UNIT II

PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING

Process Planning

- Product design for each product has been developed in the design department.
- To convert the product design into a product, a manufacturing plan is required. Activity of developing such a plan is called process planning.
- Process planning consists of preparing sets of instructions that describe how to manufacture the product and its parts.

Process Planning

- The task of process planning consists of determining the manufacturing operations required to transform a part from a rough (raw material) to the finished state specified on the engineering drawing.
- Also known as operations planning.
- It is the systematic determination of the engineering processes and systems to manufacture a product competitively and economically.
- It is a detailed specification which lists the operations, tools and facilities.
- It is usually accomplished in manufacturing department.

Process Planning Definition

- It Can be defined as “an act of preparing a detailed processing documentation for the manufacture of a piece part or assembly.” According to the American Society of Tool and Manufacturing Engineers.

- Process planning is the systematic determination of the methods by which a product is to be manufactured economically and competitively.

- It Consists of devising, selecting and specifying processes, machine tools and other equipment, transform the raw material into finished product as per the specifications called for by the drawings.

Process Planning Vs Product Planning

Process planning

- It is Concerned with the engineering and technological issues of how to make the product and its parts.
- It specifies types of equipment and tooling required to fabricate the parts and assemble the product.

Production planning

- It is concerned with the logistics issues of making the product.
- It is concerned with ordering the materials and obtaining the resources required to make the product in sufficient quantities to satisfy demand for it.
- Production is done only after the process planning.

Importance of Process Planning

- Process planning establishes the link between engineering design and shop floor manufacturing.
- It Determines how a part/product will be manufactured, the important determinant of production costs and profitability.
- Production process plans should be based on in-depth knowledge of process and equipment capabilities, tooling availability, material processing characteristics, related costs and shop practices.
- Economic future of the industry demands that process plans that are developed should be feasible low cost and consistent with plans for similar parts.
- Process planning facilitates the feedback from the shop floor to design engineering regarding the manufacturing ability of alternative.

Details of a Process Plan

- Detailed process plan usually contains the route, processes, process parameters and machine and tool selections.

- To prepare a process plan (also called as route. sheet), we require the following information:

1. Assembly and component drawings and bill of materials (part list):

- This detail give the information regarding the general description of part to be manufactured, raw material specification, dimensions and tolerances required, the surface finish and treatment required.

Details of a Process Plan

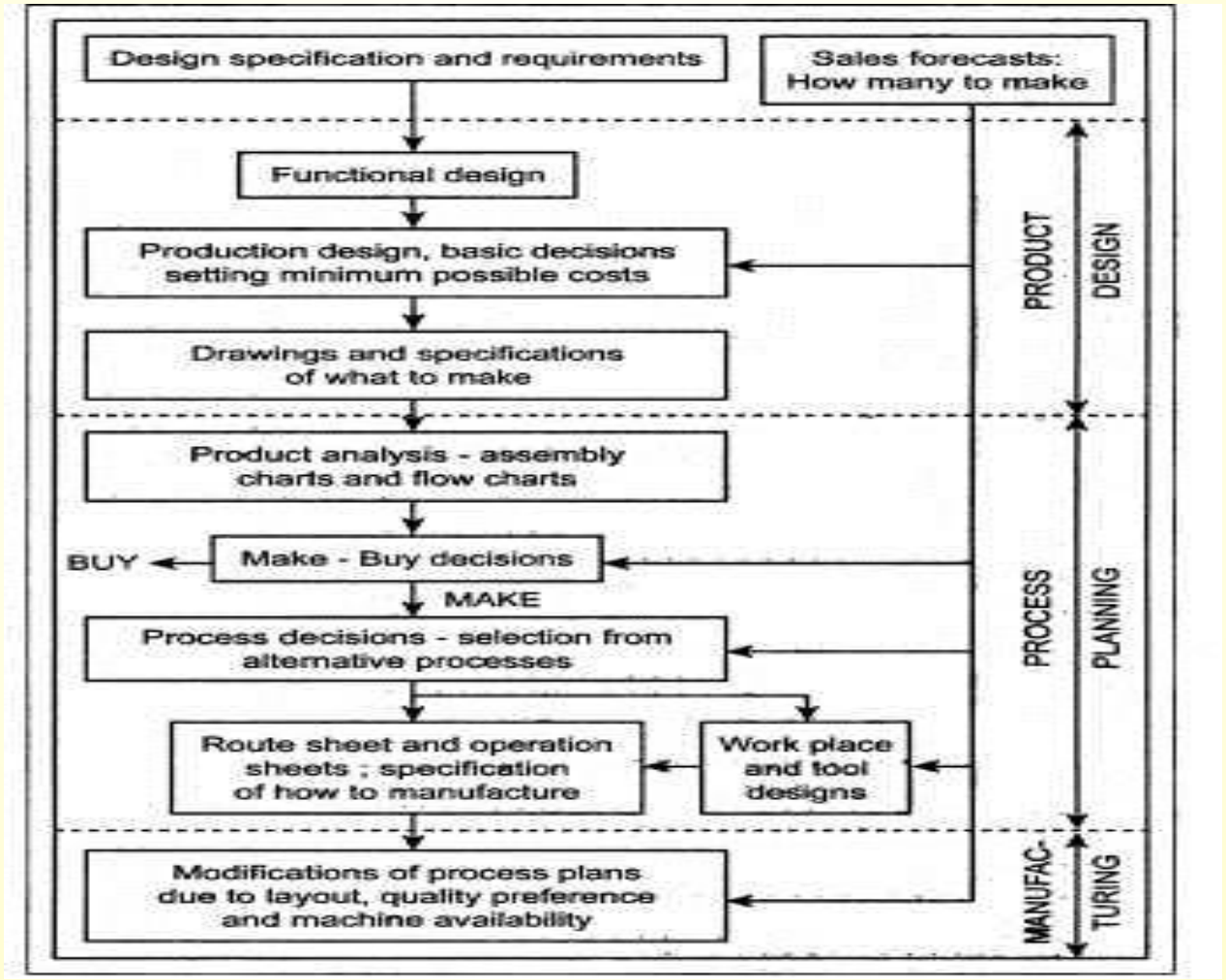
2.Machine and equipment details:

- (i)The various possible operations that can be performed.
- (ii) The maximum and minimum dimensions that can be machined on the machines.
- (iii) The accuracy of the dimensions that can be obtained.
- (iv)Available feeds and speeds on the machine.

3.Standard time for each operation and details of setup time for each job.

Details of a Process Plan

4.Availability of machines, equipment and tools.



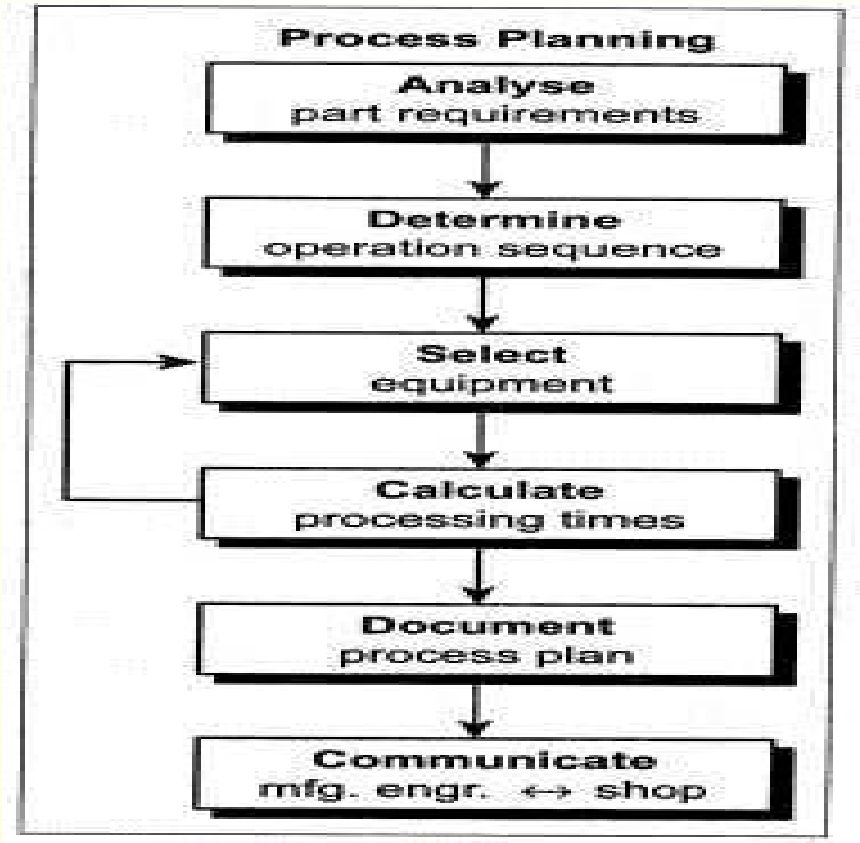
Process Planning Activities

The different steps or specific activities involved in process planning are:

- Analysis of the finished part requirements as specified in the engineering design.
- Determining the sequence of operations required.
- Selecting the proper equipment to accomplish the required operations.
- Calculating the specific operation setup times and cycle times on each machine.
- Documenting the established process plans.
- Communicating the manufacturing knowledge to the shop floor.

