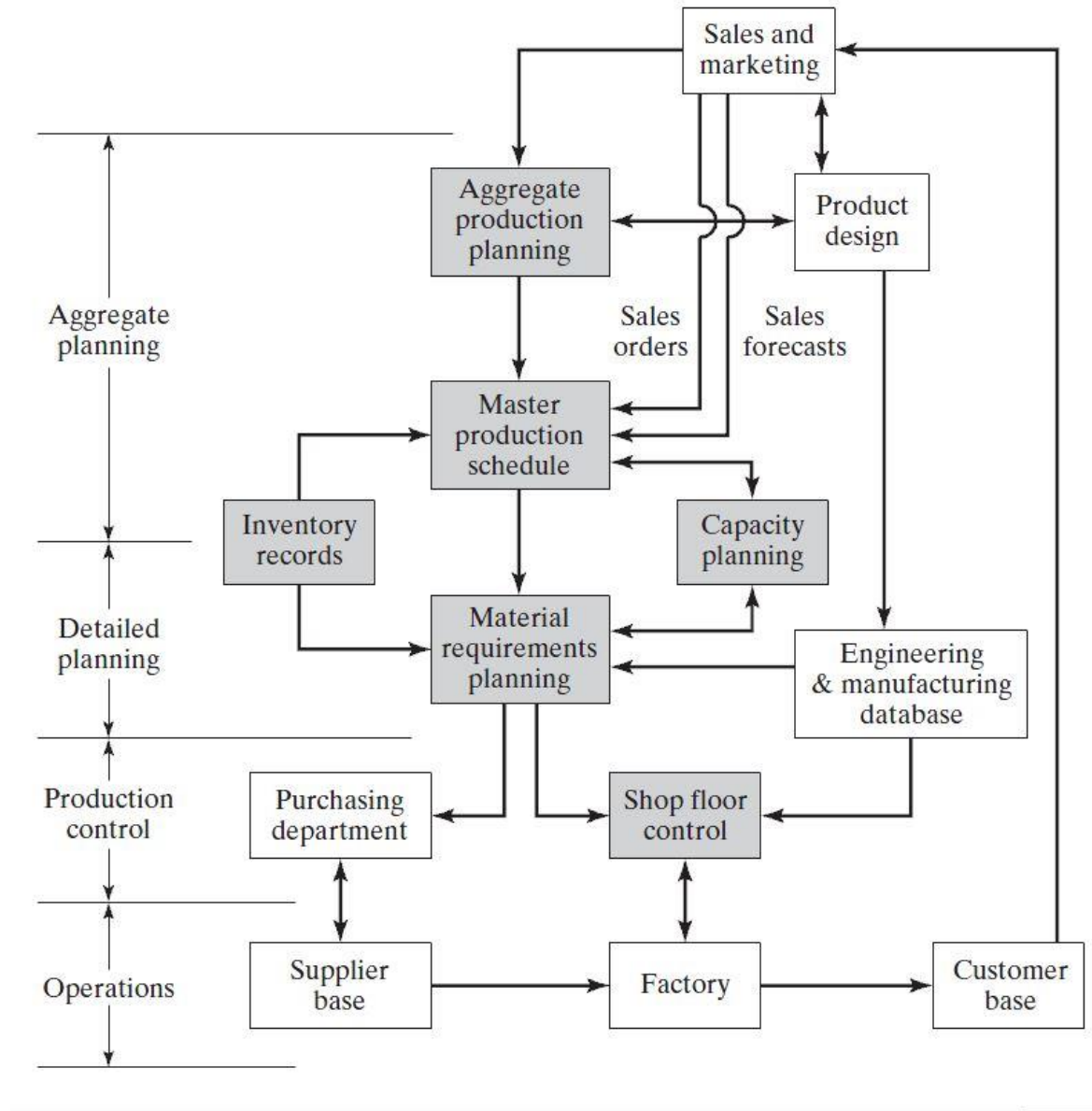   - Enterprise resource planning

Activities in a Production Planning and Control System

Aggregate Production Planning

Planning the production output levels for major product lines

- High-level corporate planning activity
- Must be coordinated with the plans of the sales and marketing departments
  - Includes products that are currently in production
    - Must consider current and future inventory levels of those products
  - Also includes new products currently being developed
- Marketing plans for current and new products must be reconciled against total capacity resources of the company

Master Production Schedule

The specific schedule of individual products and models that is derived from the aggregate production plan

- It is a list of the products to be manufactured, when they should be completed and delivered, and in what quantities

- Master production schedule includes three categories of items:
    1. Firm customer orders
    2. Forecasted demand
    3. Spare parts

Master Production Schedule

Product line	Week									
	1	2	3	4	5	6	7	8	9	10
M model line	200	200	200	150	150	120	120	100	100	100
N model line	80	60	50	40	30	20	10			
P model line							70	130	25	100

(a) Aggregate production plan

Product line models	Week									
	1	2	3	4	5	6	7	8	9	10
Model M3	120	120	120	100	100	80	80	70	70	70
Model M4	80	80	80	50	50	40	40	30	30	30
Model N8	80	60	50	40	30	20	10			
Model P1								50		100
Model P2							70	80	25	

(b) Master production schedule

Specific schedule of individual products, quantities and times

Materials Requirement

Is concerned with planning, organizing and controlling the flow of materials from their initial purchase through internal operations to the service point through distribution.

Material Requirements Planning (MRP)

Computational technique that converts the master production schedule for end products into a detailed schedule for the raw materials and components used in the end products

- Useful for dependent demand items, not independent demand items
  - Independent demand items
    - Final products and spare parts
  - Dependent demand items
    - Component parts used in final products

Inputs to the MRP System

1. Master production schedule
   - Expressed in terms of time buckets

2. Bill of materials file – product structure and list of component parts in each product

3. Inventory record file (item master file) – includes:
   - Item master data – part number, order quantities, lead times
   - Inventory status – time-phased record of inventory status
   - Subsidiary data – purchase orders, engineering changes

Inventory Record File

Period		1	2	3	4	5	6	7
Item: **Raw material M4**								
Gross requirements								
Scheduled receipts				40				
On hand	50	50	50	90				
Net requirements								
Planned order releases								

Capacity Planning

Concerned with determining labor and equipment resources required to meet the current master schedule as well as long-term future production needs of the firm

- Also serves to identify the limitations of the available production resources so that an unrealistic master schedule is not planned

Capacity Planning

- Often accomplished in three stages:

  1. Resource requirements planning – to evaluate whether the aggregate production plan is feasible

  2. Rough-cut capacity planning – to assess feasibility of master production schedule

  3. Capacity requirements planning – detailed capacity calculation for individual departments and work cells

Shop Floor Control

Concerned with releasing production orders to the factory, monitoring and controlling the progress of the orders through the plant, and acquiring current information on the status of the orders

- Manufacturing execution system (MES) - the computer software that supports shop floor control

  – Typically includes capability to respond to on-line inquiries about the status of orders in the shop

  – Other MES functions may include generation of process instructions, real-time inventory control, and labor tracking

Shop Floor Control in Production Planning and Control
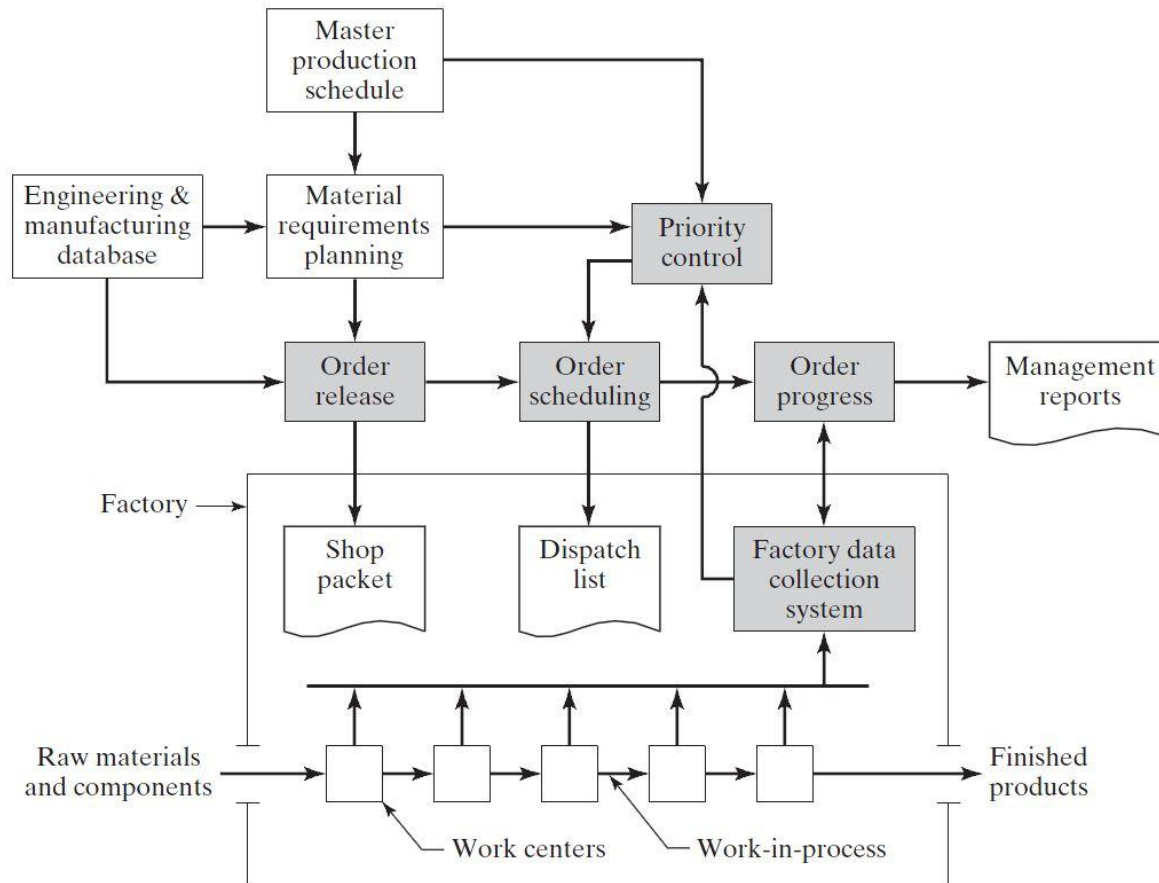
Manufacturing Resource Planning (MRP II)

Computer-based system for planning, scheduling, and controlling the materials, resources, and supporting activities needed to meet the master production schedule

- Three major modules in MRP II:

  1. Material requirements planning – planning for materials, parts, and assemblies, based on the master production schedule

  2. Capacity planning – interacts with the MRP module to ensure schedule are feasible

  3. Shop floor control – performs feedback control using the factory data collection system to implement order release, order scheduling, and order progress

Order Scheduling

Assigns production orders to work centers in the plant

- Executes the dispatching function in production planning and control

- Solves two problems in production control:
  1. Machine loading – allocating orders to work centers
     - Shop loading – loading all machines in the plant
  2. Job sequencing – determining the sequence in which orders will be processed through each work center

Types of Schedules

- Generic schedules
- Master production schedule (MPS)
- Material requirement planning (MRP)
- Daily production schedule (DPS)
- Critical path method (CPM)
- Project review and evaluation technique (PERT)
- Others

Critical Path = 4 Days
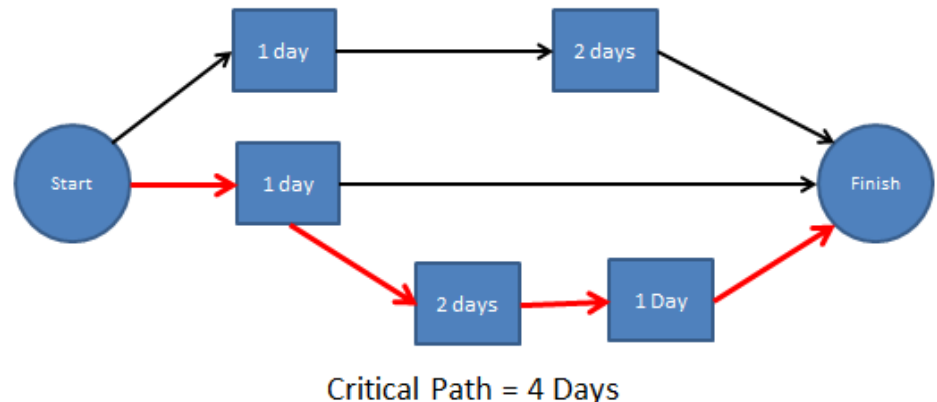
Scheduling in CIM Environment

