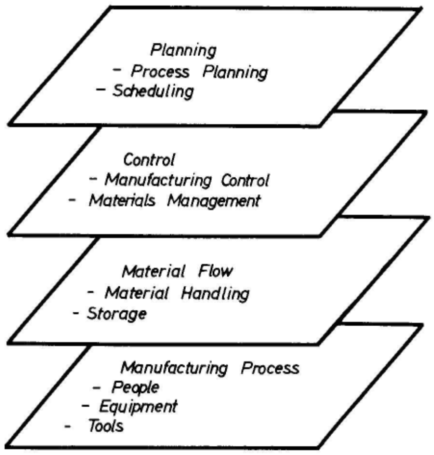
Introduction to Computer Integrated Manufacturing (CIM)

1. Flexible Manufacturing System (FMS)
2. Variable Mission Mfg. (VMM)
3. Computerized Mfg. System (CMS)

Four-Plan Concept of Manufacturing



CIM System discussed:

- Computer Numerical Control (CNC)
- Direct Numerical Control (DNC)
- Computer Process Control
- Computer Integrated Production Management
- Automated Inspection Methods
- Industrial Robots etc.

A CIM System consists of the following basic components:

I. Machine tools and related equipment
II. Material Handling System (MHS)
III. Computer Control System
IV. Human factor/labor

CIMS Benefits:

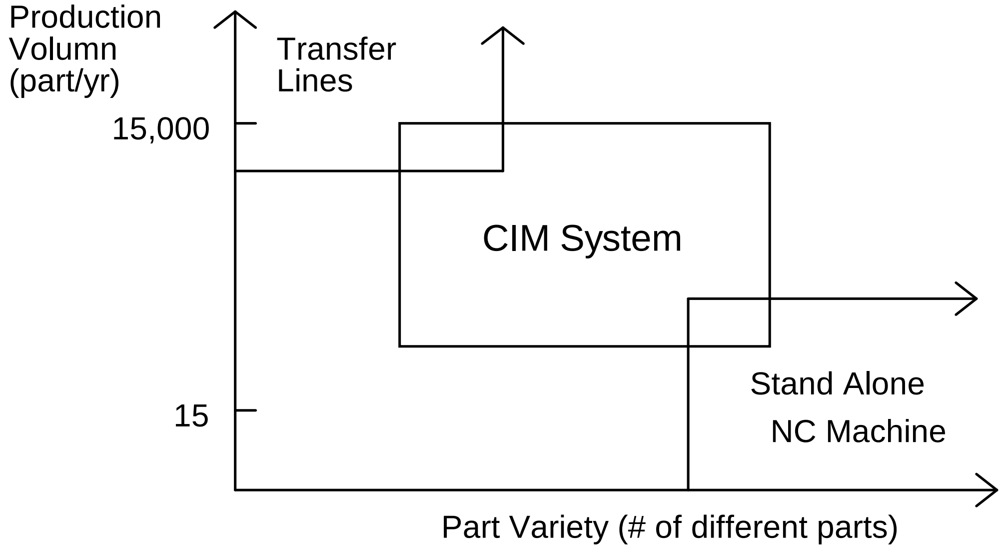
1. Increased machine utilization
2. Reduced direct and indirect labor
3. Reduce mfg. lead time
4. Lower in process inventory
5. Scheduling flexibility
6. etc.

CIM refers to a production system that consists of:

1. A group of NC machines connected together by
2. An automated materials handling system
3. And operating under computer control

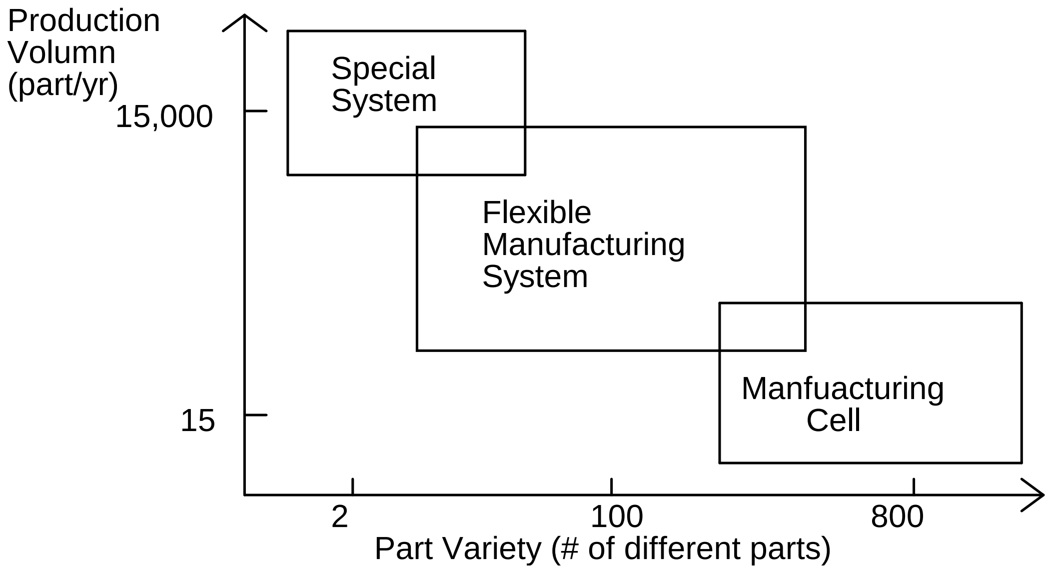
Why CIMS?