Process Planning Activities

- The above process planning activities are diagrammatically presented in figure.



Process Planning Activities

1) Analyse Finished Part Requirements

- First step in the process planning is to analyse the finished part requirements as specified in the engineering design.
- Engineering design may be shown either on an engineering drawing or in a CAD model format.
- Component drawing should be analysed in detail to identify its features, dimensions and tolerance specifications.
- Part's requirement defined by its feature, dimensions and tolerance specifications determines the corresponding processing requirements (such as operations encompassing part shape generation, inspections, testing, heat treatment, surface coating, packaging, etc.)

Process Planning Activities

2) Determine Operating Sequence

- Second step is to determine the sequence of operations required to transform the features, dimensions and tolerances on the part from a rough (initial) to a finished state.

- Basic aim of this step is to determine the type of processing operation that has the capability to generate the various types of features, given the tolerance requirements.

Process Planning Activities

3) Select "Machines"

- Once the appropriate type of manufacturing process has been determined, the next step in process planning is to select appropriate machines equipment and tools to accomplish the required operations.

- There are many factors which influence the selection of machines.

Process Planning Activities

The following considerations are to be made while selecting a machine:

(i) Economic considerations: Due analysis should be made with respect to the initial cost, maintenance and running cost. An alternative which results in lower total cost should be selected.

(ii) Production rate and unit cost of production.

(iii) Durability and dependability.

(iv) Lower process rejection.

(v) Minimum set up and put away times.

(vi) Longer productive life of machines or equipment.

(vii) Functional versatility i.e. ability to perform more than one functions.

Process Planning Activities

4) Material Selection Parameters

- Selection of a sound, economic material is an another important aspect of process planning.

Primary parameters affecting the choice of a material are given below:

- **Function :** Many of the parameters developed for material selection are related to the functions the product must perform in terms of mechanical, physical, electrical and thermal properties of materials.

- **Appearance:** The aesthetic value of the material must be considered while selecting the material.

Process Planning Activities

- **Reliability :** Important criterion for material selection because of increasing consumer demands for trouble free products.
- **Service life:** The length of service life over which the material maintains its desirable characteristics is a very important consideration in material selection.
- **Environment:** The environment to which the material is exposed during the product life is a very important consideration, depending on whether the environment is beneficial or harmful.

Process Planning Activities

5) Calculate Processing Times

- After an appropriate set of required machines is selected, next step is to calculate the specific operation setup times and cycle times on each machine.
- Determination of setup times requires knowledge of available tooling and the sequence of steps necessary to prepare the machine for processing the given work piece.
- For establishing accurate setup times, detailed knowledge of equipment capability, tooling and shop practice is required.

Process Planning Activities

6) Document Process Planning

- Having selected the best processing alternatives and associated machines, the next step in process planning is to document clearly all the information in detail.
- Resulting process plan is generally documented as a job routing or operation sheet.
- Operation sheet is also called “route sheet”, “instruction sheet”, “traveller” or “planner”.
- Route sheet lists the production operations and associated machine tools for each component and sub assembly of the product.

Manual Process Planning

- In traditional process planning systems the process plan is prepared manually.
- It involves examining and interpreting engineering drawings, making decisions on machining processes selection, equipment selection, operations sequence and shop practices.
- The manual process plan is very much dependent on the skill, judgement and experience of the process planner.
- If different planners were asked to develop a process plan for the same part, they would probably come up with different plans.

Advantages of Manual Process Planning

- Manual process planning is very much suitable for small scale companies with few process plans to generate.
- Highly flexible.
- Requires low investment costs.

Computer Aided Process Planning (CAPP)

- To overcome the drawbacks of manual process planning, the computer- aided process planning (CAPP) is used. With the use of computers in the process planning, one can reduce the routine clerical work of manufacturing engineers.

- It provides the opportunity to generate, rational consistent and optimal plans. In addition CAPP provides the interface between CAD and CAM.

Benefits of CAPP

The benefits of implementing CAPP include the following:

- **Process rationalization and standardization:** CAPP leads to more logical and consistent process plans than manual process planning.
- **Productivity improvement:** As a result of standard process plan, the productivity is improved.
- **Product cost reduction:** Standard plans tend to result in lower manufacturing costs and higher product quality.
- Elimination of human error.
- **Reduction in time:** As a result of computerised work, a job that used to take several days, is now done in a few minutes.

Benefits of CAPP

- Reduced clerical effort and paper work
- **Improved legibility:** Computer-prepared route sheets are neater and easier to read than manually prepared route sheets.
- **Faster response to engineering changes:** Since the logic is stored in the memory of the computer, CAPP becomes more responsive to any changes in the production parameters than the manual method of process planning.
- **Incorporation of other application programs**: The CAPP program can be interfaced with other application programs, such as cost estimating and work standards.

Approaches of CAPP

The two basic approaches or types of CAPP system are:

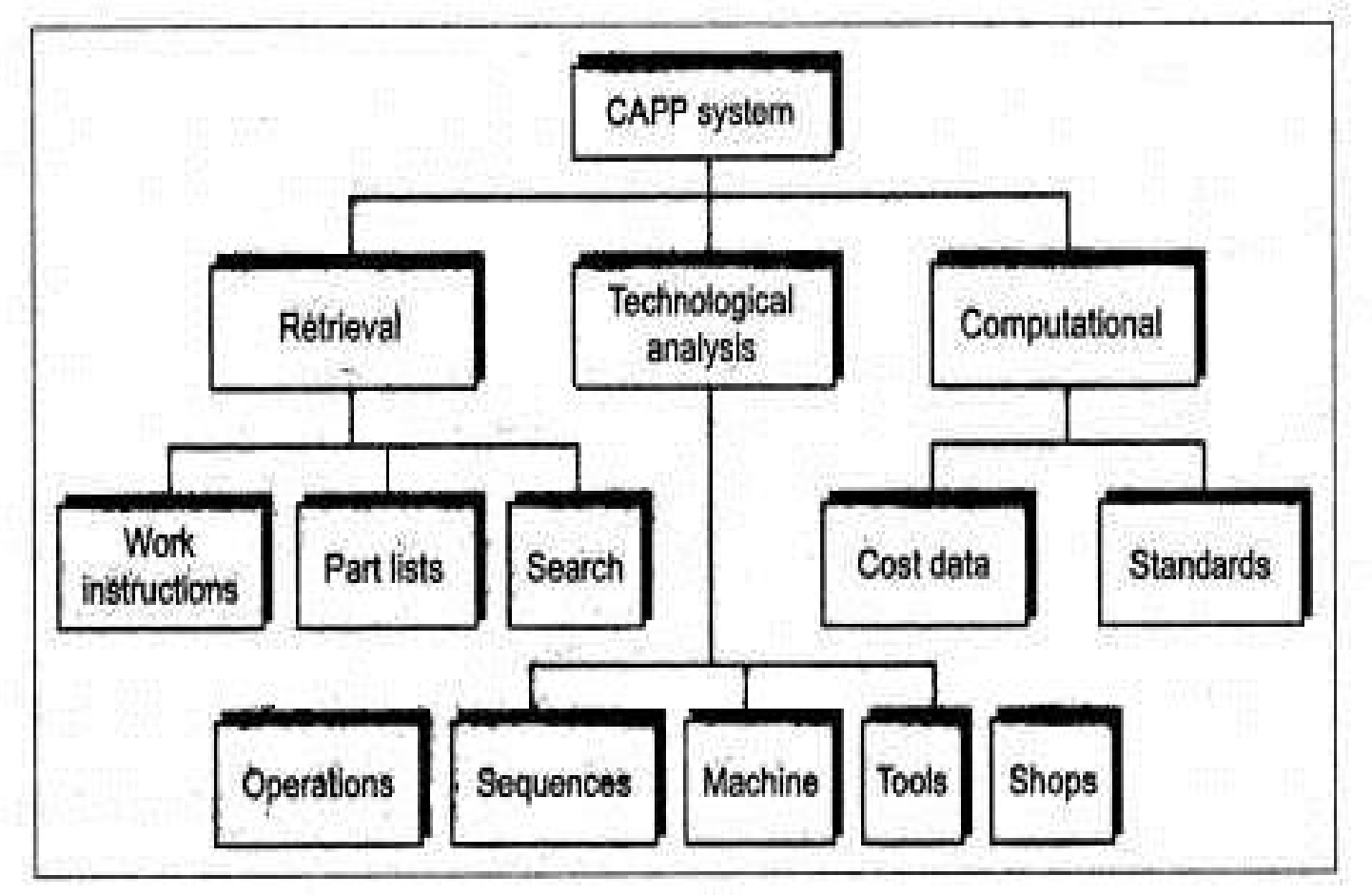
1. Retrieval (or variant) CAPP system.