- Scheduling information in CIM must be:
  - Shared by all
  - Seen by all
  - Retrieved by all
  - Contained in the Database
  - Must be functional
  - Must be in real time
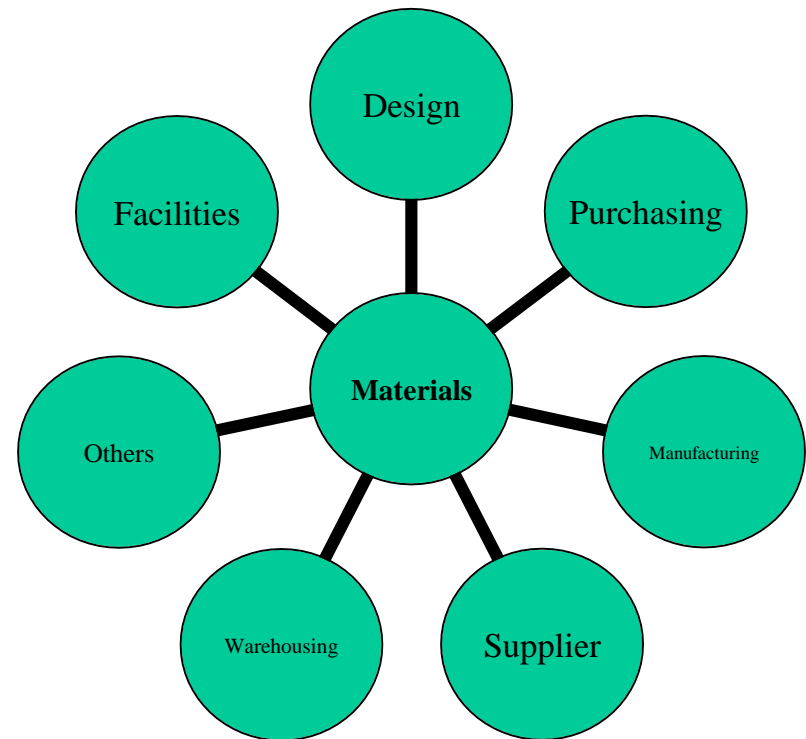 - Must be self updating

Sample Manufacturing Scheduling

Materials Scheduling in CIM

- JIT
- MRP
- Purchasing
- Networking Members:
  - Design
  - Purchasing
  - Manufacturing
  - Supplier
  - Warehousing
  - Facilities
 - Others

People Scheduling in CIM

- By job type
- By operation type
- By product type
- By shift

Assignment Cell Color Codes				Delete All Daily Assignment	
No Assignment Required				Delete Daily Assignments	Delete Daily Assignments
Assignment Required					
Assigned to More Than 1 Shift					
Violates Start/Stop Times				Sun	Mon
Category	Shift/Location	Start	Stop	14-Dec-03	15-Dec-03
Off	Off 1	8:00 AM	4:00 PM		
Off	Training	8:00 AM	4:00 PM		
Off	Vacation	8:00 AM	4:00 PM		
Manager	Open	6:00 AM	2:00 PM	Green, Ann	Green, Ann
Manager	Close	2:00 PM	10:00 PM	Olson, Andy	Olson, Andy
Cook	Open	6:00 AM	2:00 PM	Smith, Cindy	Smith, Cindy
Cook	Close	2:00 PM	10:00 PM	Mason, Jack	Mason, Jack
Waiter	Station A	6:00 AM	2:00 PM	Jones, Fox	Jones, Fox
Waiter	Station B	2:00 PM	10:00 PM	Clark, Tammy	Smith, Quid
Waiter	Station C	2:00 PM	10:00 PM	Mathers, Bill	Young, Jim

Green, Ann
Young, Jim
Olson, Andy
Smith, Cindy
Mathers, Bill
Mason, Jack
Jones, Fox
Clark, Tammy

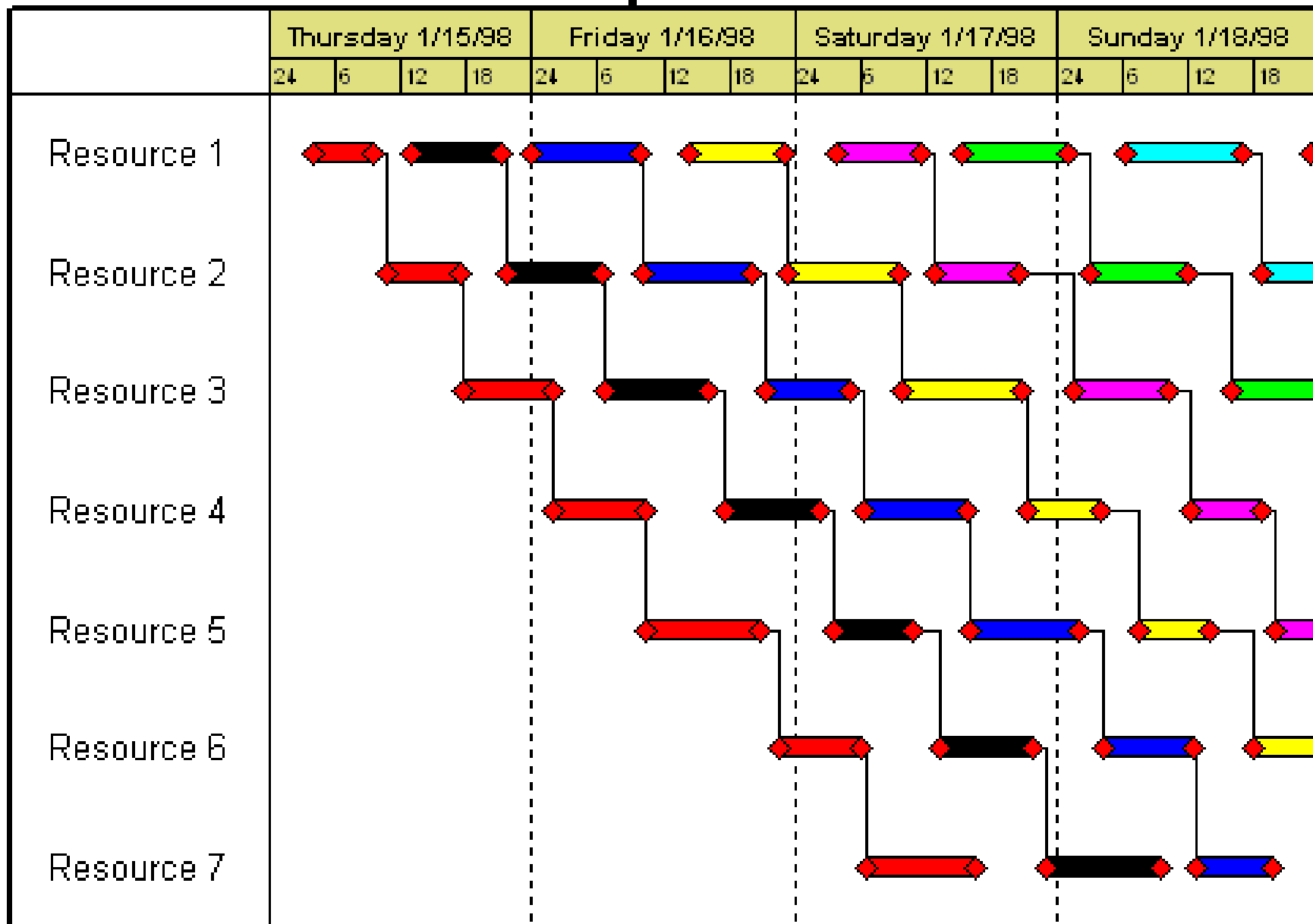# Equipment & Tooling Scheduling in CIM

- Process types
- Number available
- Routing issues
- Maintenance
- Facilities
- Others
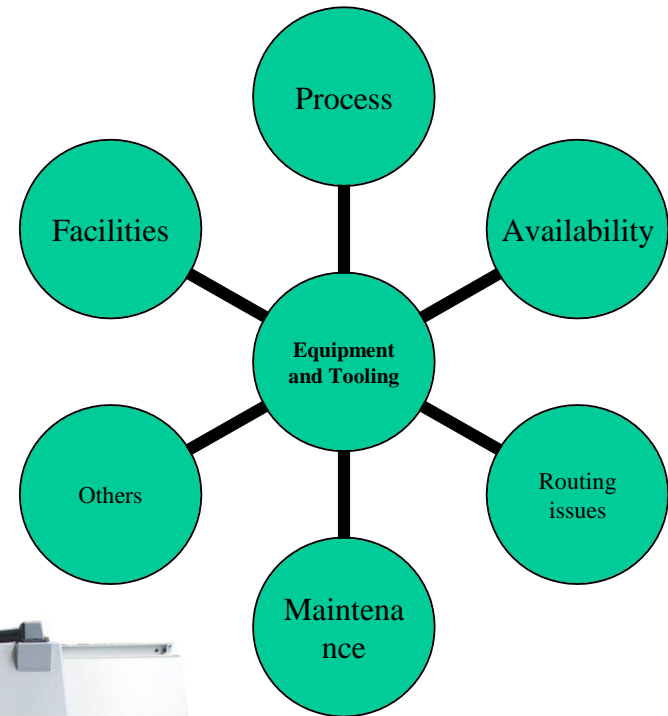
Lab Machine Schedule

	12/9/98											
	7AM	8AM	9AM	10AM	11AM	12PM	1PM	2PM	3PM	4PM	5PM	6PM
Machine A	Project 1 (7:30–10:30)				Project 2 (11:30–2:30)				Project 3 (4:00–6:30)			
Machine B	Project 4 (7:30–10:30)				Project 5 (12:00–3:00)				Project 6 (4:00–6:30)			
Machine C			Project 7 (9:30–12:30)			Project 8 (1:00–2:00)		Project 9 (3:30–6:00)				
Machine D		Project 10 (8:00–11:00)			Project 11 (12:00–1:30)		Project 12 (2:30–5:00)					
Machine E		Project 13 (8:30–11:00)			Project 14 (12:00–2:30)							
Machine F		Project 15 (8:00–9:30)	Project 16 (10:30–12:00)		Project 17 (12:30–2:00)		Project 18 (3:00–4:30)		Project 19 (5:00–6:30)			
Machine G			Project 20 (9:30–12:30)			Project 21 (1:30–4:30)						

Job Shop Schedule

	Thursday 1/15/98				Friday 1/16/98				Saturday 1/17/98				Sunday 1/18/98			
	24	6	12	18	24	6	12	18	24	6	12	18	24	6	12	18