In Production Systems



1. Transfer Lines: is very efficient when producing "identical" parts in large volumes at high product rates.
2. Stand Alone: NC machine: are ideally suited for variations in work part configuration.

In Manufacturing Systems:



1. Special Mfg. System: the least flexible CIM system. It is designed to produce a

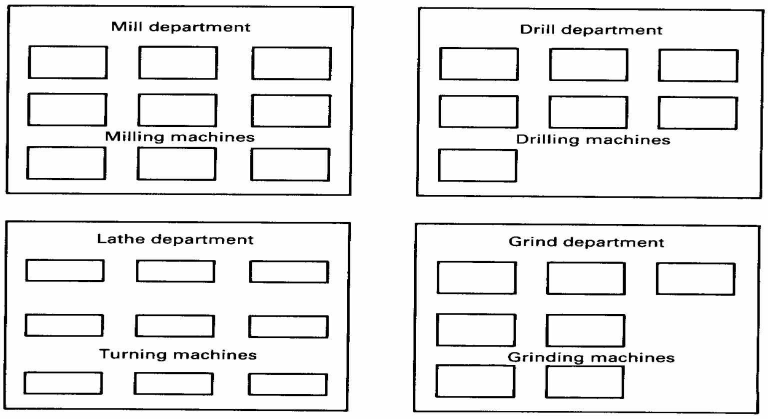
very limited number of different parts (2 - 8).
2. Mfg. Cell: the most flexible but generally has the lowest number of different parts manufactured in the cell would be between 40 - 80. Annual production rates rough from 200 - 500.
3. Flexible Mfg. System: A typical FMS will be used to process several part families with 4 to 100 different part numbers being the usual case.

General FMS

Conventional Approaches to Manufacturing

Conventional approaches to manufacturing have generally centered around machines laid out in logical arrangements in a manufacturing facility. These machine layouts are classified by:

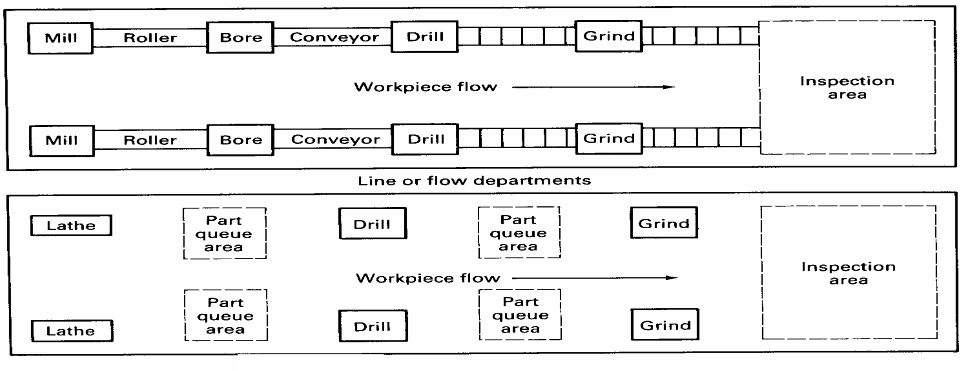
1. Function - Machines organized by function will typically perform the same function, and the location of these departments relative to each other is normally



Machine layout by function.

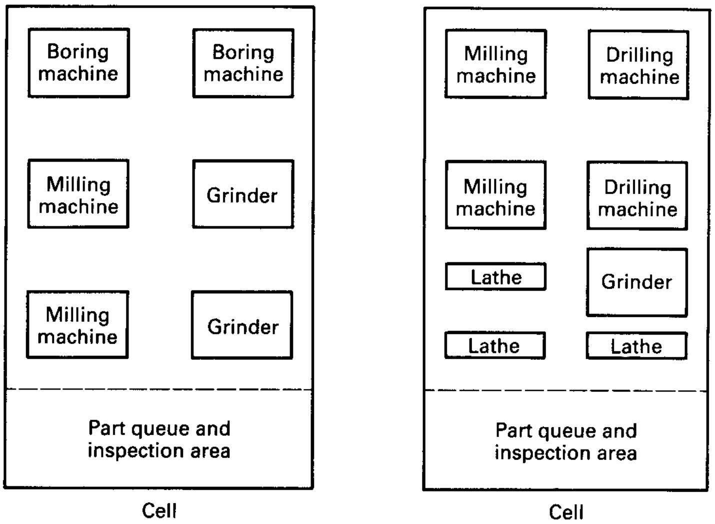
arranged so as to minimize interdepartmental material handling. Workpiece produced in functional layout departments and factories are generally manufactured in small batches up to fifty pieces (a great variety of parts).