2. Generative CAPP system.

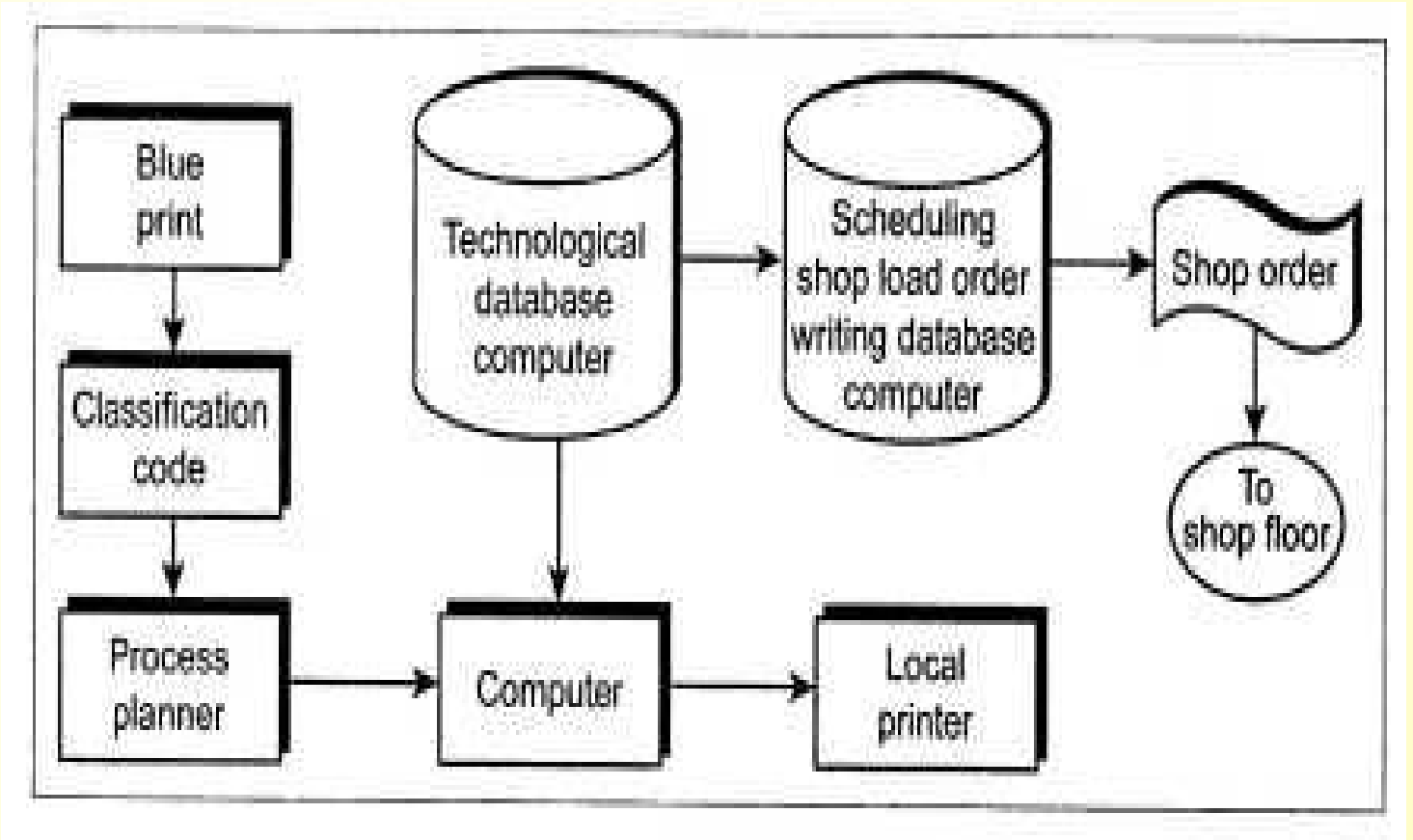
- A CAPP tool can be represented as having three separate functions:

  (i) Retrieval
  (ii) Technological analysis
  (iii) Computational

Approaches of CAPP



CAPP System for Engineering Data



Retrieval (or Variant) CAPP System

- It is also called a variant CAPP system and has been widely used in machining applications.
- Basic idea behind the retrieval CAPP is that similar parts will have similar process plans.
- A process plan for a new part is created by recalling, identifying and retrieving an existing plan for a similar part and making the necessary modifications for the new part.
- Variant CAPP is a computer-assisted extension of the manual approach.

Advantages of Retrieval CAPP System

- Once a standard plan has been written, a variety of parts can be planned.
- Comparatively simple programming and installation (compared with generative CAPP systems) is required to implement a planning system.
- Efficient processing and evaluation of complicated activities and decisions, thus reducing the time and labour requirements.
- Standardized procedures by structuring manufacturing knowledge of the process planners to company's needs.
- Lower development and hardware costs.
- Shorter development times.
- The system is understandable and the planner has control of the final plan.
- It is easy to learn and easy to use.

Disadvantages of Retrieval CAPP System

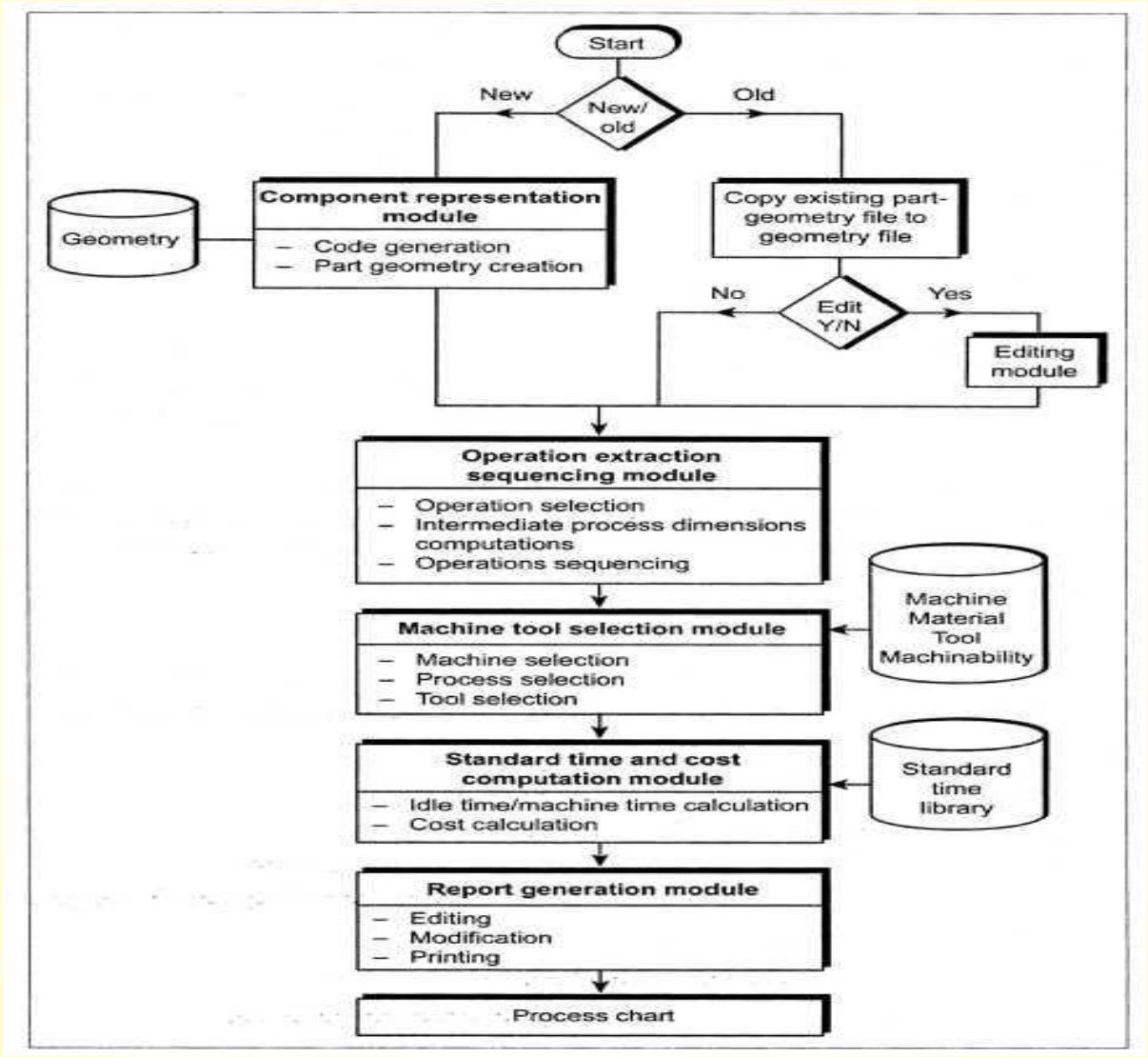
- The components to be planned are limited to similar components previously planned.
- Maintaining consistency in editing is difficult.
- Experienced process planners are still required to modify the standard plan for the specific component.