Facilities Scheduling in CIM

- Layout issues
- Size and space issues
- Availability issues

Product Scheduling in CIM

- Delivery Issues
  - Customer issues
  - Production issues

New Product Launch

TASK	MANAGER	2008											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Create brochures	Pat D.	1/18		3/2		5/4		7/1		8/30		11/29	
Research product	Roy S.		2/16		4/20		6/15		8/21		10/28		
Design web site	Cari W.		2/15		4/4		6/15			9/11	10/30		
Conduct surveys	Corey K.				4/7		6/23			9/7		11/5	
Manufacture product	Sean B.		2/16	3/23		5/16		7/11		9/6		11/23	
Begin marketing	Sue B.	1/20		3/4	4/23		6/29			9/7	10/27		
Hire sales staff	Joe J.		2/28			5/9		7/15		9/21			
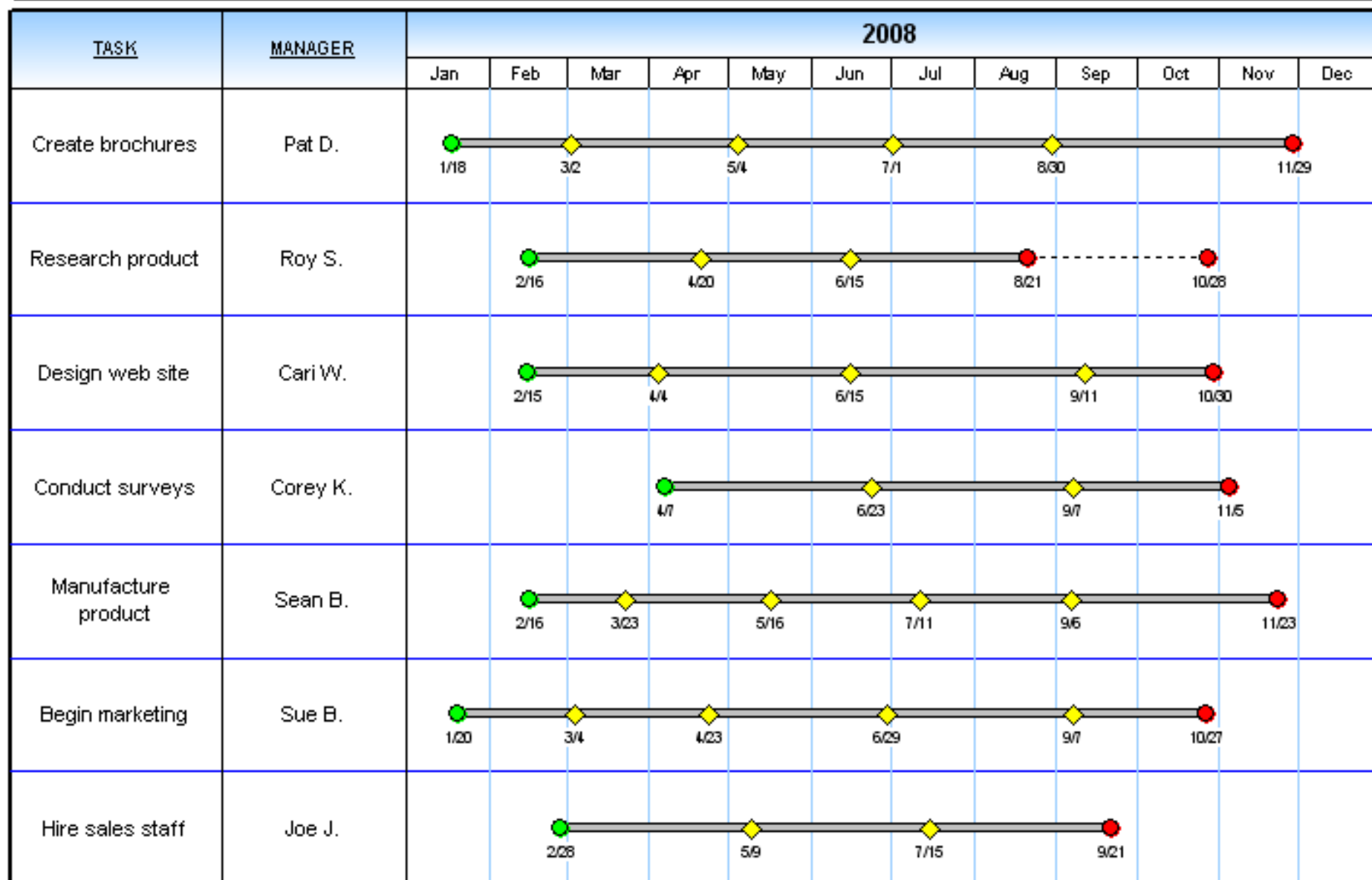
Legend: ● start ▬▬ progress ◆ milestone ● end ------ schedule slip

DAILY PRODUCTION SCHEDULE

ORDER #	WEEK 1 2 3 4 5 6 7	WEEK 1 2 3 4 5 6 7	WEEK 1 2 3 4 5 6 7	WEEK 1 2 3 4 5 6 7	WEEK 1 2 3 4 5 6 7	WEEK 1 2 3 4 5 6 7

1 2 3 4 5 6 7 1 2 3 4 5 6 7 1 2 3 4 5 6 7 1 2 3 4 5 6 7 1 2 3 4 5 6 7 1 2 3 4 5 6 7

Inventory Control

- Concerned with achieving an appropriate compromise between two opposing objectives:

  1. Minimizing the cost of holding inventory

     - Implies keeping inventory to a minimum

  2. Maximizing customer service

     - Implies keeping large stocks on hand so the customer can immediately take possession

Costs of Holding Inventory

1. Investment costs
   - Cost of money tied up in inventory until the customer pays for the finished product

2. Storage costs
   - Cost of space to store the inventory

3. Cost of possible obsolescence or spoilage
   - Reduction in value of inventory when it cannot be used

- Collectively, these costs are referred to as carrying costs or holding costs

Order Point Inventory Systems

- Concerned with two related problems that must be solved when managing inventories of independent demand items:

  1. How many units should be ordered?

     - Often solved by using economic order quantity formulas

  2. When should the order be placed?

     - Can be solved using reorder point methods

Inventory Model in Make-To-Stock
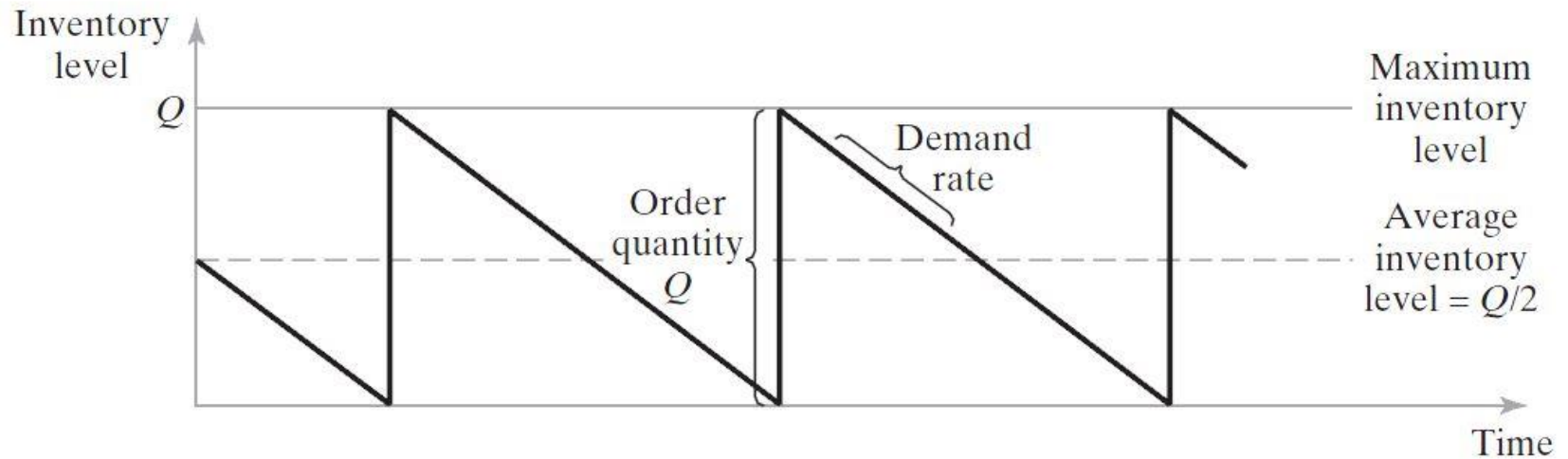
Inventory level over time in a typical make-to-stock situation

Economic Order Quantity Formula

- Situations when EOQ formula is appropriate:

  1. Demand rate for the item is fairly constant

  2. Rate of production is significantly greater than the demand rate

Total Inventory Cost Equation

- Total annual cost of inventory includes two terms

    1. Cost of holding inventory

    2. Cost of reordering or setup

- Equation for total inventory cost TIC

$$TIC = \frac{C_h Q}{2} + \frac{C_{su} D_a}{Q}$$

where C_h = holding cost, Q = order quantity, C_{su} = setup cost, and D_a = annual demand for the item

EOQ Formula

- By taking the derivative of *TIC* with respect to *Q* and setting the derivative equal to zero, the minimum cost order quantity can be determined

$$Q = EOQ = \sqrt{\frac{2D_a C_{su}}{C_h}}$$

Reorder Point Systems

- The actual demand rate for the item is not constant throughout the order cycle

- The time to reorder occurs when the actual inventory level falls below a point known as the reorder point

Operation of Reorder Point System
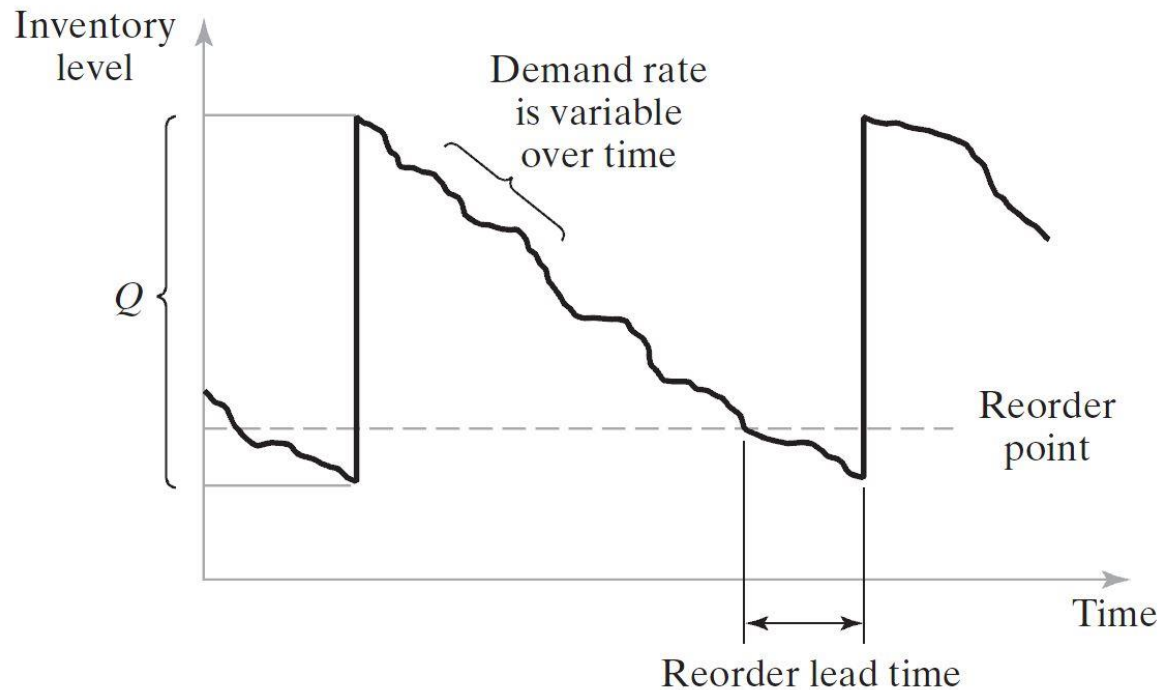
When inventory level reaches the reorder point, the next order for quantity Q is placed

Enterprise Resource Planning (ERP)

Defined as a computer software system that organizes and integrates all of the data and business functions of an organization through a single, central database

- The functions include:

Sales	Marketing	Purchasing
Operations	Logistics	Distribution
Inventory control	Accounting	Finance
Human resources		

- ERP runs as a client-server system - users access the system through their PCs
- ERP operates company-wide, not just plant-based

Enterprise Resource Planning (ERP)

- ERP is one of the newer system concepts that focuses on the integration of business systems

- These integrated systems support all of the functional departments in the enterprise: sales and order entry, engineering, manufacturing, finance and accounting, distribution, order planning and execution, and the supply chain flow

- Tech 149 team project is taking advantage of this philosophy in its systems integration approach

Enterprise Resource Planning (ERP)

Since businesses are increasingly focusing on customers, customer relationship management (CRM) systems are being developed to help companies manage the information they have about their customers, the products these customers buy, and the way the customers prefer to do business

Some Related Aspects of ERP
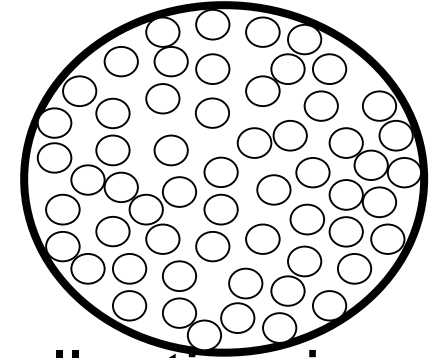
- Product data management (PDM)

- Information technology issues (data collection issues and system integration problems)