2. Line or flow layout - the arrangement of machines in the part processing order or sequence required. A transfer line is an example of a line layout. Parts progressively move from one machine to another in a line or flow layout by means of a roller conveyor or through manual material handling. Typically, one or very few different parts are produced on a line or flow type of layout, as all parts processed require the same processing sequence of operations. All machining is performed in one department, thereby minimizing interdepartmental material handling.



Line or flow machine layout.

3. Cell - It combines the efficiencies of both layouts into a single multi-functional unit. It referred to as a group technology cell, each individual cell or department is comprised of different machines that may not be identical or even similar. Each cell is essentially a factory within a factory, and parts are grouped or arranged into families requiring the same type of processes, regardless of processing order. Cellular layouts are highly advantageous over both function and line machine layouts because they can eliminate complex material flow patterns and consolidate material movement from machine to machine within the cell.



Machine layout by cell based on part families to be processed

Manufacturing Cell

Four general categories:

1. **Traditional stand-alone NC machine tool** - is characterized as a limited-storage, automatic tool changer and is traditionally operated on a one-to-one machine to operator ratio. In many cased, stand-alone NC machine tools have been grouped together in a conventional part family manufacturing cell arrangement and operating on a one-to-one or two-to-one or three-to-one machine to operator ratio.

2. **Single NC machine cell or mini-cell** - is characterized by an automatic work changer with permanently assigned work pallets or a conveyor-robot arm system mounted to the front of the machine, plus the availability of bulk tool storage. There are many machines with a variety of options, such as automatic probing, broken tool detection, and high-pressure coolant control. The single NC machine cell is rapidly gaining in popularity, functionality, and affordability.

3. **Integrated multi-machine cell** - is made up of a multiplicity of metal-cutting machine tools, typically all of the same type, which have a queue of parts, either at the entry of the cell or in front of each machine. Multi-machine cells are either serviced by a material-handling robot or parts are palletized in a two- or three-machine, in-line system for progressive movement from one machining

station to another.

FMS - sometimes referred to as a flexible manufacturing cell (FMC), is characterized by multiple machines, automated random movement of palletize parts to and from processing stations, and central computer control with sophisticated command-driven software. The distinguishing characteristics of this cell are the automated flow of raw material to the cell, complete machining of the part, part washing, drying, and inspection with the cell, and removal of the finished part.

I. Machine Tools & Related Equipment

- Standard CNC machine tools
- Special purpose machine tools
- Tooling for these machines
- Inspection stations or special inspection probes used with the machine tool

The Selection of Machine Tools

1. Part size
2. Part shape
3. Part variety
4. Product life cycle
5. Definition of function parts
6. Operations other than machining - assembly, inspection etc.

II. Material Handling System

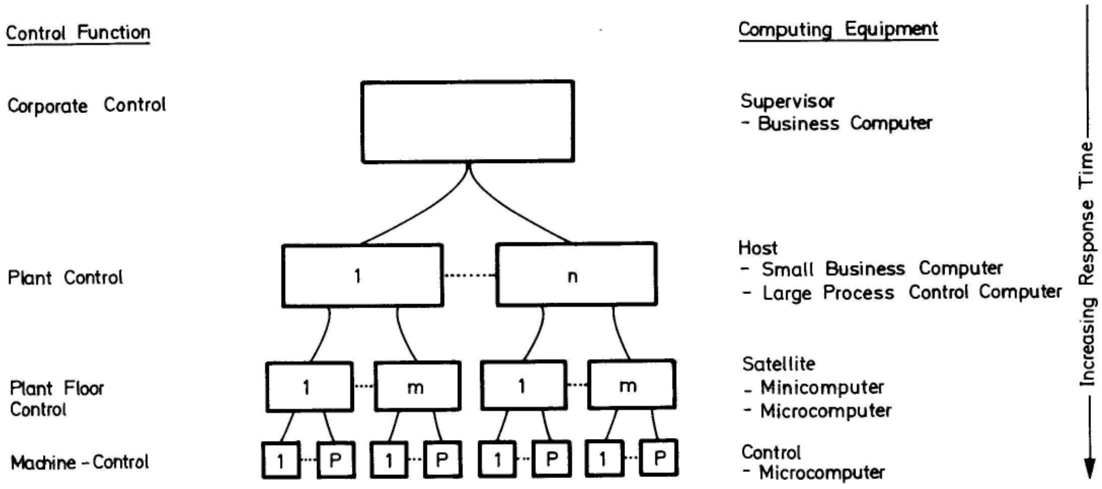
A. The primary work handling system - used to move parts between machine tools in the CIMS. It should meet the following requirements.

i). Compatibility with computer control
ii). Provide random, independent movement of palletized work parts between machine tools.
iii). Permit temporary storage or banking of work parts.
iv). Allow access to the machine tools for maintenance tool changing & so on.
v). Interface with the secondary work handling system
vi). etc.