Components of a Generative CAPP System

The various components of a generative system are:

- A part description, which identifies a series of component characteristics, including geometric features, dimensions, tolerances and surface condition.
- A subsystem to define the machining parameters, for example using look-up tables and analytical results for cutting parameters.
- A database of available machines and tooling.
- A report generator which prepares the process plan report.

Structure of a Generative CAPP System



Advantages of Generative CAPP System

The generative CAPP has the following advantages:

- It can generate consistent process plans rapidly.
- New components can be planned as easily as existing components.
- It has potential for integrating with an automated manufacturing facility to provide detailed control information.

Drawbacks of Generative CAPP System

- The generative approach is complex.
- It is very difficult to develop.

CMPP Process Planning Functions

The CMPP system can perform the following four process planning functions:

- CMPP generates a sequence of operations in a summary format.
- The summary format contains for each operation an operation, number and description, type of machine orientation of the work piece on the machine, surfaces cut and heat treatment.
- CMPP determines the dimensioning reference surfaces for each cut in each operation. CMPP selects the clamping and locating surfaces.
- CMPP determines machining dimensions, tolerances and stock removals for each surface cut in each operation.

CMPP Process Planning Functions

CMPP produces three process plan documents:

(i) A printed summary of operations.

(ii) A printed tolerance analysis

(iii) Dimensional work piece sketches for each machining operation.

CMPP Process Planning Functions

Even though the CMPP system has received limited use in the industrial environment, the CMPP system is considered very significant because of the following three reasons:

(i) CMPP represent one of the most successful attempts at developing a generative system.

(ii) CMPP achieves a higher degree of automated process planning.

(iii) CMPP is being used as a basis for further search into automated process planning.

Selection of a CAPP System

- Evaluation and selection of the best process planning system for a particular firm involves numerous engineering management decisions.
- Process involves identifying, weighing and comparing various interrelated factors.

Logical Steps in Computer Aided Process Planning

Step 1: Define the coding scheme

- Adopt existing coding or classification schemes to label parts for the purpose of classification. In some extreme cases, a new coding scheme may be developed.

Step 2: Group the parts into part families

- Group the part families using the coding scheme defined in Step 1 based on some common part features. A standard process plan is attached to each part family (see: Step 3).
- Often, a number of part types are associated with a family, thereby reducing the total number of standard process plans.

Logical Steps in Computer Aided Process Planning

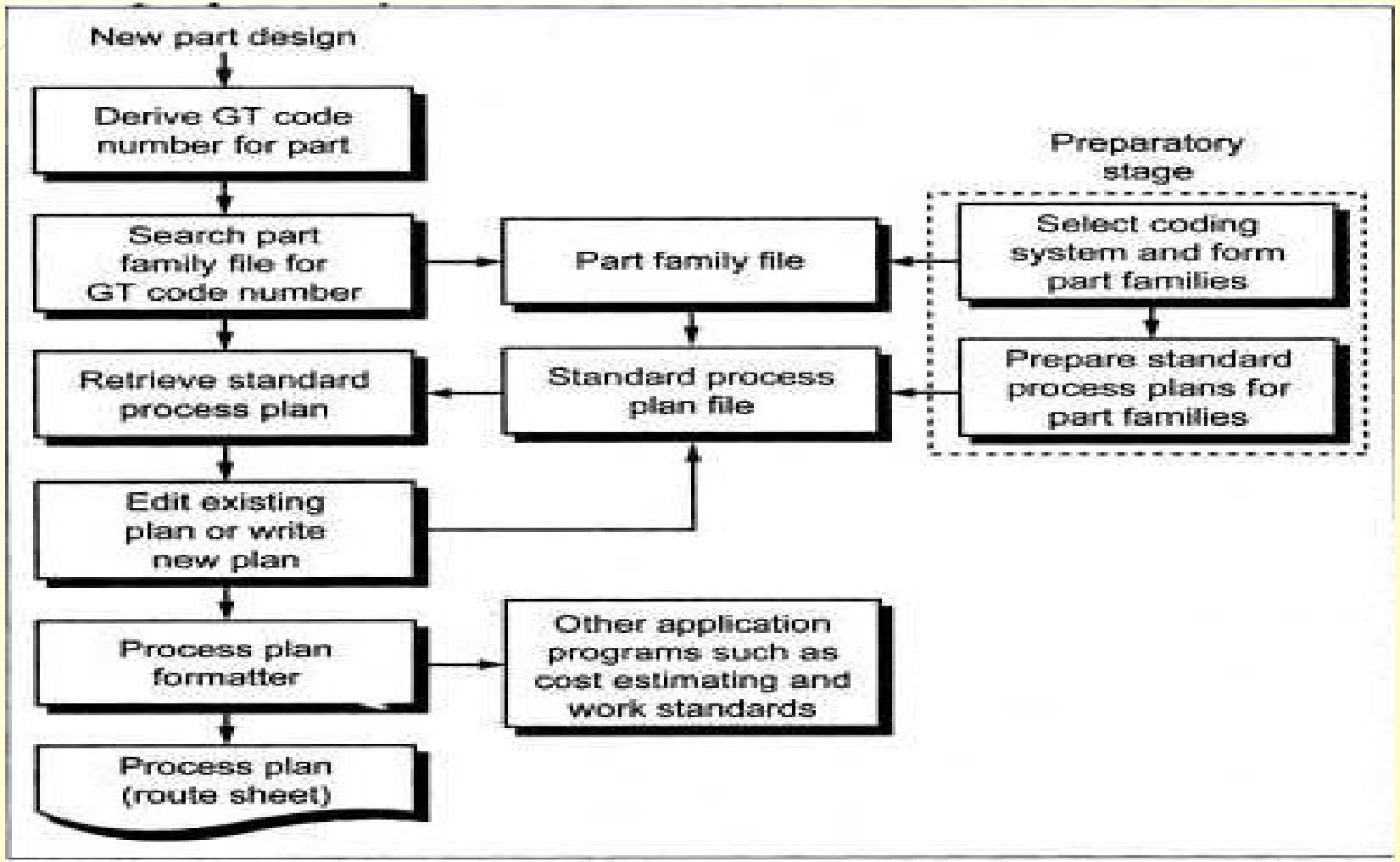
Step 3: Develop a standard process plan

- Develop a standard process plan for each part family based on the common features of the part types.
- This process plan can be used for every part type within the family with suitable modifications.

Step 4: Retrieve and modify the standard plan

- When a new part enters the system, it is assigned to a part family based on the coding and classification scheme.
- Then the corresponding standard process plan is retrieved and modified to accommodate the unique features of the new part.

Retrieval CAPP System Procedure



Aggregate Production Planning and the Master Production Schedule

Aggregate Production Planning

- Aggregate planning is concerned with determining the quantity and timing of production for the intermediate future (often 3 to 8 months) ahead, setting employment, inventory and subcontracting.