- The role of the Internet

- Sample ERP systems include: PeopleSoft, SAP R/3, Oracle, Sterling, Legacy, and JBA

Network Systems is All About Communications and Connectivity
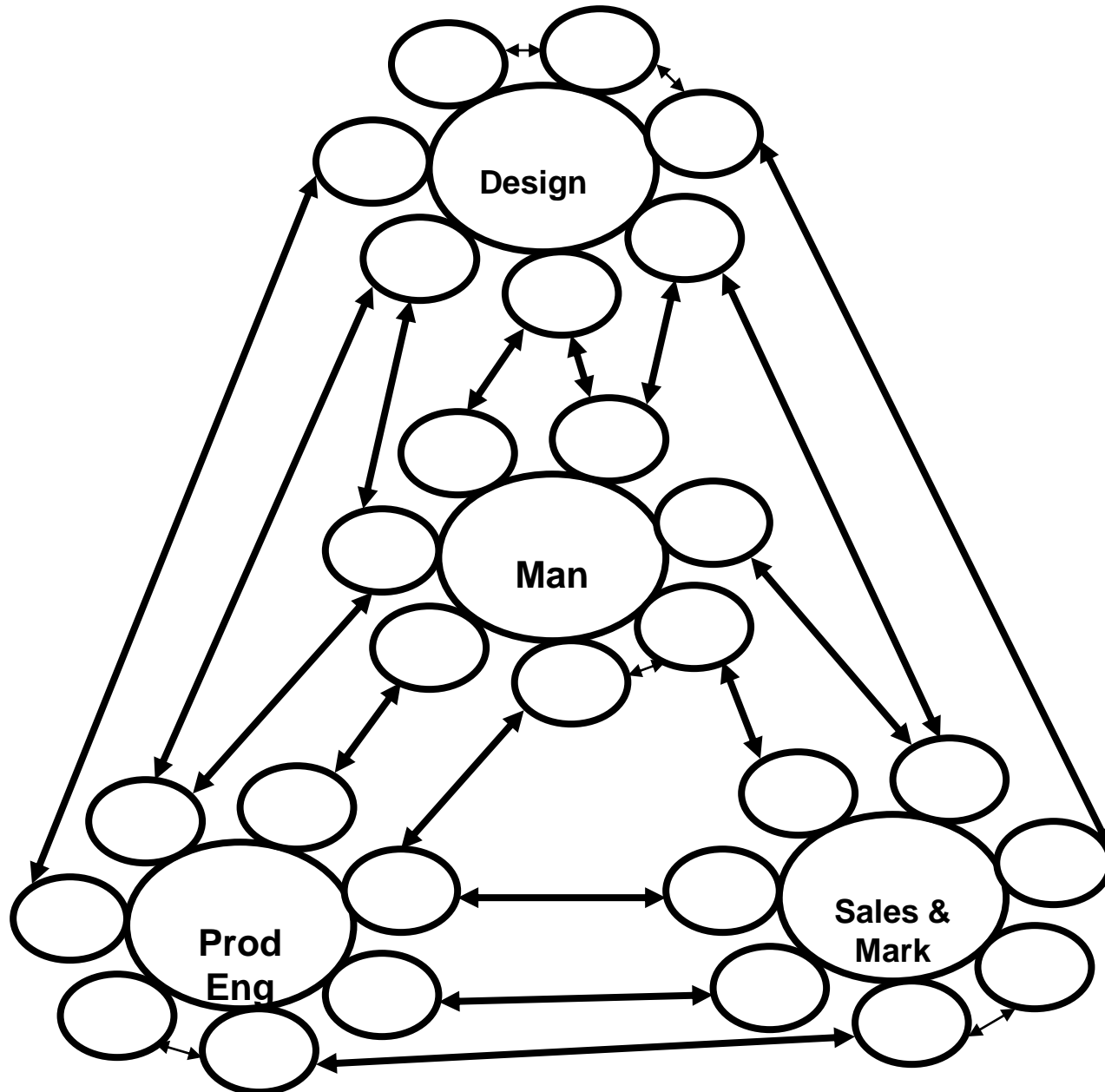
Enterprise Resource Planning (ERP)
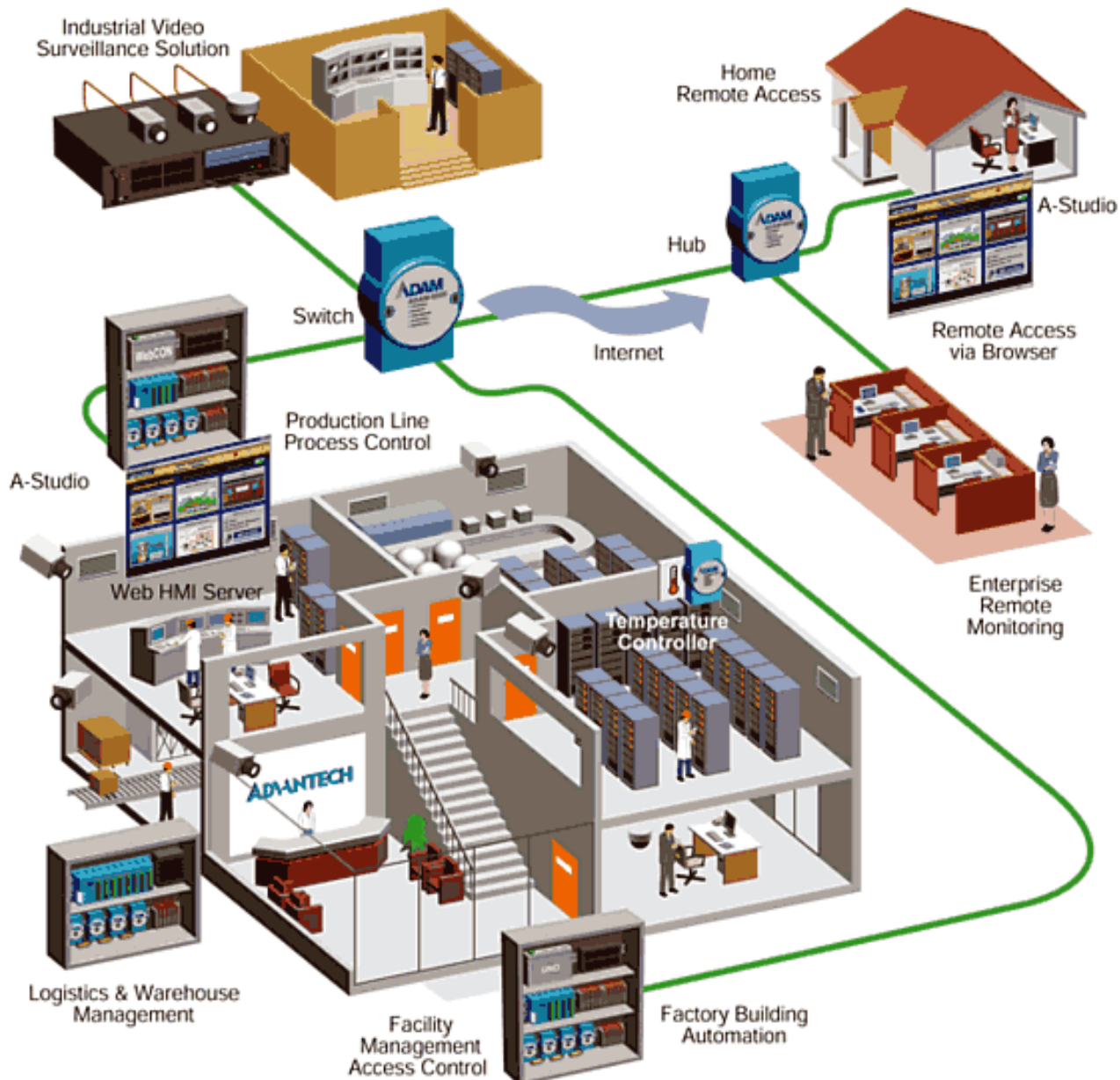
Enterprise Resource Planning
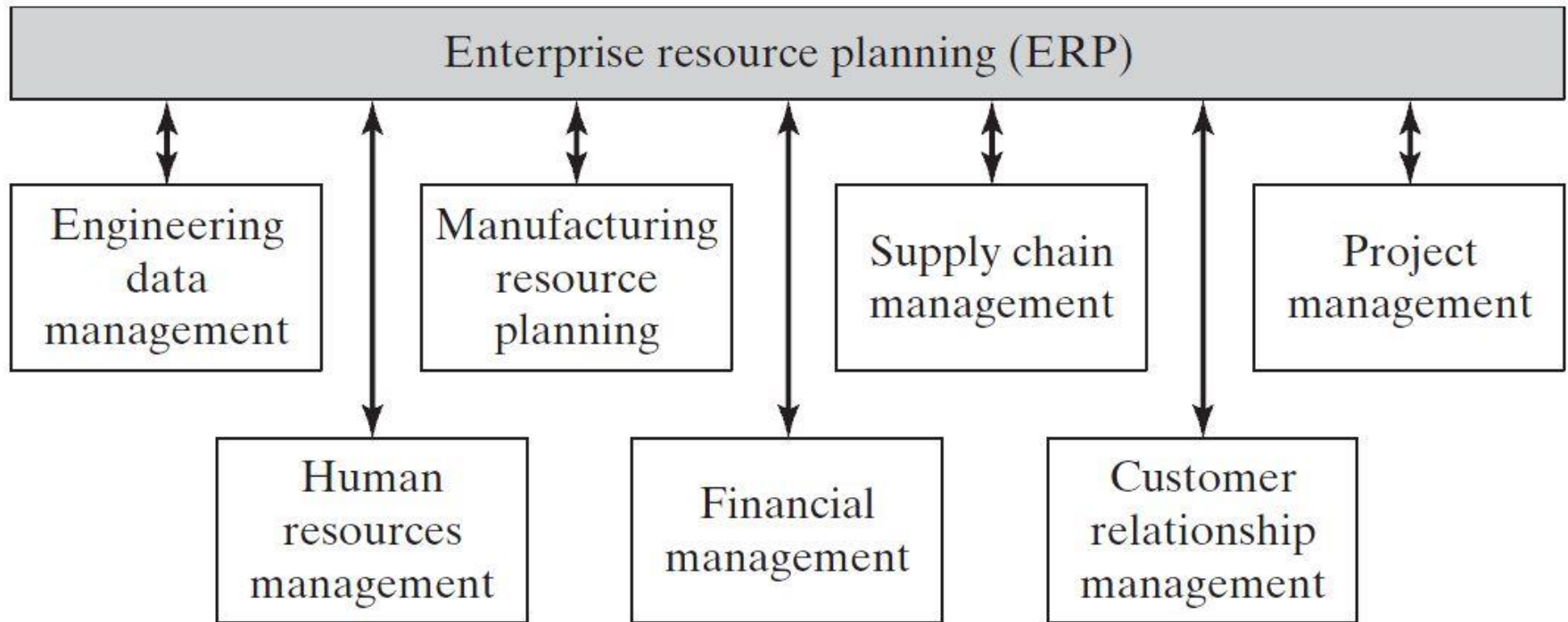
Possible software modules in an ERP system

Business Functions in ERP Modules

ERP Module	Typical Business Functions Included
Engineering data management	Product research and development, product design, computer-aided design, bills of materials, product data management, product lifecycle management
Manufacturing resource management	Master production scheduling, material requirements planning, capacity planning, shop floor control, process planning, inventory control, product costing, quality control
Supply chain management	Supply chain planning, vendor relationship management, supplier scheduling, purchasing, inventory management
Project management	Project planning, project costing, work breakdown structure, project scheduling, project control
Human resources management	Payroll, benefits, training, workforce planning, recruiting, job applicant processing, job descriptions, training, employee performance appraisals, employee personal data, time and attendance, retirement and separation, organization charts
Financial management	Capital budgeting, asset management, investment management, cost accounting, cost control, activity-based costing, accounts payable, accounts receivable, cash management
Customer relationship management	Sales, marketing, customer contact, customer service, order input and processing, pricing, product availability, delivery, shipping, invoicing, product returns, handling of customer complaints

ERP Uses a Single Database

- Avoids problems such as
  - Data redundancy or conflicting data in different databases
  - Time delays in entering the data
  - Communication issues between different databases
- Everyone in the organization has access to the same sets of data according to their individual job responsibilities
  - Not all of the data can be accessed by all employees

Quality Systems

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V8 x 5™ = 900%

Renscan5™ represents the biggest step-change in measurement capability that we have ever introduced.