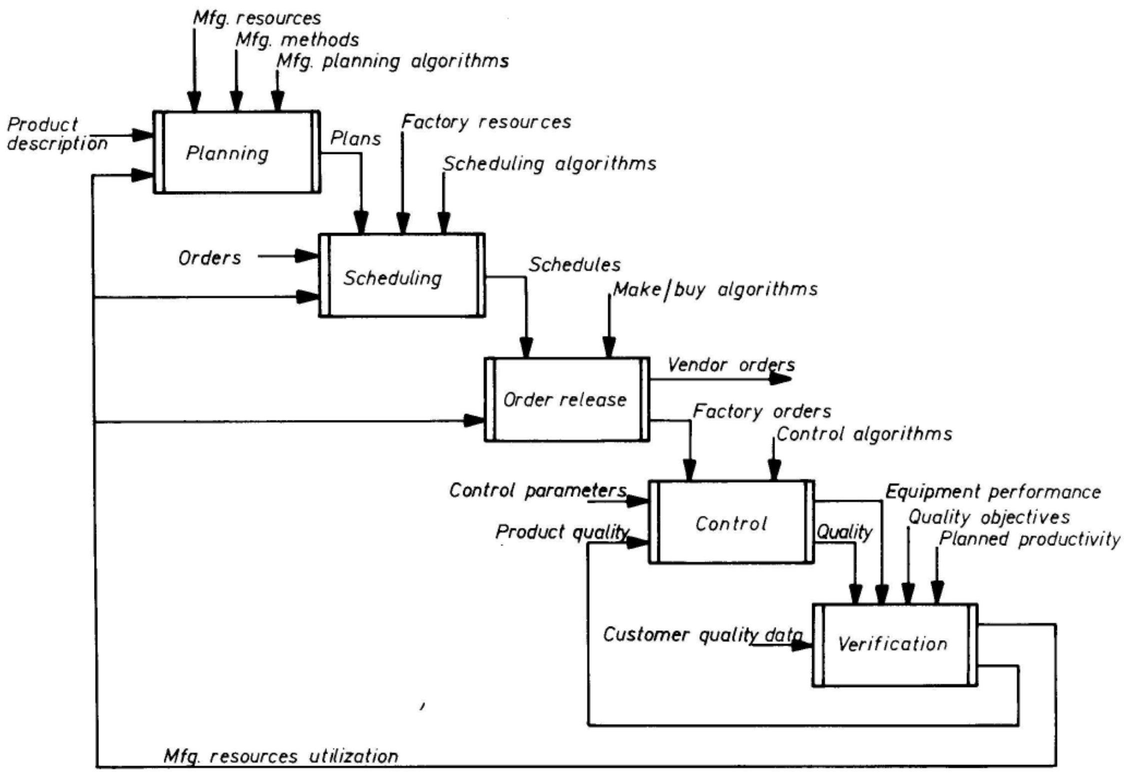
B. The secondary work handling system - used to present parts to the individual machine tools in the CIMS.

i). Same as A (i).
ii). Same as A (iii)
iii). Interface with the primary work handling system
iv). Provide for parts orientation & location at each workstation for processing.