- Aggregate plans should be coordinated among various functions in the firm, including product design, production, marketing and sales.

Aggregate Production Planning and the Master Production Schedule

Aggregate Production Planning

- The aggregate production planning strategy provides the data to plan the variable resources, which include full and temporary employment levels, total labour hours per period and number of subcontractors.

- In addition, the aggregate production plan, along with forecasted customer demand, provides the aggregate information from which the disaggregate master production schedule (MPS) is produced.

Aggregate Production Planning

	Month				
	Jan.	Feb.	Mar.	Apr.	May
Planned output (Number of units of product)	1400	1750	1700	2250	2750
Product line models	Month				
	Jan.	Feb.	Mar.	Apr.	May
Model M1	475	500	500	600	625
Model M2	150	400	425	450	650
Model M3	450	500	475	600	675
Model M4	175	150	125	275	425
Model M5	150	200	175	250	300

Aggregate Production Planning and the Master Production Schedule

Master Production Schedule

- The aggregate production plan must be converted into master production schedule (MPS).
- Master production schedule is a listing of the products to be manufactured, when they are to be delivered and in what quantities.
- Aggregate plan lists the production quantities of the major product lines, whereas MPS provides a very specific schedule of individual products.
- Usually MPS is developed from customer orders and forecasts of future demand.

Basic Characteristics of MRP

- Two basic characteristics of MRP are:

1. Drives demand for components, sub assemblies, materials, etc. from demand for and production schedules of parent items.

2. Offsets replenishment orders (purchase orders or production schedules) relative to the date when replenishment is needed.

Information Needed for MRP

The following information are needed for MRP:

- Demand for all products.
- Lead times for all finished goods, components, parts and raw materials.
- Lot sizing policies for all parts.
- Opening inventory levels.
- Safety stock requirements.
- Any orders previously placed but which haven't arrived yet.

Inputs to MRP

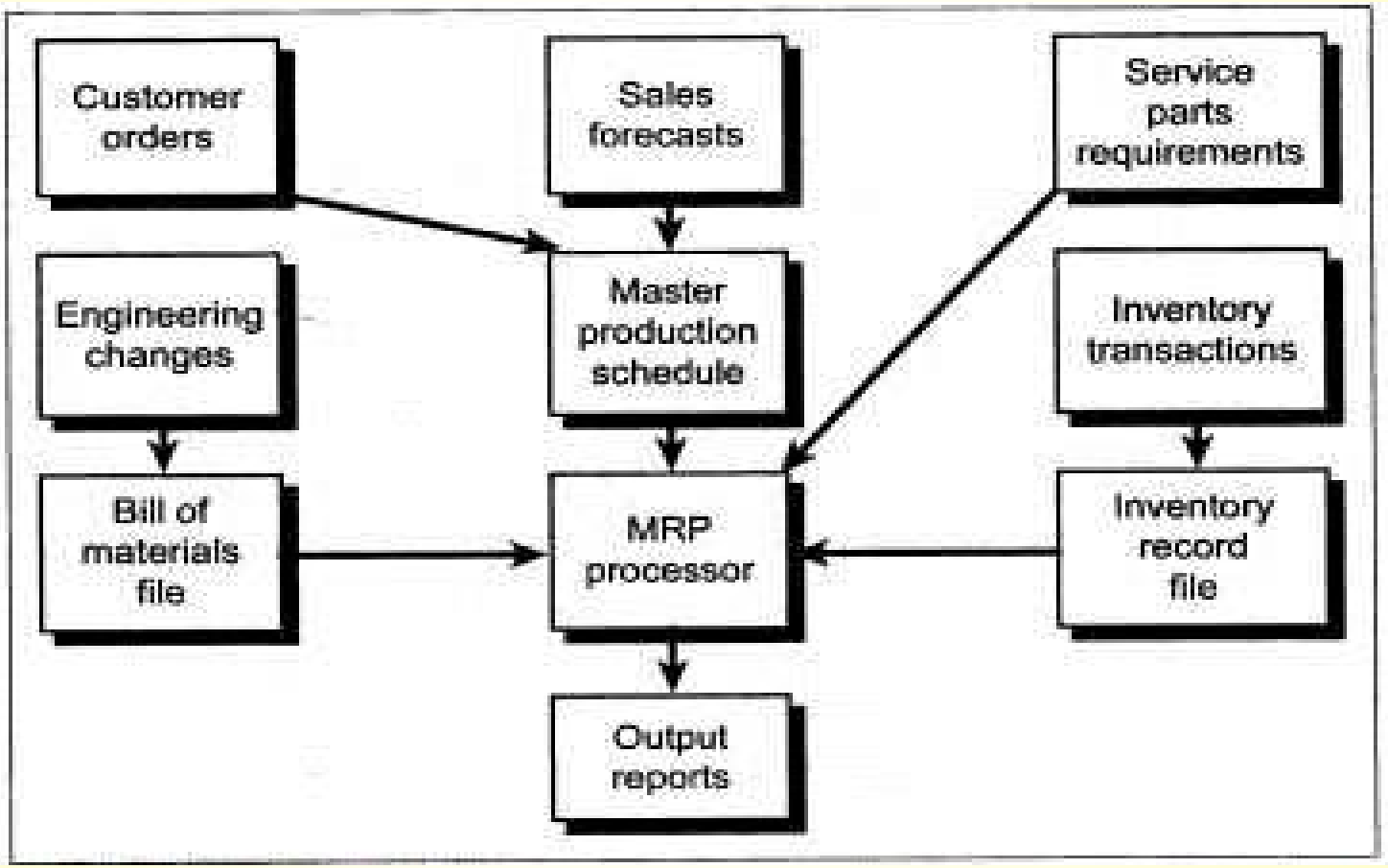
The three important inputs to MRP are:

1.Master production schedule,

2.Bill of materials file and

3.Inventory record file.

Inputs to MRP



Master Production Schedule (MPS)

- It is a detailed plan that states how many end items (i.e. the final product to be sold to the customer) will be available for sale or distribution during specific periods.

Purpose of the master production schedule:

(i) To set due dates for the availability of end items.

(ii) To provide information regarding resources and materials required to support the aggregate plan.

(iii) Input to MRP will set specific production schedules for parts and components used in end items.

Master Production Schedule (MPS)

- **Inputs to MPS:**

The MPS inputs are:

1.Market requirements.

2.Production plan from aggregate planning

3.Resources available.

- **MRP Output:**

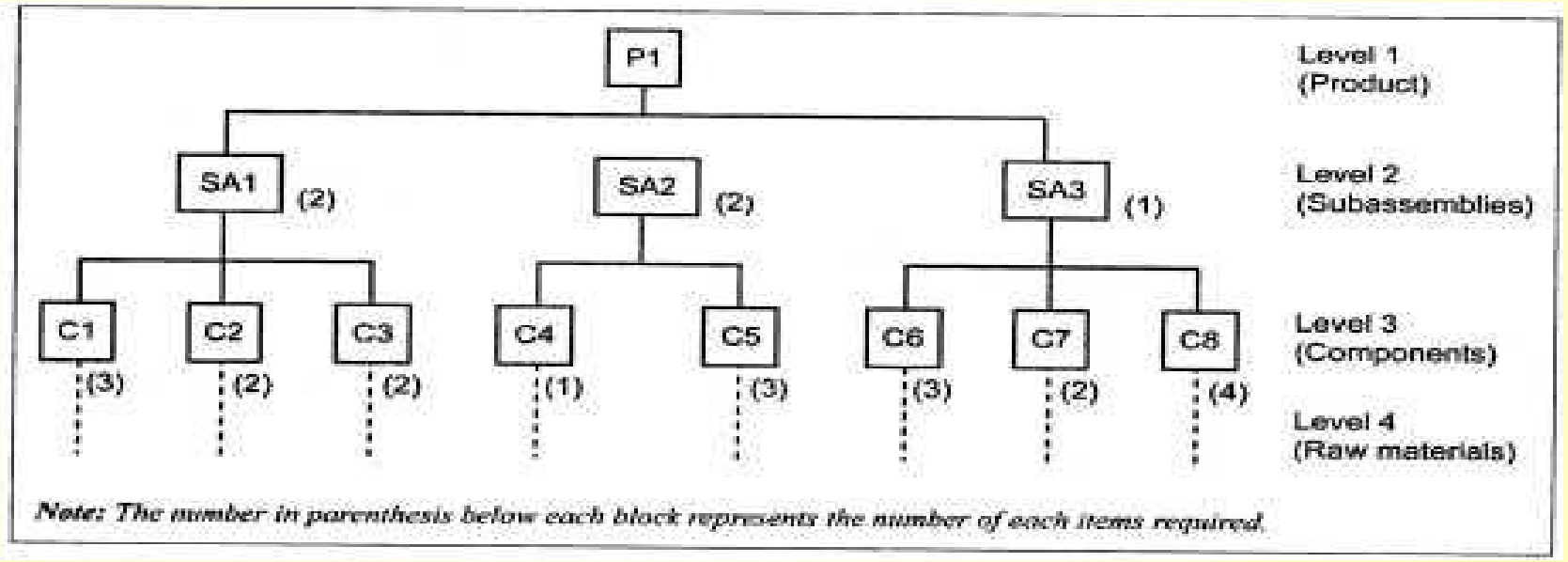
- It is the list of end items available every period that is feasible with respect to demand and capacity.