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www.renscan5.com

Quality Systems
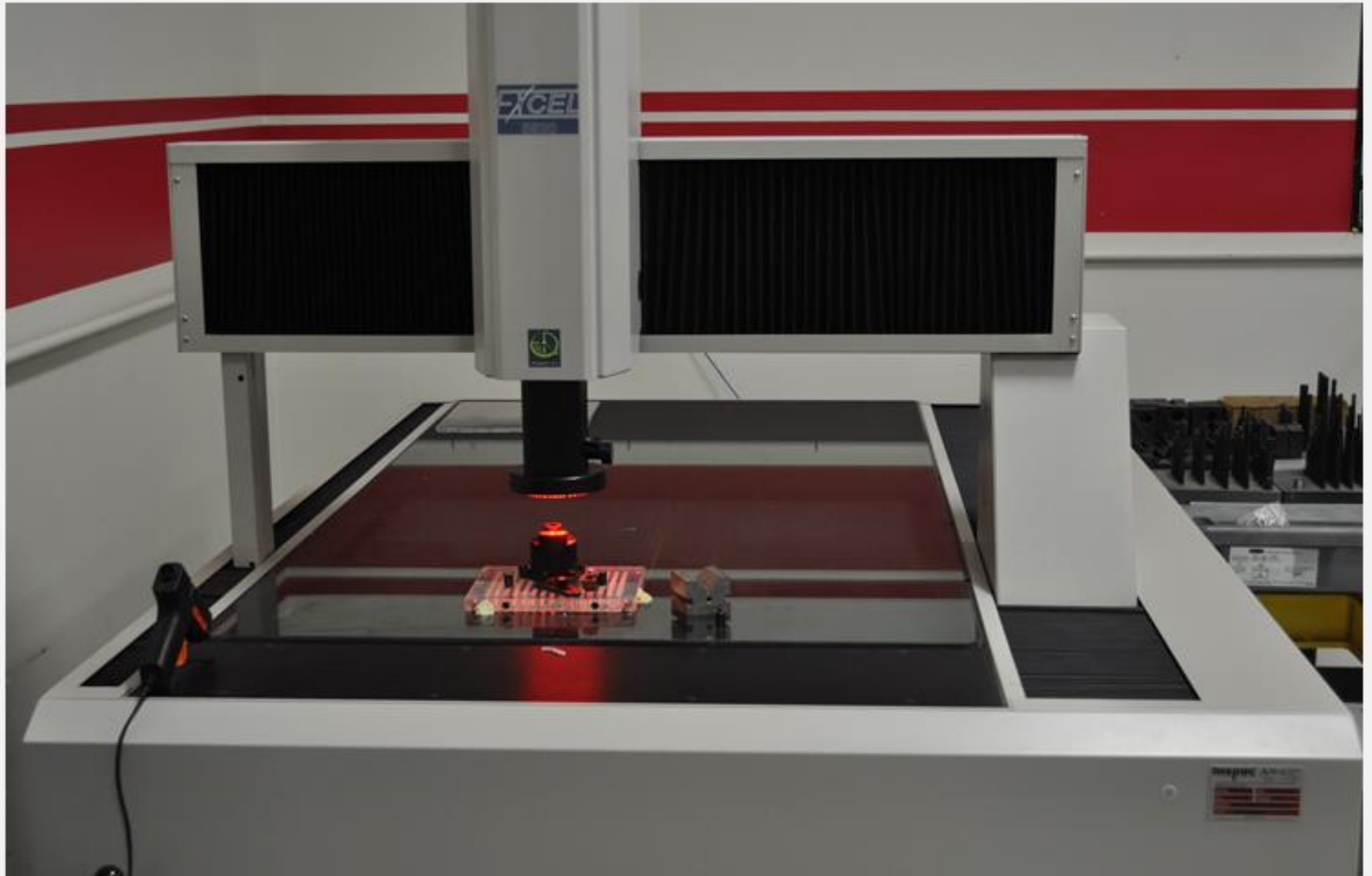
Quality Systems

Quality Systems

- https://youtu.be/_EHoif-ZSqg

Quality System in Network Systems
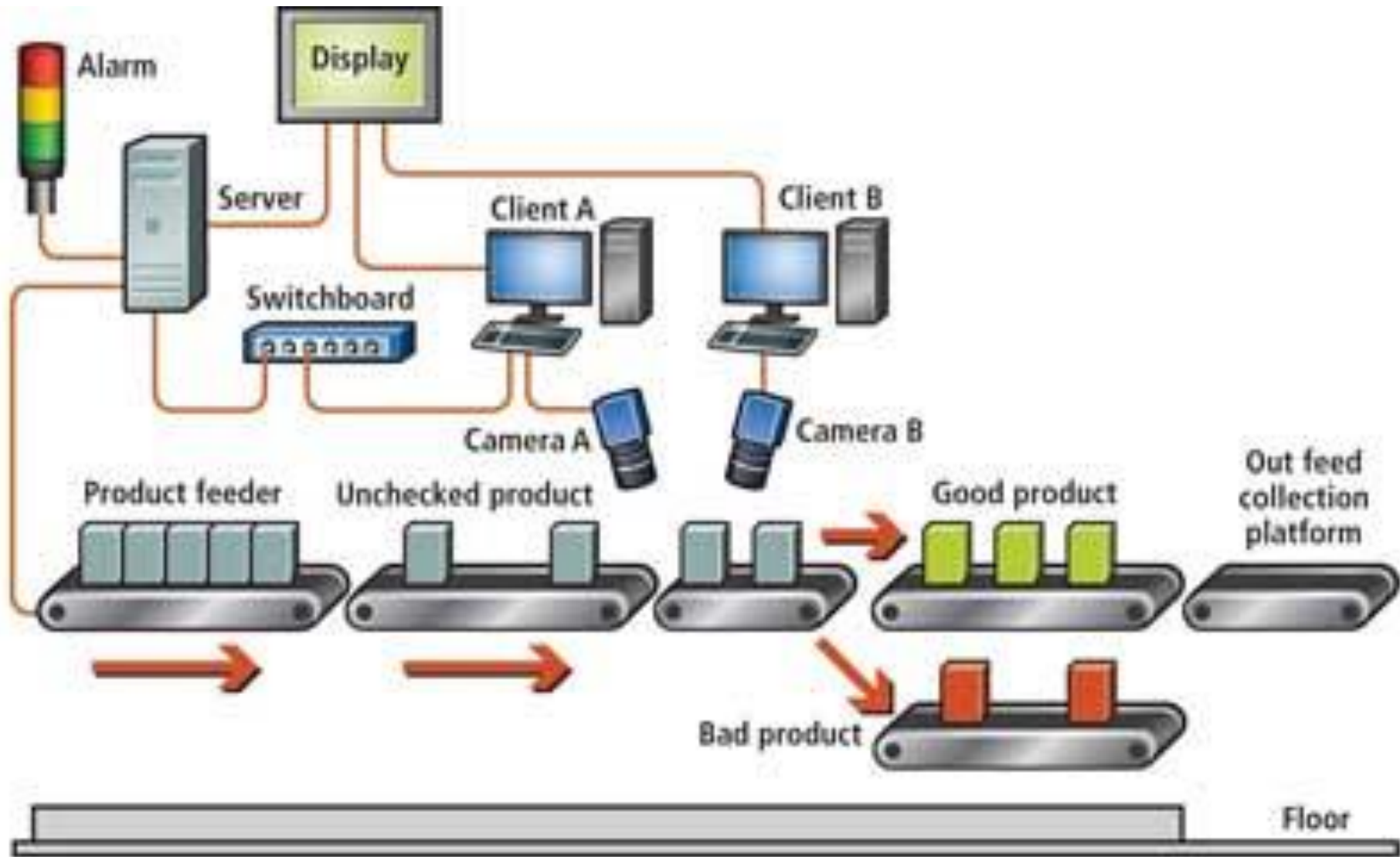
Chapter 20: Quality Programs for Manufacturing

Sections:

1. Quality in Design and Manufacturing
2. Traditional and Modern Quality Control
3. Process Variability and Process Capability
4. Statistical Process Control
5. Six Sigma
6. Taguchi Methods in Quality Engineering
7. ISO 9000

Two Aspects of Quality in Design and Manufacturing

1. Product features
   - Characteristics that result from design
   - Functional and aesthetic features that appeal to the customer
   - "Grade"

2. Freedom from Deficiencies
   - Product does what it is supposed to do
   - Product is absent of defects and out-of-tolerance conditions

Aspects of Quality: Product Features

- Design configuration, size, weight
- Function and performance
- Distinguishing features of the model
- Aesthetic appeal
- Ease of use
- Availability of options
- Reliability and dependability
- Durability and long service life
- Serviceability
- Reputation of product and producer

Aspects of Quality: Freedom from Deficiencies

- Absence of defects
- Conformance to specifications
- Components within tolerance
- No missing parts
- No early failures

Traditional Quality Control

- Widespread use of statistical quality control (SQC), in which inferences are made about the quality of the population of manufactured parts and products based on a sample

- Two principal sampling methods in SQC
  - Control charts
    - Graphical technique used to track measured variable of interest over time
  - Acceptance sampling
    - If the sample passes, the batch is accepted

Traditional Quality Control

Typical management principles and practices:

- Customers are external to the organization
  - The sales and marketing department are responsible for customers
- Company is organized by functional departments
- Inspection department is responsible for quality
- Inspection follows production
- Knowledge of SQC techniques resides only in the minds of the QC experts in the organization

Modern View of Quality Control

High quality is achieved by a combination of:

- Good management – three objectives of "total quality management":

    1. Achieving customer satisfaction
    2. Continuous improvement
    3. Encouraging involvement of entire work force

- Good technology – traditional statistical tools combined with modern measurement and inspection technologies

Total Quality Management (TQM)

Typical management principles and practices:
- Quality is focused on customer satisfaction
  - Internal customers and external customers
- Quality goals are driven by top management
- Quality control is pervasive in the organization
- Quality must be built into the product, not inspected in afterward
  - Production workers must inspect their own work
- Continuous improvement
  - A never ending chase to design and produce better products

Process Variability

Manufacturing process variations are of two types:

1. Random variations – result from intrinsic variability in the process
   - Process is operating normally
   - Human variations from cycle to cycle, minor variations in starting materials, machine vibration

2. Assignable variations – indicate an exception from normal operating conditions
   - Operator errors, defective raw materials, tool failures, equipment malfunctions