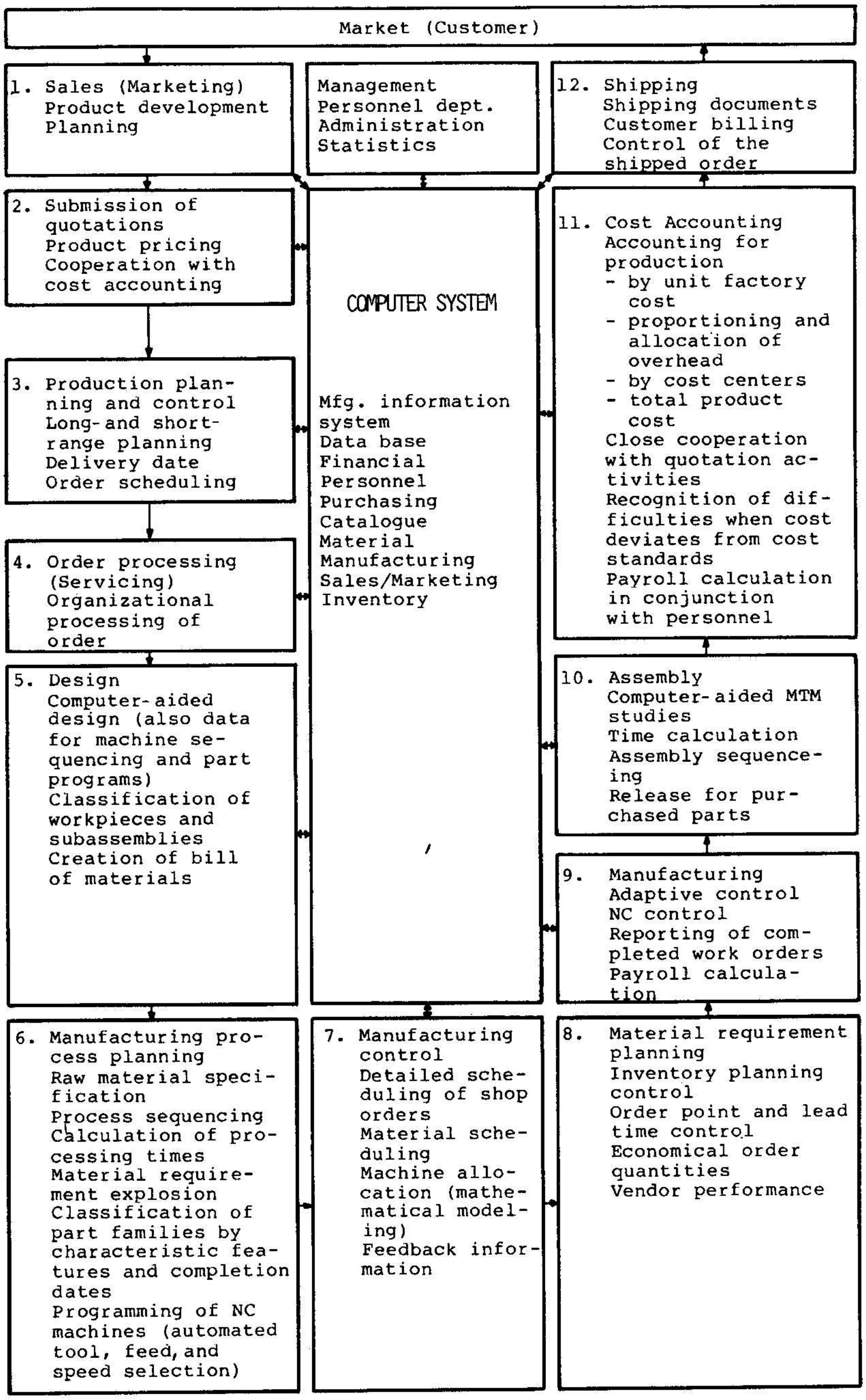
III. Computer Control System - Control functions of a firm and the supporting computing equipment



Control Loop of a Manufacturing System

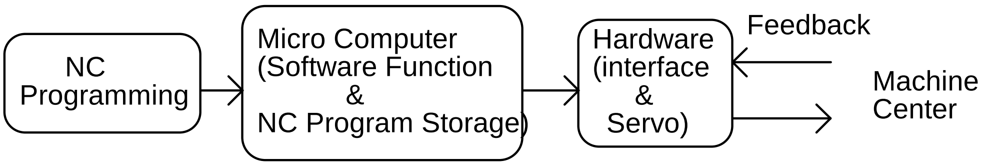


IV. Functions of the computer in a manufacturing organization



V. Functions of Computer in CIMS

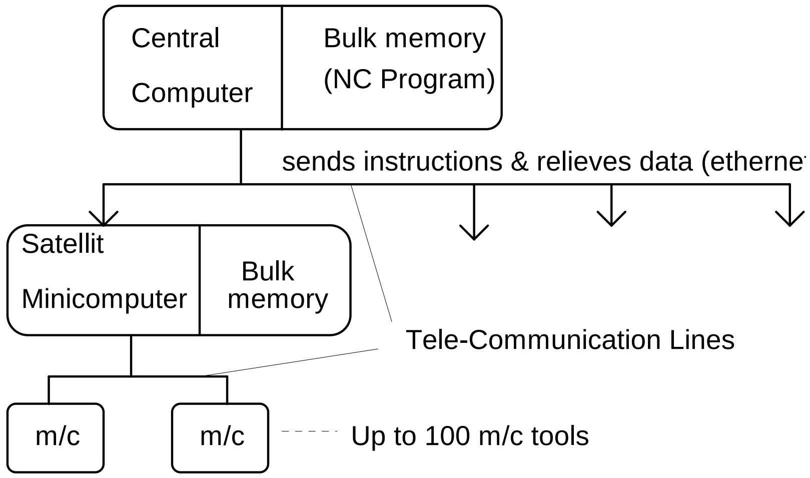
1. Machine Control – CNC



2. Direct Numerical Control (DNC) - A manufacturing system in which a number of m/c are controlled by a computer through direct connection & in real time.