Bill of Materials File

- Designates what items and how many of each are used to make up a specified final product.
- Used to compute the raw material and component requirements for end products listed in the master schedule.
- It Provides information on the product structure by listing the component parts and subassemblies that make up each product.

Product structure

- Structure of an assembled product, in the form of a pyramid, can be depicted as shown in Fig.
- It can be seen from Figure. that the product P1 is the parent of sub assemblies SA1, SA2, and SA3. similarly SA1 is the parent of components C1, C2 and C3, and so on.



Inventory Record File

- All the data related to the inventory are recorded in the inventory record file.

- The inventory record file contains the following three segment.

(i) Item Master Data Segment

(ii) Inventory Status Segment

(iii) Subsidiary Data Segment

Working of MRP

- MPS provides a period-by-period list of final products required.
- BOM defines what materials and components are needed for each product.
- Inventory record file contains information on the current and future inventory status of each component. using these three inputs, the MRP processor computes the number of each component and raw material required for the given final product.

MRP Output Reports

Types of reports	Purpose
II. Secondary Output Reports	
1. Performance reports of various types	To indicate costs, item usage, etc
2. Exception reports	To show deviations from schedule, orders that are overdue, scrap and so on
3. Inventory forecasts	To indicate the projected level in future periods
4. Cancellation notices	To indicate the cancellation of open orders because of changes in the master schedule
5. Reports on inventory status	To indicate the current status of the inventory

Benefits of MRP

The various benefits of implementing MRP system are:

- Reduced inventory levels.
- Better production scheduling.
- Reduced production lead time.
- Reduced setup cost.
- Reduced product changeover cost.
- Better machine utilization.
- Improved product quality.
- Quicker response to changes in demand.

Capacity Planning

- It is a major business problem Dependent on the type of company and the state of business;
- Much easier if the work load is declining.
- Simplified if the factory has been laid out, after careful simulation, for a planned production level.
- It takes place in three phases, which need to be reviewed within CIM systems.
- Finite capacity calculations are often optimistic, because they do not show the effect of future work, i.e. work not yet released to the factory.

Logic Required In Capacity Planning Under CIM

- The logic for detailed finite capacity planning (i.e. calculations based on actual capacity) must include the ability to summarize the various priority factors such as lateness on due date, important customer, accumulated cost, into a single numeric value so that queues can be sequenced.

Logic Required In Capacity Planning Under CIM

In addition, a number of other process routines that are as follows:

- Reduction of standard inter-operation (or move) time for urgent jobs.
- Overlapping of jobs across different work centres, e.g. the first items in a batch being heat treated while the last items are still being machined.
- Splitting of batches across identical machines,
- Use of alternative routing data, i.e. there may be different ways of making a product that could be chosen, depending on the load at the time on different work centres.

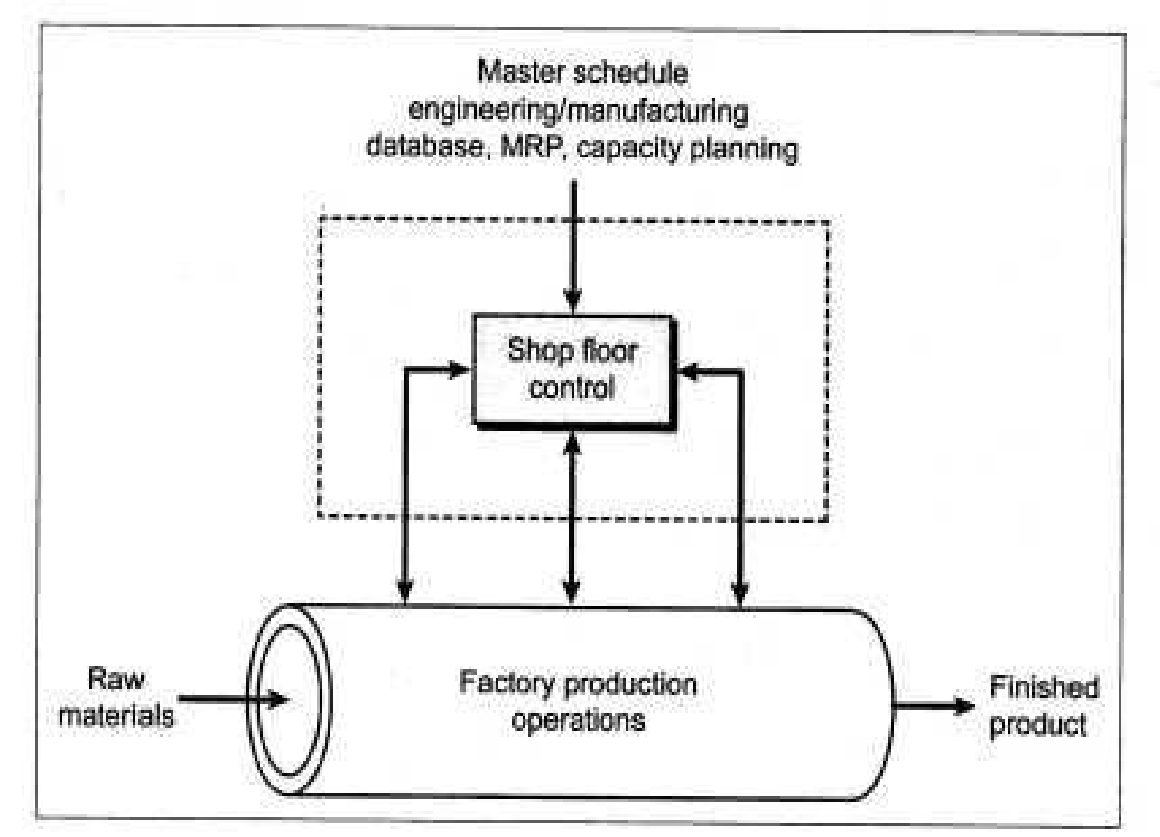
Control Systems

Shop Floor Control

- This control Manages the detailed flow of materials inside the production facility.
- It Encompasses the principles, approaches and techniques needed to schedule, control, measure and evaluate the effectiveness of production operations.
- Is an activity of production control one of the activity of process planning and control (PPC).
- To understand the significance of the shop floor control, it is essential to have the basic knowledge of various activities of PPC and their relations to shop floor control.
- It is defined as a system for utilizing data from the shop floor as well as data processing files to maintain and communicate status information on shop orders and work centre.

Shop Floor Control

Shop Floor Control



Shop Floor Control

Shop floor control (SFC) is concerned with:

(i) The release of production orders to the factory.

(ii) Monitoring and controlling the progress of the orders through the various work centres.

(iii) Acquiring information on the status of the orders.

(iv) Shop floor control deals with managing the work-in-process.