Distribution of Values of Part Characteristics at Four Times during process operation
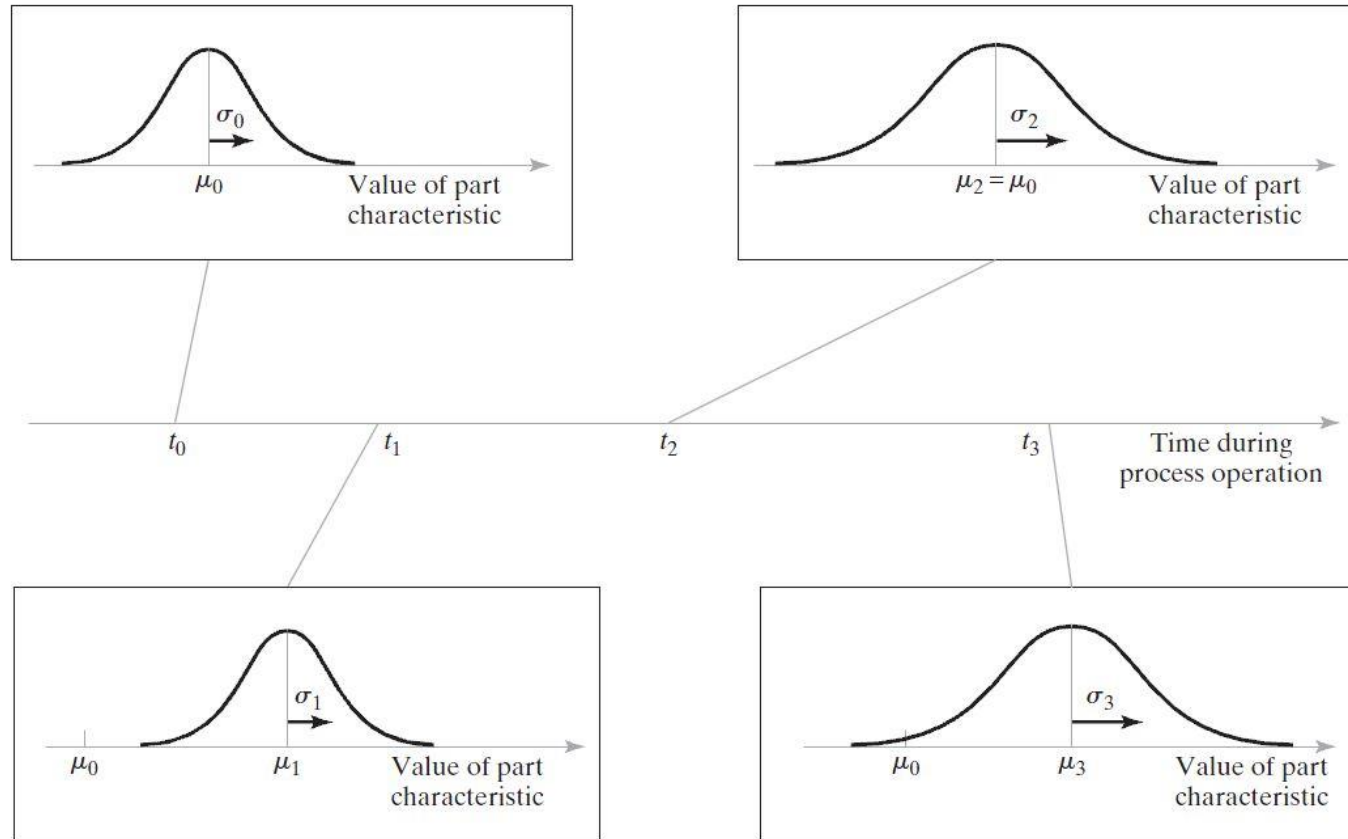
Process Capability

$$PC = \mu \pm 3\sigma$$

where PC = process capability, μ = process mean set at nominal value of the parameter of interest (bilateral tolerances assumed), σ = standard deviation of the process

- Assumptions:
  - Output is normally distributed
  - Steady state operation
  - Process is in statistical control

Process Capability and Tolerances

- Natural tolerance limits – when tolerance is set = process capability

- Process capability index

$$PCI = \frac{UTL - LTL}{6\sigma}$$

where *PCI* = process capability index, *UTL* and *LTL* = upper and lower tolerance limits, and 6σ = range of natural tolerance limits

Statistical Process Control (SPC)

Use of various methods to measure and analyze a process, either in manufacturing or non-manufacturing situations

- Objectives of SPC:

  1. Improve quality of process output

  2. Reduce process variability and achieve process stability

  3. Solve processing problems

Seven Tools of SPC

Sometimes referred to as the "magnificent seven"

1. Control charts
2. Histograms
3. Pareto charts
4. Check sheets
5. Defect concentration diagrams
6. Scatter diagrams
7. Cause and effect diagrams

Control Charts

A graphical technique in which statistics computed from measured values of a process characteristic are plotted over time to determine if the process remains in statistical control

- Underlying principle is that the variations in a process divide into two categories:

  1. Random variations
  2. Assignable variations

Control Chart
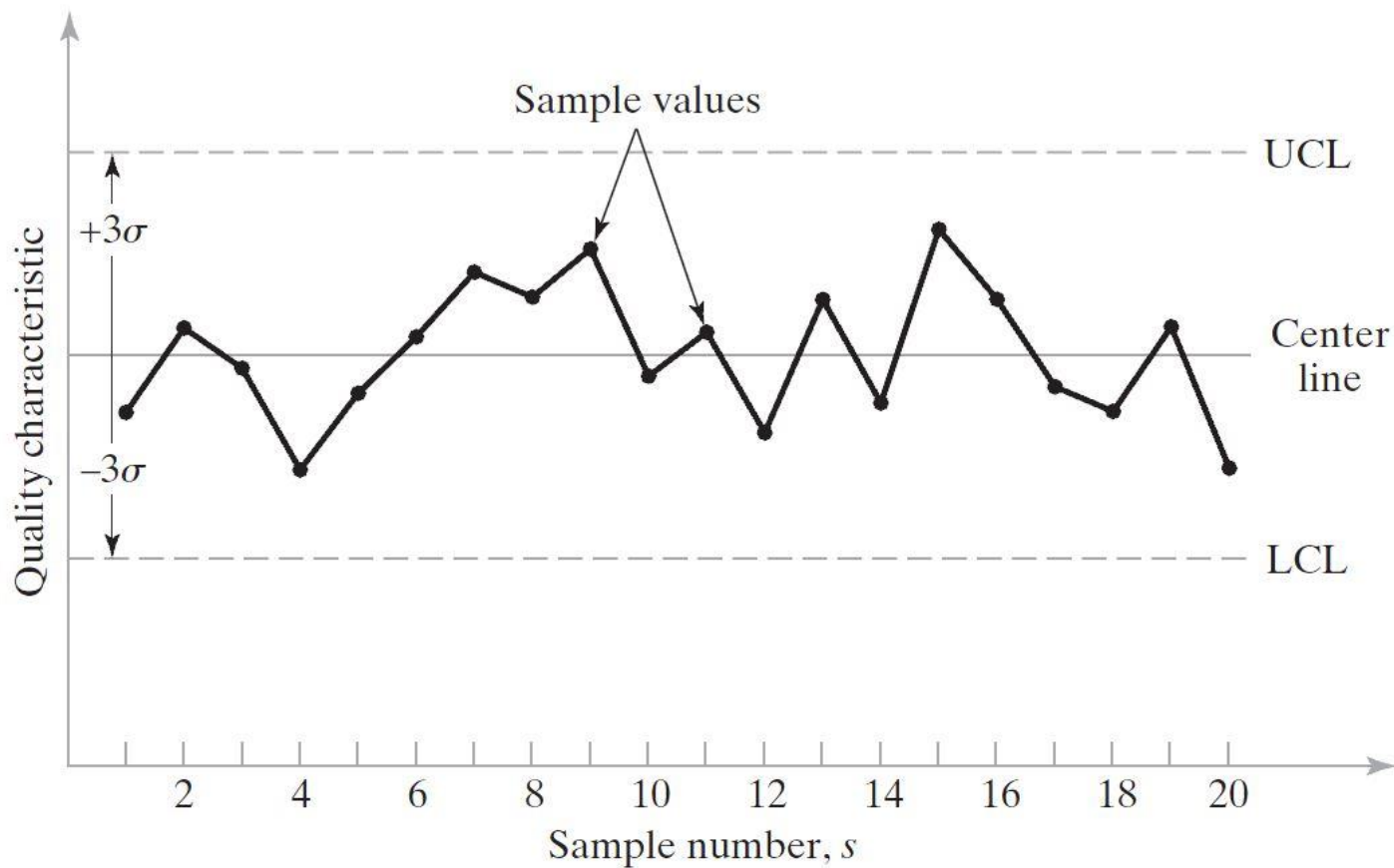
Two Basic Types of Control Charts

1. Control charts for variables
   - Require a measurement of the quality characteristic of interest
   - Two principle types: (1) X-bar chart and (2) R chart
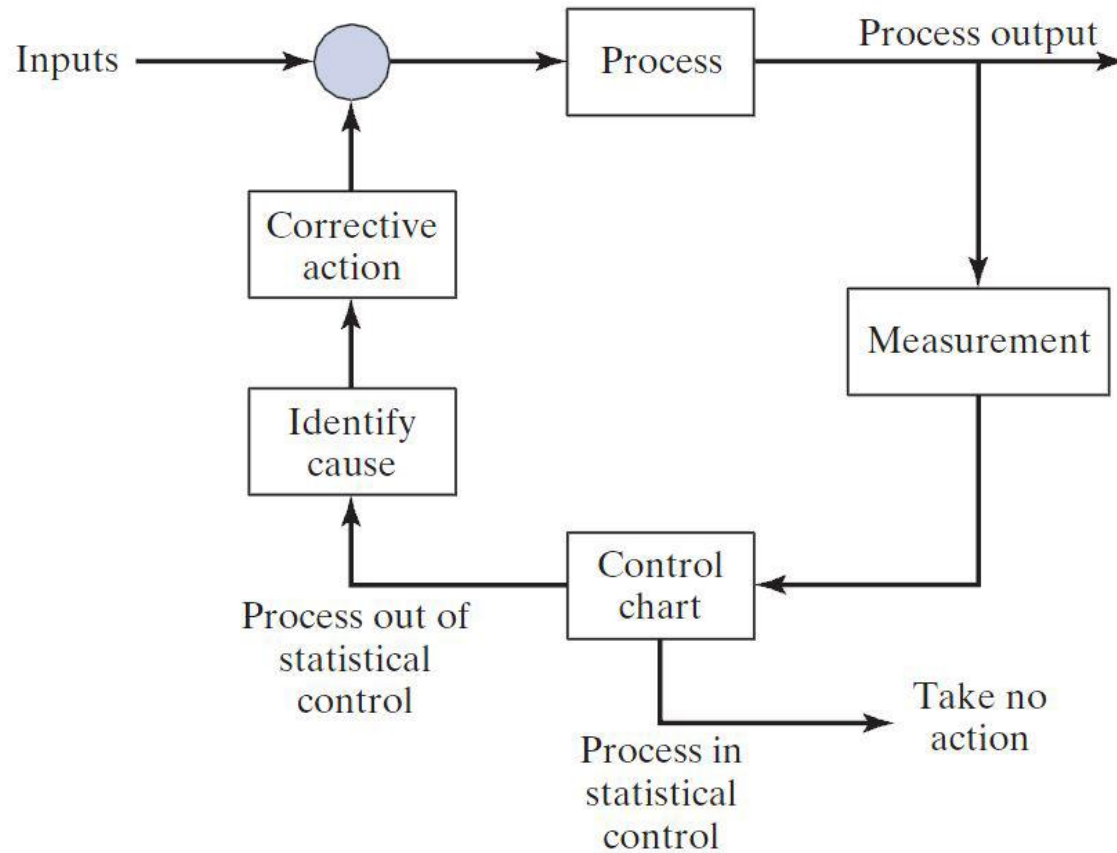2. Control charts for attributes
   - Require a determination of either fraction of defects in the sample or number of defects in the sample
   - Two principle types: (1) p chart and (2) c chart

Control Charts for Variables
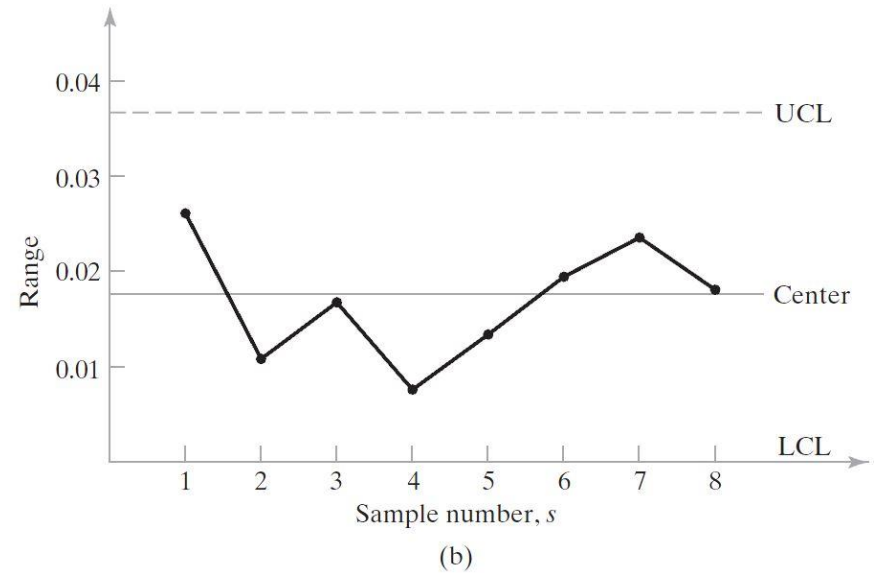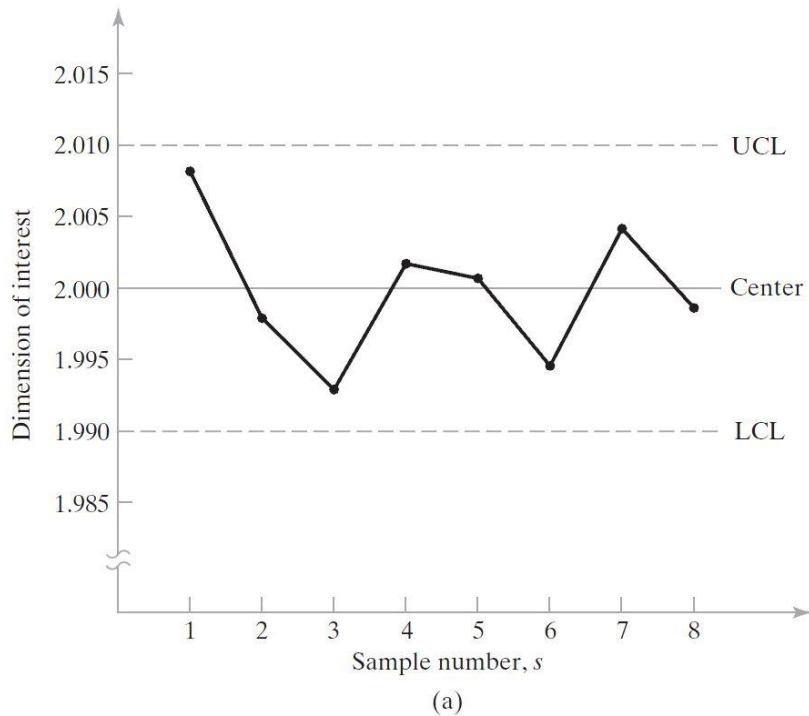
(a) X-Bar chart and (b) R-chart