Consists of 4 basic elements:

- Central computer
- Bulk memory (NC program storage)
- Telecommunication line
- Machine tools (up to 100)



3. Production Control - This function includes decision on various parts onto the system.

Decision are based on:

- red production rate/day for the various parts
- Number of raw work parts available
- Number of available pallets

4. Traffic & Shuttle Control - Refers to the regulations of the primary & secondary transportation systems which moves parts between workstation.

5. Work Handling System Monitoring - The computer must monitor the status of each cart & /or pallet in the primary & secondary handling system.

6. Tool Control

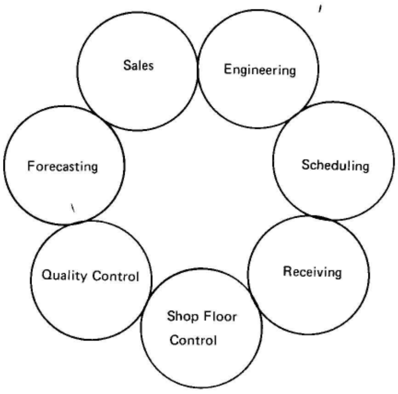
- Keeping track of the tool at each station
- Monitoring of tool life

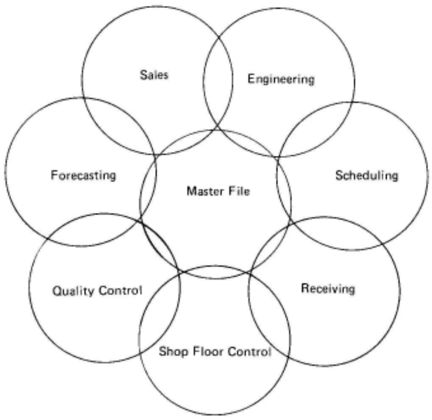
7. System Performance Monitoring & Reporting - The system computer can be programmed to generate various reports by the management on system performance.

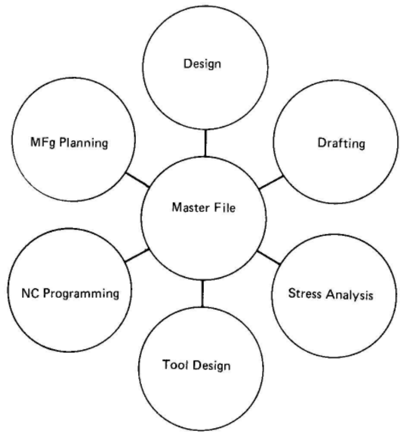
- Utilization reports - summarize the utilization of individual workstation as well as overall average utilization of the system.
- Production reports - summarize weekly/daily quantities of parts produced from a CIMS (comparing scheduled production vs. actual production)
- Status reports - instantaneous report "snapshot" of the present conditions of the CIMS.
- Tool reports - may include a listing of missing tool, tool-life status etc.

8. Manufacturing data base

- Collection of independent data bases
- Centralized data base
- Interfaced data base
- Distributed data base







Production Strategy

The production strategy used by manufacturers is based on several factors; the two most critical are customer lead time and manufacturing lead time.

Customer lead time identifies the maximum length of time that a typical customer is willing to wait for the delivery of a product after an order is placed.

Manufacturing lead time identifies the maximum length of time between the receipt of an order and the delivery of a finished product.

Manufacturing lead time and customer lead time must be matched. For example, when a new car with specific options is ordered from a dealer, the customer is willing to wait only a few weeks for delivery of the vehicle. As a result, automotive manufacturers must adopt a production strategy that permits the manufacturing lead-time to match the customer's needs.

The production strategies used to match the customer and manufacturer lead times are grouped into four categories:

1. Engineer to order (ETO)
2. Make to order (MTO)
3. Assemble to order (ATO)
4. Make to stock (MTS)

Engineer to Order

A manufacturer producing in this category has a product that is either in the first stage of the life-cycle curve or a complex product with a unique design produced in single-digit quantities. Examples of ETO include construction industry products (bridges, chemical plants, automotive production lines) and large products with special options that are stationary during production (commercial passenger aircraft, ships, high-voltage switchgear, steam turbines). Due to the nature of the product, the customer is willing to accept a long manufacturing lead time because the engineering design is part of the process.

Make to Order

The MTO technique assumes that all the engineering and design are complete and the production process is proven. Manufacturers use this strategy when the demand is unpredictable and when the customer lead-time permits the production process to start on receipt of an order. New residential homes are examples of this production strategy. Some outline computer companies make personal computer to customer specifications, so they followed MTO specifications.