Shop Floor Control

Functions of Shop Floor Control

- The major functions of shop floor control are:

1. Assigning priority of each shop order (Scheduling).

2. Maintaining work-in-process quantity information (Dispatching).

3. Conveying shop-order status information to the office (Follow up).

4. Providing actual output data for capacity control purposes.

5. Providing quantity by location by shop order for work-in-process inventory and accounting purposes.

6. Providing measurement of efficiency, utilisation and productivity of manpower and machines.

Shop Floor Control

- The functions of SFC are:

1. Scheduling
2. Dispatching and
3. Follow-up or Expediting.

Shop Floor Control

Phases of SFC

The three important phases of SFC are:

1.Order release

2.Order scheduling and

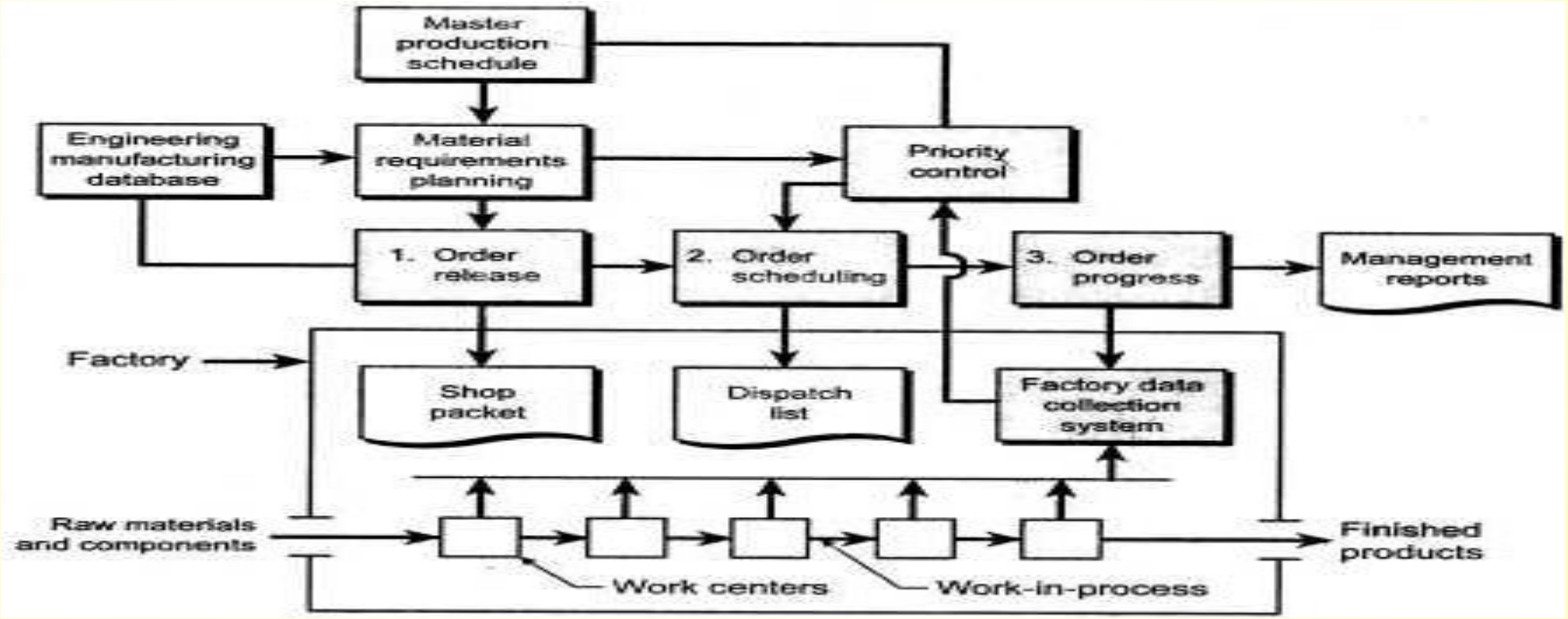
3.Order progress.

It Depicts the three phases and their relationship to other functions in the production management system.

In a computer integrated manufacturing system these phases are managed by computer software.

Shop Floor Control

- In a typical factory which works on manual processing of data, the above documents move with the production order and are used to track the progress through the shop.
- In a CIM factory, more automated methods are used to track the progress of the production orders.



Shop Floor Control

i) The first input is the authorization to produce (that derives from master schedule). This authorisation proceeds through MRP which generates work orders with scheduling information.

(ii) The second input is the engineering and manufacturing database.

- This database contains engineering data (such as the product design, component material specifications, bills of materials, process plans, etc.) required to make the components and assemble the products.

- Database input provides the product structure and process planning information needed to prepare the various documents that accompany the order through the shop.

Shop Floor Control

2) Order Scheduling

- The two inputs required to the order scheduling are:

(i) The order release and

(ii) The priority control information

- It Priority control is used in production planning and control to denote the function that maintains the appropriate levels for the various production orders in the shop.

Shop Floor Control

The order scheduling module is used to solve the following two problems in production controls:

- **Machine loading:** Allocating orders to work centres is known as machine loading.
- The term shop loading is used when loading of all machines in the plant are done.
- **Job sequencing:** Determining the priority in which the jobs should be processed is termed as job sequencing.
- Each work centre will have a queue of orders waiting to be processed. Queue problem can be solved by job sequencing.
- Priority sequencing rules, also known as dispatching rules, have been developed to establish priorities for production orders in the plant.

Shop Floor Control

Some of the commonly used priority sequencing rules are presented below.

- **SOT (shortest operating time**): Run the job with the shortest completion time first, next shortest second and so on.
- **Earliest due date:** Run the job with the earliest due date first.
- **STR (slack time remaining):** This is calculated as the difference between the time remaining before the due date minus the processing time remaining. Orders with the STR are run first.
- **STR/OP (slack time per operation):** Orders with shortest STR/OP are run first. STR/OP is calculated as follows:

$$\text{STR/OP} = \frac{\left\{\begin{matrix}\text{Time remaining}\\ \text{before due date}\end{matrix}\right\} - \left\{\begin{matrix}\text{Remaining}\\ \text{processing time}\end{matrix}\right\}}{\text{Number of remaining operations}}$$

- **CR (critical ratio):** This is calculated as the difference between the due date and the current date divided by the number of work days remaining. Orders with the smallest CR are run first.

Shop Floor Control

Some of the commonly used priority sequencing rules are presented below.

- **QR (queue ratio):** This is calculated as the slack time remaining in the schedule divided by the planned remaining queue time. Orders with the smallest QR are run first.
- **FCFS (first-come, first-served):** Orders are run in the order they arrive in the department.
- **LCFS (last-come, first-served):** As orders arrive, they are placed on the top of the stock and are run first.

Shop Floor Control

3) Order Progress

- The third and final phase of SFC is order progress phase.
- The order progress phase monitors the status of the various orders in the plant, work-in-progress (WIP)
- Order progress collects data from shop floor and generates reports to assist production management.
- Function of order progress module is to provide information that is useful in managing the factory based on data collected from the factory.

Shop Floor Control

- **Progress reports:** These reports indicate the performance of the shop during a certain time period (say, week or month in the master schedule).

- Typical information listed in these reports include how many orders were completed during the period, how many orders that should have been completed during the period were not completed.

- **Exception reports:** These reports indicate the deviations from the production schedule (e.g. overdue jobs), and similar exception information.

Shop Floor Control

The three forms of order progress reports that are presented to production management are;

- **Work order status reports :** These reports indicate the current status o each shop through the shop.

- It provides information on the current work centre where each order is located, processing hours remaining before completion of each order, whether the job is on-time or behind schedule and priority level.

Control Systems

Inventory Control

- **Inventory Management:**

It is defined as the scientific method of determining what to order, when to order and how much to order and how much to stock so that costs associated with buying and storing are optimal without interrupting production and sales.

- **Inventory decisions:**

There are two basic decisions to be made for every item in the inventory. They are:

(i) How much of an item to order when the inventory of that item is to be replenished (i.e. order quantity) and

(ii) When to replenish the inventory of that item?

The use of inventory models answer the above two questions.

Inventory Control

- **Objective of Inventory Control**

The main objectives of inventory control are:

(i) To ensure continuous supply of materials so that production should not suffer at any time.

(ii) To maintain the overall investment in inventory at the lowest level, consistent with operating requirements.

(iii) To minimize holding, replacement and shortage cost of inventories and maximize the efficiency in production and distribution.

(iv) To keep inactive, waste, surplus, scrap and obsolete items at the minimum level.

Inventory Control

- **Objective of Inventory Control**

(v) To supply the product, raw material, WIP, etc., to its users as per their requirements at right time and at right price.

(vi) To ensure timely action for replenishment.

(vii) To maintain timely record of inventories of all the items and to maintain the stock within the desired limits.

(viii) To avoid both over-stocking and under-stocking of inventory.

Inventory Control

- Costs Associated with Inventory (What are Inventory Costs?)

The major costs associated with procuring and holding inventories are:

1. Ordering costs
2. Carrying (or holding) costs
3. Shortage (or stock out) costs and
4. Purchase costs.

Inventory Control

1) Ordering costs

There are costs associated with the placement of an order for the acquisition of inventories.