# Control Chart used as Feedback Loop in Statistical Process Control

Histogram

Statistical graph consisting of bars representing different members of a population, in which the length of each bar indicates the frequency or relative frequency of each member

- A useful tool because the analyst can quickly visualize the features of the data, such as:
  - Shape of the distribution
  - Any central tendency in the distribution
  - Approximations of the mean and mode
 - Amount of scatter in the data

Histogram
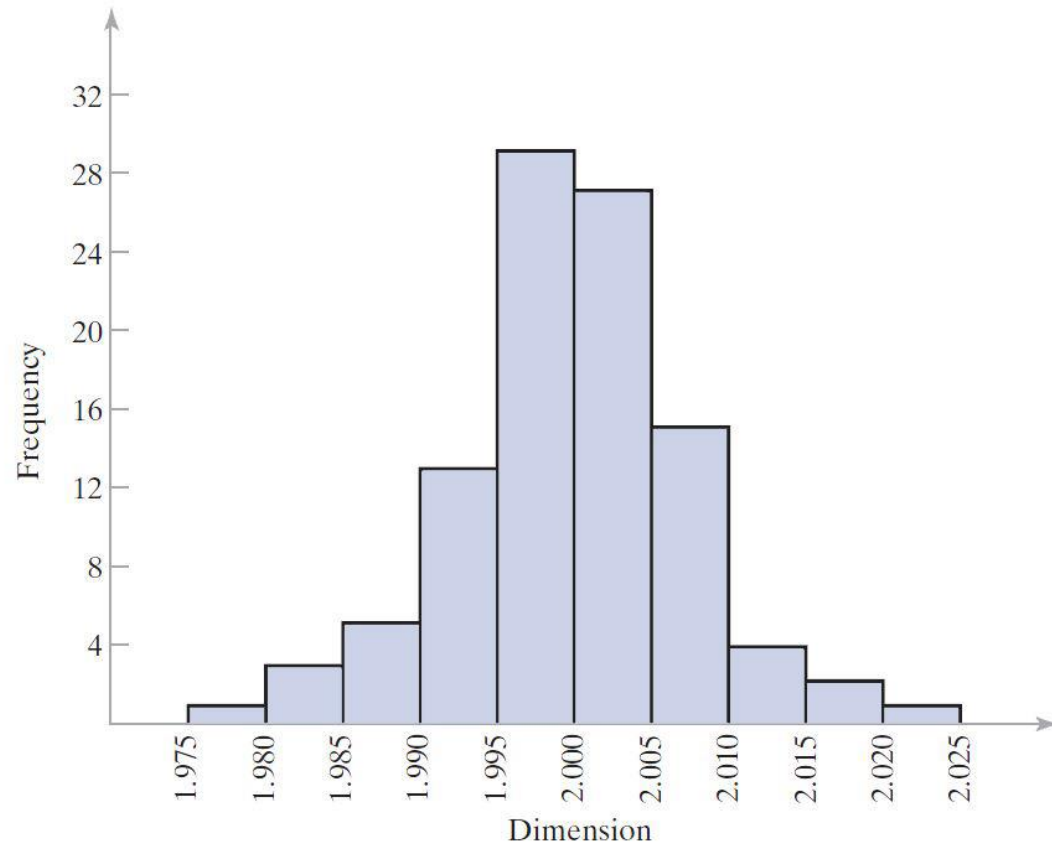
Pareto Chart

Special form of histogram in which attribute data are arranged according to some criterion such as cost or value

- Based on Pareto's Law: "the vital few and the trivial many"

- Often identified as the 80%-20% rule
  - 80% of a nation's wealth is owned by 20% of the population
  - 80% of sales are accounted for by 20% of the SKUs

Pareto Chart
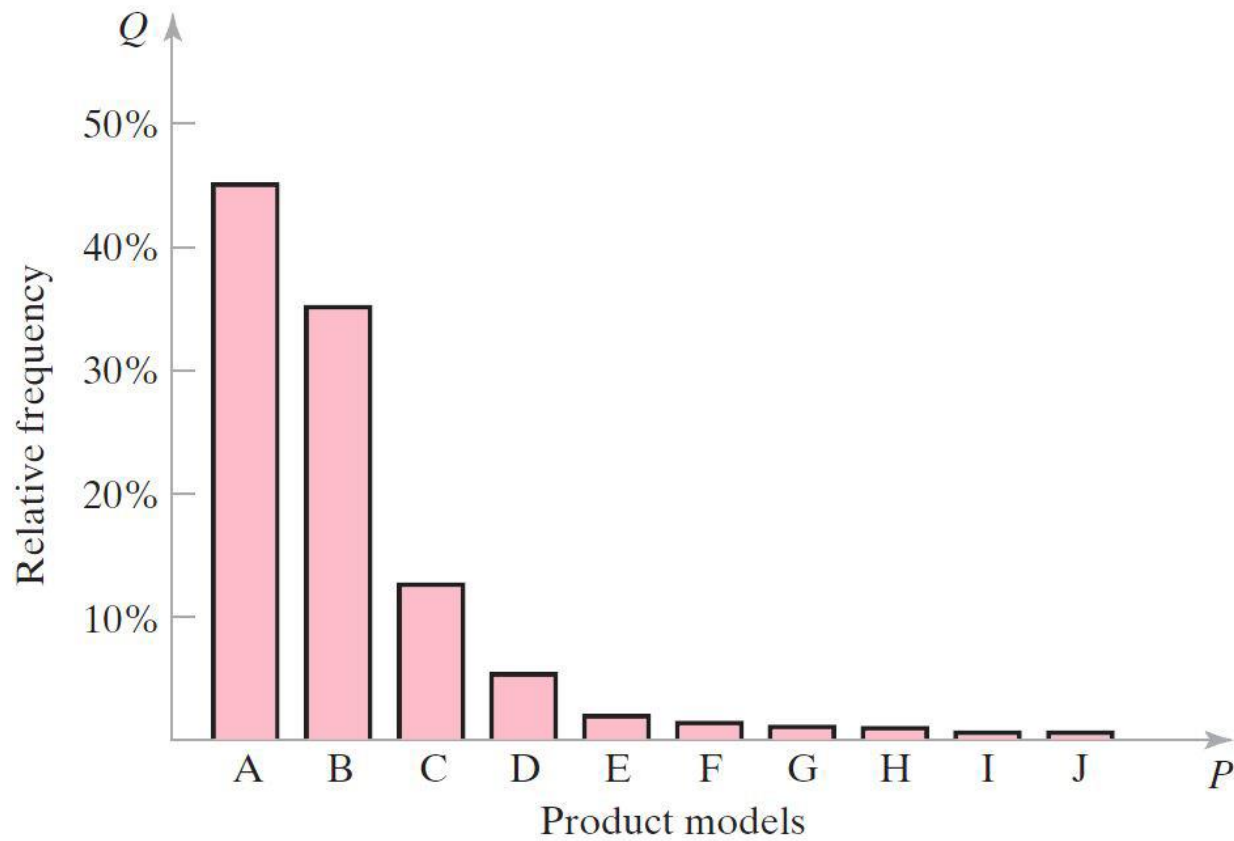
Check Sheet

Data collection tool generally used in the preliminary stages of a study of a quality problem

- Data often entered by worker as check marks in a given category
- Examples:
  - Process distribution check sheet - data on process variability
  - Defective item check sheet – types and frequencies of defects on the product
  - Defect location check sheet - where defects occur on the product

Defect Concentration Diagram

A drawing of the product (all relevant views), onto which the locations and frequencies of various defect types are added

- Useful for analyzing the causes of product or part defects

- By analyzing the defect types and corresponding locations, the underlying causes of the defects can possibly be identified

Scatter Diagrams

An x-y plot of data collected on two variables, where a correlation between the variables is suspected

- The data are plotted as pairs; for each x_i value, there is a corresponding y_i value

- The shape of the collection of data points often reveals a pattern or relationship between the two variables