Assemble to Order

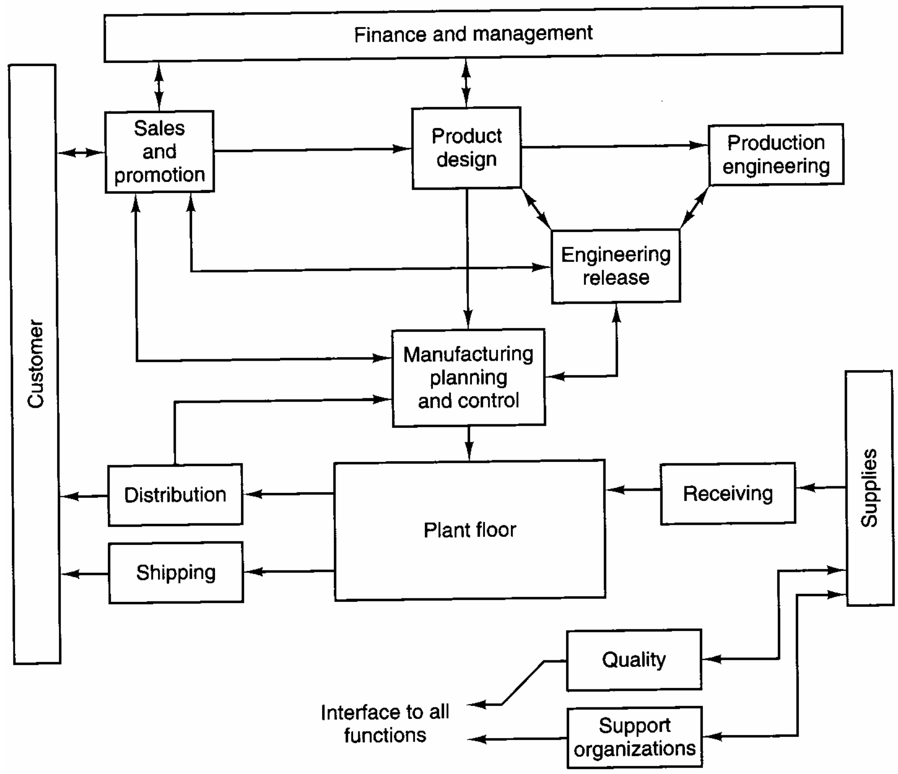
The primary reason that manufacturers adopt the ATO strategy is that customer lead time is less than manufacturing lead time. An example from the automotive industry was used in the preceding section to describe this situation for line manufacturing systems. This strategy is used when the option mix for the products can be forecast statistically: for example, the percentage of four-door versus two-door automobiles assembled per week. In addition, the subassemblies and parts for the final product are carried in a finished components inventory, so the final assembly schedule is determined by the customer order. John Deere and General Motors are examples of companies using this production strategy.

Make to Stock

MTS, is used for two reasons: (1) the customer lead time is less than the manufacturing lead time, (2) the product has a set configuration and few options so that the demand can be forecast accurately. If positive inventory levels (the store shelf is never empty) for a product is an order-winning criterion, this strategy is used. When this order-winning criterion is severe, the products are often stocked in distribution warehouses located in major population centers. This option is often the last phase of a product's life cycle and usually occurs at maximum production volume.

Manufacturing Enterprise (Organization)

- In most manufacturing organizations the functional blocks can be found as:
- A CIM implementation affects every part of an enterprise; as a result, every block in the organizational model is affected.



Sales and Promotion

- The fundamental mission of sales and promotion (SP) is to create customers. To achieve this goal, nine internal functions are found in many companies: sales, customer service, advertising, product research and development, pricing, packaging, public relations, product distribution, and forecasting.

sales and promotion interfaces with several other areas in the business:

- The customer services interface supports three major *customer* functions: order entry, order changes, and order shipping and billing. The order change interface usually involves changes in product specifications, change in product quantity (ordered or available for shipment), and shipment dates and requirements.
- Sales and marketing provide strategic and production planning information to the *finance and management* group, product specification and customer feedback information to *product design*, and information for master production scheduling to the *manufacturing planning and control group*.