- It is Refer to the managerial and clerical costs to prepare the purchase or production order.
- It is also known by the names procurement costs, replenishment costs and acquisition costs.

These costs include:

(i) Costs of staff of purchase department,

(ii) Costs of stationery consumed for ordering, postage, telephone bills, etc.

(iii) Depreciation costs and expenses for maintaining equipment required for ordering, receiving and inspecting incoming items.

(iv) Inspection costs of incoming materials.

Inventory Control

2) Holding (or inventory carrying) costs

- Inventory carrying costs are the costs associated with holding a given level of inventory on hand.
- It varies in direct proportion to the amount of holding and period of holding the stock in stores. This cost will not occur if inventory is not carried out.

The holding costs include:

(i) Costs for storage facilities.

(ii) Handling costs.

(iii) Depreciation, taxes and insurance.

(iv) Costs on record keeping.

(v) Losses due to pilferage, spoilage, deterioration and obsolescence.

(vi)Opportunity cost of capital.

Inventory Control

3) Shortage (or stock-out) costs

When the stock of an item is depleted and there is a demand for it, then the shortage cost will occur.

Shortage cost is the cost associated with stock-out.

The shortage costs include:

(i) Back order costs.

(ii) Loss of future sales.

(iii) Loss of customer goodwill.

(iv) Loss of profit contribution by lost sales revenue.

(iv) Extra cost associated with urgent, small quantity ordering costs.

Inventory Control

4) Purchase (or production) costs

- These are the costs incurred to purchase/or produce the item. This Costs include the price paid or the labour, material and overhead charges necessary to produce the item.

Manufacturing Resource Planning (MRP-II)

- It Represents the natural evolution of closed-loop MRP (materials requirements planning).
- It is an integrated information system that synchronize all aspects of the business.
- It is Coordinates sales, purchasing, manufacturing, finance and engineering by adopting a focal production plan and by using one unified database to plan and update the activities in all the systems.
- MRP II consists of virtually all the functions in the PPC system (presented in Figure) plus additional business functions that are related to production.

Manufacturing Resource Planning (MRP-II)

- Important MRP II system functions include:

1.**Management planning** — business strategy, aggregate production planning, master production scheduling, rough-cut capacity planning and budget planning.

2.**Customer services** — sales forecasting, order entry, sales analysis and finished goods inventory.

3.**Operations planning** — purchase order and work order release.

4.**Operations execution** — purchasing, product scheduling and control, work-in - process inventory control, shop floor control and labour hour tracking.

5. **Financial functions** — cost accounting, accounts receivable, accounts payable, general ledger and payroll.

Manufacturing Resource Planning (MRP-II)

Now-a-days many commercial software are available incorporating MRP II functions with more features.

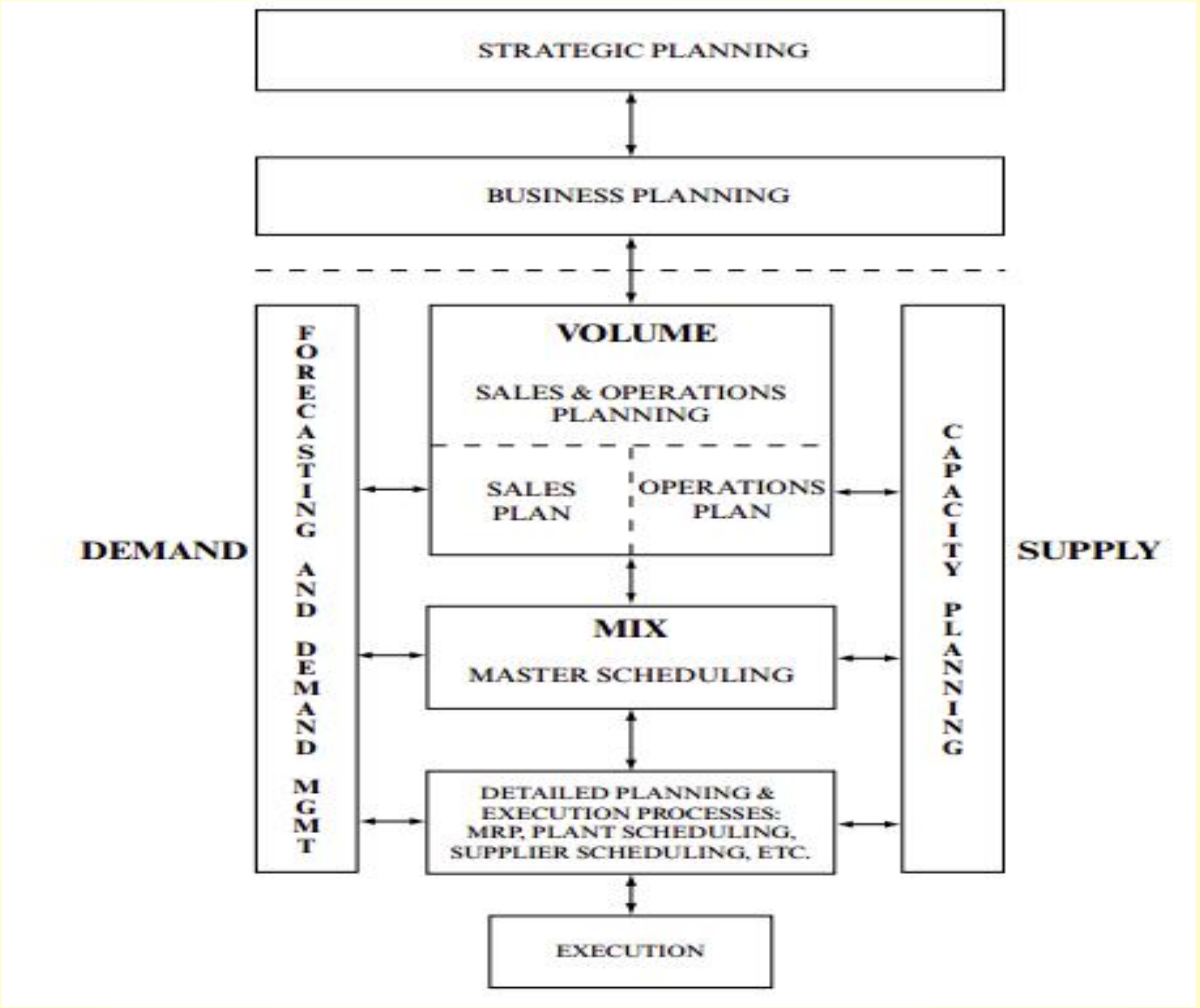
Some of them include:

- Enterprise Resource Planning (ERP)
- Customer-Oriented Manufacturing Management Systems (COMMS)
- Manufacturing Execution Systems (MES)
- Customer-Oriented Management Systems (COMS).

Enterprise Resource Planning (ERP)

- It latest step in this evolution is Enterprise Resource Planning (ERP).
- Fundamentals of ERP are the same as with MRP II.
- Predicts and balances demand and supply.
- It is an enterprise-wide set of forecasting, planning and scheduling tools.
- Links customers and suppliers into a complete supply chain, Employs proven processes for decision-making and Coordinates sales, marketing, operations, logistics, purchasing, finance, product development and human resources.
- Goals include high levels of customer service, productivity, cost reduction and inventory turnover and it provides the foundation for effective supply chain management and e-commerce.

Enterprise Resource Planning (ERP)



Enterprise Resource Planning (ERP)

- Enterprise Resource Planning is a direct outgrowth and extension of Manufacturing Resource Planning and as such includes all of MRP II's capabilities.

a) Applies a single set of resource planning tools across the entire enterprise,

b) Provides real-time integration of sales, operating and financial data and

c) Connects resource planning approaches to the extended supply chain of customers and suppliers.

- Primary purpose of implementing Enterprise Resource Planning is to run the business, in a rapidly changing and highly competitive environment, far better than before.

Enterprise Resource Planning (ERP)

- **The Applicability of ERP**

ERP and its predecessor, MRP II, have been successfully implemented in companies with the following characteristics:

- Make-to-stock
- Design-to-order
- Simple product
- Single plant
- Manufacturers with distribution networks
- Make-to-order
- Complex product
- Multiple plants
- Contract manufacturers
- Sell direct to end users

Enterprise Resource Planning (ERP)

ERP problems fall into these four types:

- The system itself is bad.
- The system is good, but it's set up incorrectly.
- The system is good, but it's not being used.
- The system is good, but it's being used ineffectively.