Scatter Diagram

Effect of cobalt
binder content on
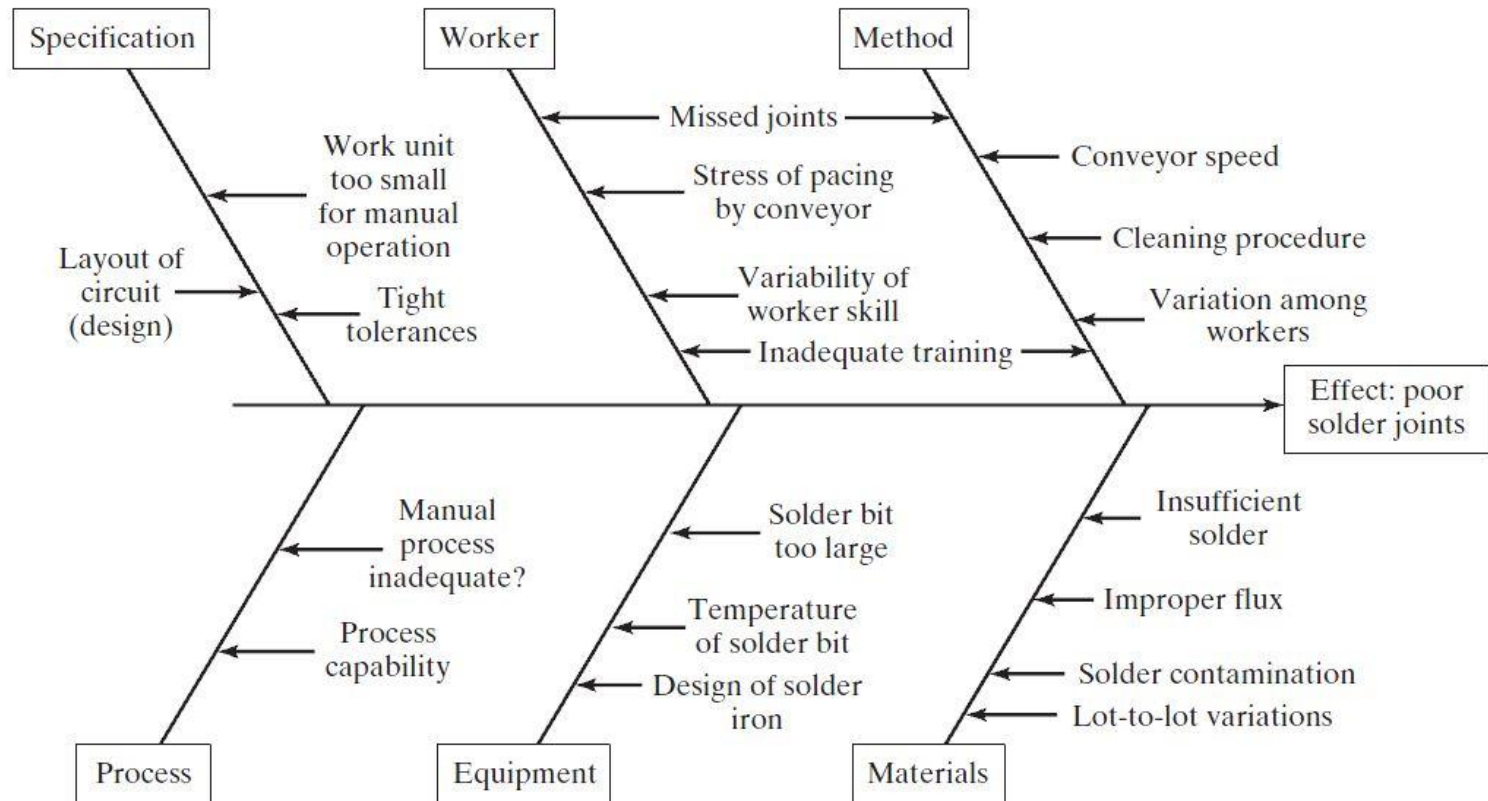wear resistance
of a cemented
carbide cutting
tool insert
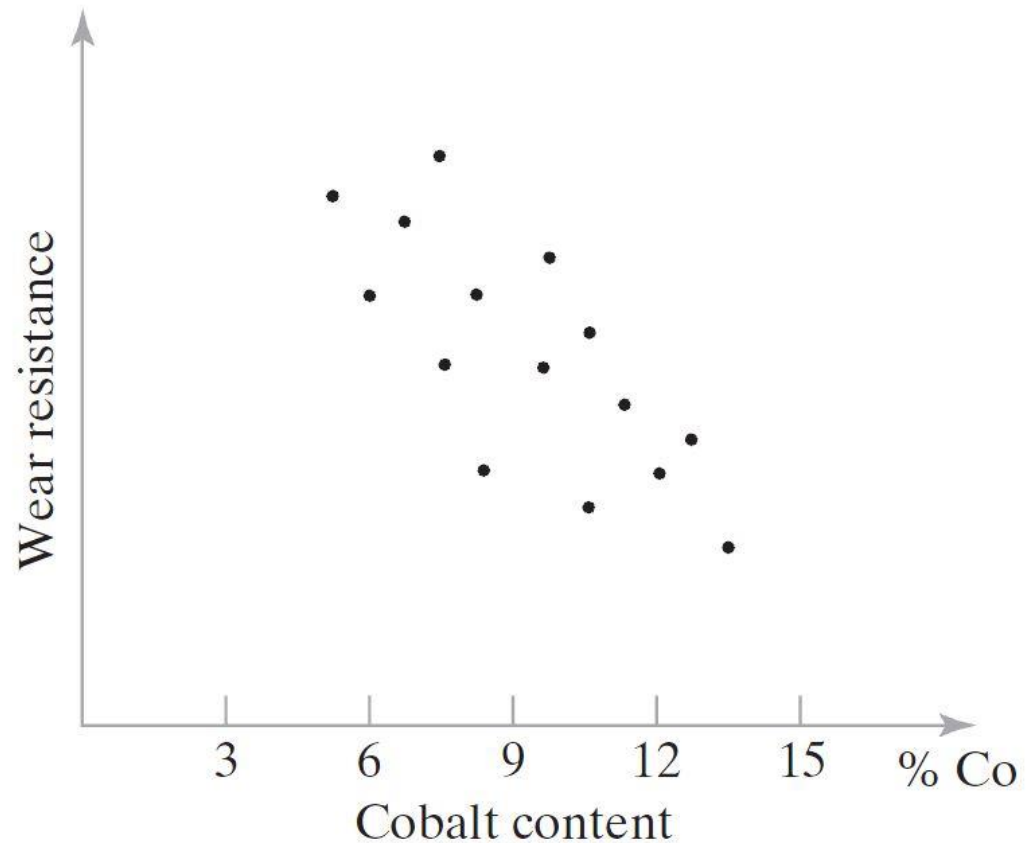
Cause and Effect Diagram

A graphical-tabular chart used to list and analyze the potential causes of a given problem

- Also known as a "fishbone diagram"

- Can be used to identify which causes are most consequential and how to take corrective action against them

Cause-and-Effect Diagram

Implementing SPC

Five elements usually present in a successful SPC program:

1. Management commitment and leadership

   – Management sets the example for others to follow

2. Team approach to problem solving

   – Team members contribute a broad pool of knowledge

3. SPC training for all employees

4. Emphasis on continuous improvement throughout the organization

5. A recognition and communication system to recognize successful SPC efforts

Six Sigma

A quality-focused program that utilizes worker teams to accomplish projects aimed at improving an organization's operational performance

- General goals of Six Sigma:
  - Better customer satisfaction
  - High quality products and services
  - Reduced defects
  - Improved process capability
  - Continuous improvement
  - Cost reduction by more effective & efficient processes

Quality Based on Normal Distribution

- Traditional metric for good process quality is $\pm 3\sigma$
  - Includes 99.73% of population
  - Defect rate = 2700 defects per million

- Six Sigma metric is $\pm 6\sigma$
  - In the Standard Normal tables:
    - Includes 99.9999998% of population
    - Defect rate = 0.002 defects per million

$\pm 3\sigma$ in the Normal Distribution
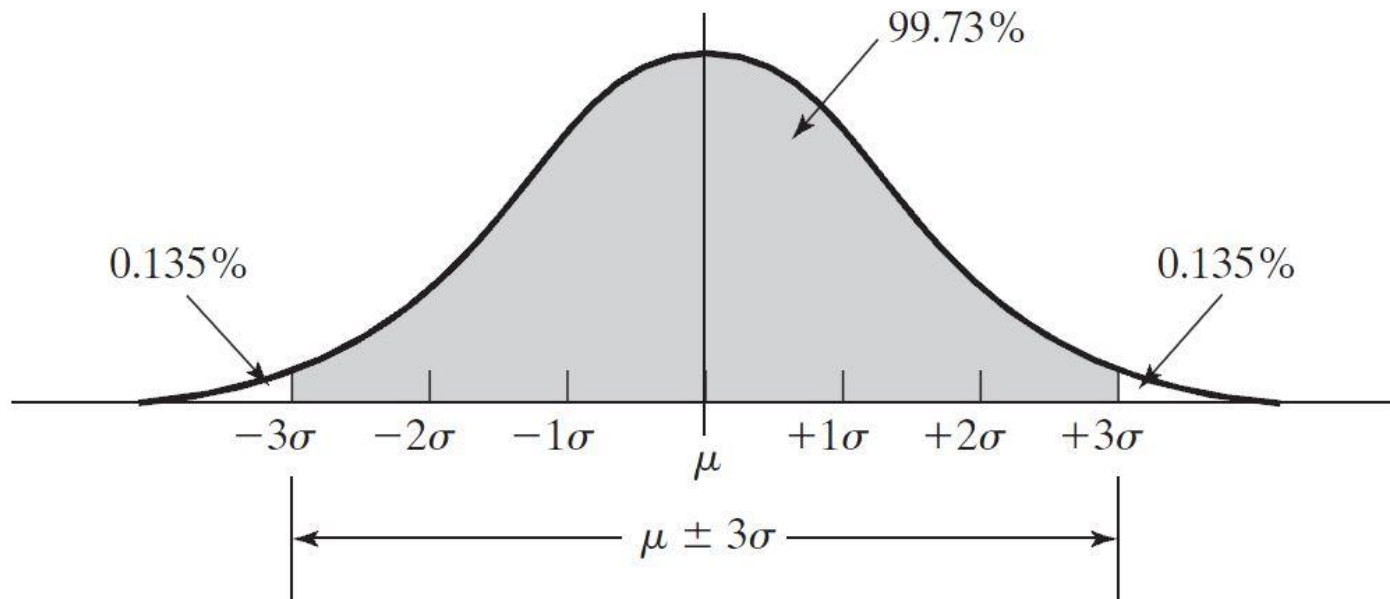
Normal distribution of process output variable, showing the $\pm 3\sigma$ limits

±6σ in the Normal Distribution
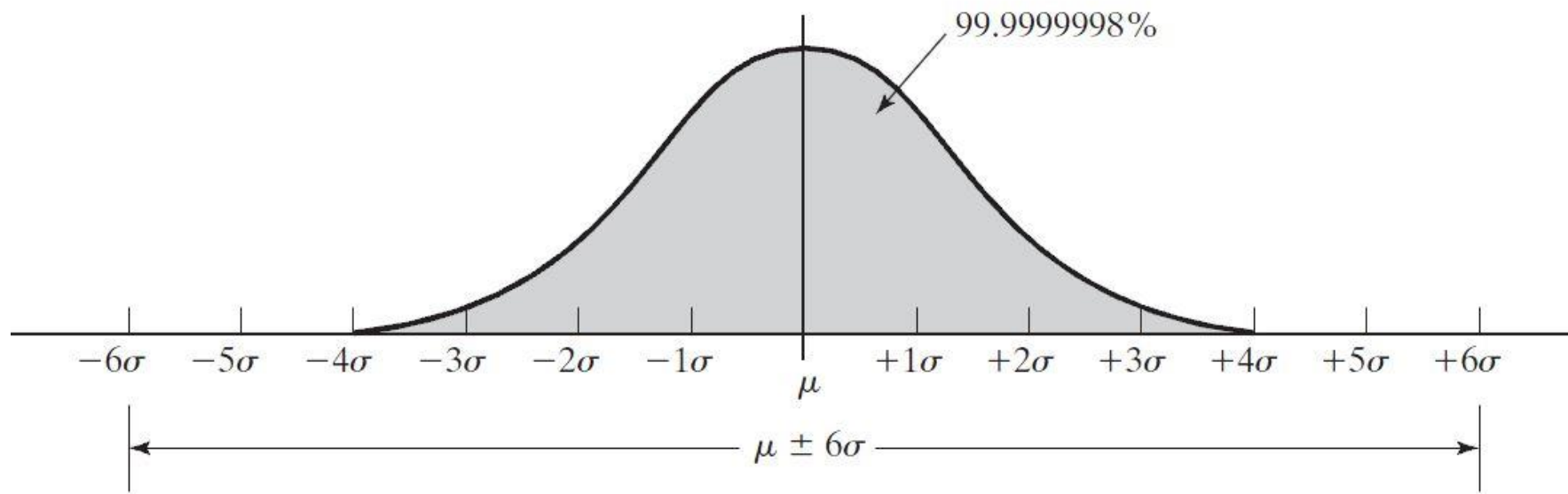
Sigma Value and Defect Rate in the Six Sigma Program

Process sigma	Defect rate	Yield
1σ	691,462 pm	30.9%
2σ	308,538 pm	69.1%
3σ	66,807 pm	93.3%
4σ	6,210 pm	99.4%
5σ	233 pm	99.98%
6σ	3.4 pm	99.99966%

Taguchi Methods in Quality Engineering

Quality engineering = broad range of engineering and operational activities whose aim is to ensure that a product's quality characteristics are at their nominal or target values

- Shares much with Total Quality Management

- Taguchi methods:
    1. Robust design
    2. Taguchi loss function

Taguchi Loss Function

- According to Taguchi, quality is "the loss a product costs society from the time the product is released for shipment"

- Loss includes:
  - Costs to operate
  - Failure to function, maintenance and repair costs
  - Customer dissatisfaction
  - Injuries caused by poor design, etc.

- Defective products (or their components) that are detected, repaired, reworked prior to shipment are manufacturing costs

ISO 9000

- ISO = International Organization for Standardization
- U.S. representative to ISO 9000 is ANSI/ASQC
- ISO 9000 is a standard for the systems and procedures used by a facility that affect the quality of the products and services provided by the facility
  - It is not a standard for the products and services
- ISO 9000 is generic, not industry specific
  - It can be applied to any facility producing any product or providing any service

Two Ways to Apply ISO 9000

1. Implement the standards simply for the sake of improving a firm's quality systems
2. ISO 9000 Registration – formal certification that the facility satisfies the standard
   - Benefits:
     - Reduce frequency of quality audits by customer firms
     - Qualify for business partnerships with companies that require ISO 9000 registration (especially in Europe)