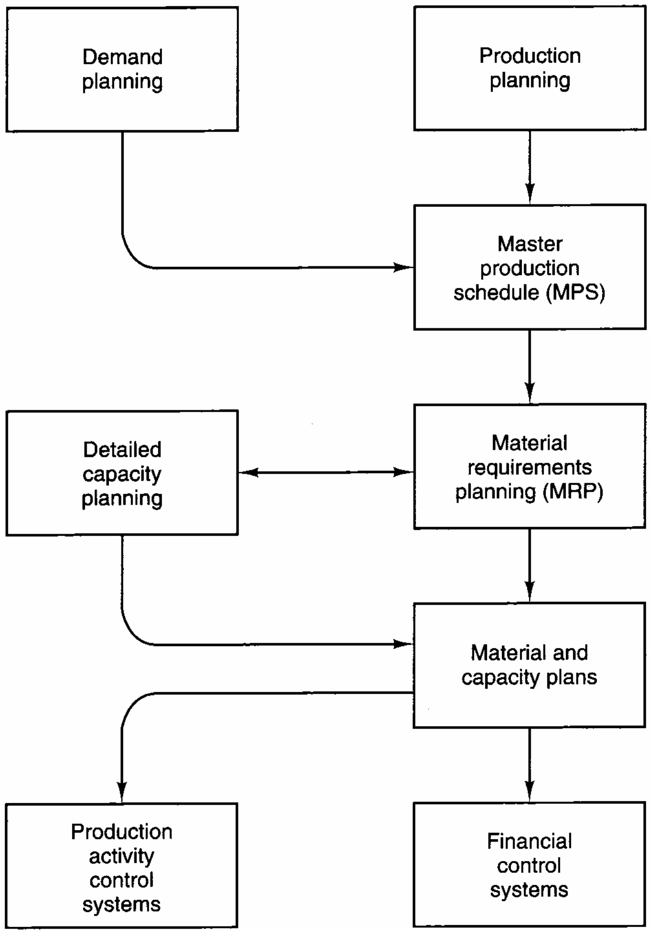
Product/Process Definition Engineering

- The unit includes *product design*, *production engineering*, and *engineering release*.
- The product design provides three primary functions: (1) product design and conceptualization, (2) material selection, and (3) design documentation.
- The production engineering area establishes three sets of standards: work, process, and quality.
- The engineering release area manages engineering change on every production part in the enterprise. Engineering release has the responsibility of securing approvals from departments across the enterprise for changes made in the product or production process.

Manufacturing Planning and Control (MPC)

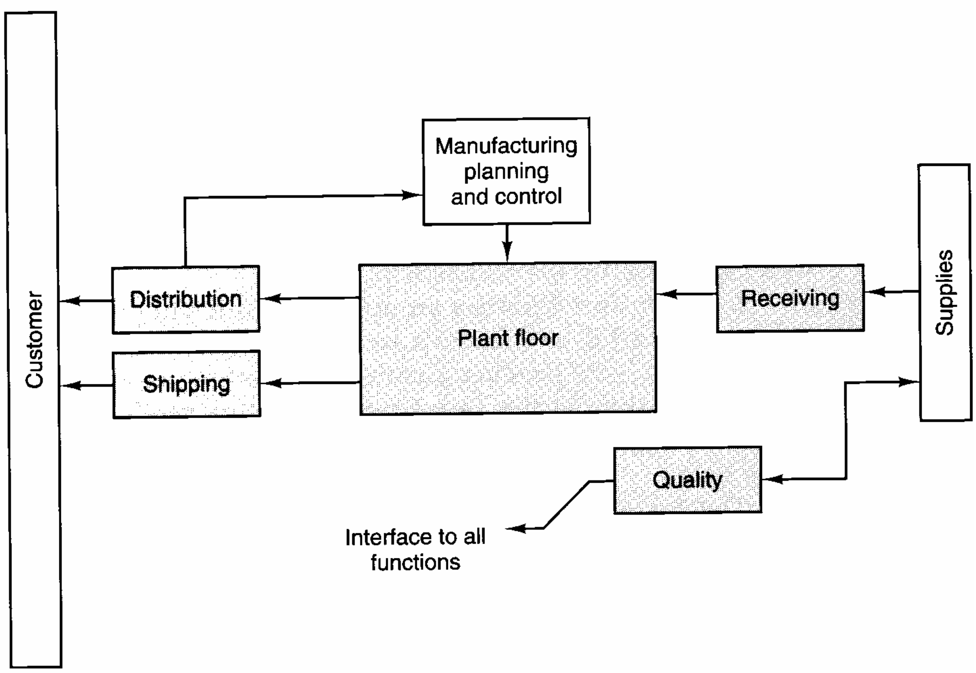
- The manufacturing planning and control unit has a formal data and information interface with several other units and departments in the enterprise.
- The MPC unit has responsibility for:
    1. Setting the direction for the enterprise by translating the management plan into manufacturing terms. The translation is smooth if order-winning criteria were used to develop the management plan.
    2. Providing detailed planning for material flow and capacity to support the overall plan.
    3. Executing these plans through detailed shop scheduling and purchasing action.

MPC Model for Information Flow



Shop Floor

- Shop floor activity often includes job planning and reporting, material movement, manufacturing process, plant floor control, and quality control.
- Interfaces with the shop floor unit are illustrated.



Support Organization

- The support organizations, indicated vary significantly from firm to firm.
- The functions most often included are security, personnel, maintenance, human resource development, and computer services.
- Basically, the support organization is responsible for all of the functions not provided by the other model elements.

Production Sequence :one possibility for the flow required to bring a product to a customer