CAD/CAM 18ME72

ATME College of Engineering

Module-2

1.CAD and Computer Graphics Software
2.Computerized Manufacturing Planning and Control System

Mr.Shashidhar.M.K
Assistant Professor,
Dept. of Mechanical Engineering,
ATMECE, Mysuru

CAD- Computer Aided Design

- Computer-aided design involves any type of design activity which makes use of the computer to **develop, analyze, or modify an engineering design**.

- Modem CAD systems (also often called CAD/CAM systems) are based on **interactive computer graphics (ICG).**

- Interactive computer graphics denotes a user-oriented system in which the computer is employed to **create, transform, and display data in the form of pictures or symbols.**

- The user in the computer graphics design system is the designer, who communicates data and commands to the computer through any of several input devices.

Fundamental reasons for implementing a computer-aided design system

1. **To increase the productivity of the designer.** This is accomplished by helping the designer to design the product and its component subassemblies and parts; and by **reducing the time required in synthesizing, analyzing, and documenting the design**. This productivity improvement translates not only into **lower design cost** but also into **shorter project completion times**.

2. **To improve the quality of design**. A CAD system permits a more thorough engineering analysis and a larger number of design alternatives can be investigated. **Design errors are also reduced** through the **greater accuracy** provided by the system. These factors lead to a better design.

3. **To improve communications**. Use of a CAD system provides better engineering drawings, more standardization in the drawings, better documentation of the design, fewer drawing errors and greater legibility.

4. **To create a database for manufacturing**. In the process of creating the documentation for the product design (geometries and dimensions of the product and its components, material specifications for components, bill of materials, etc.), much of the required database to manufacture the product is also created.

The Design Process

l. Recognition of need

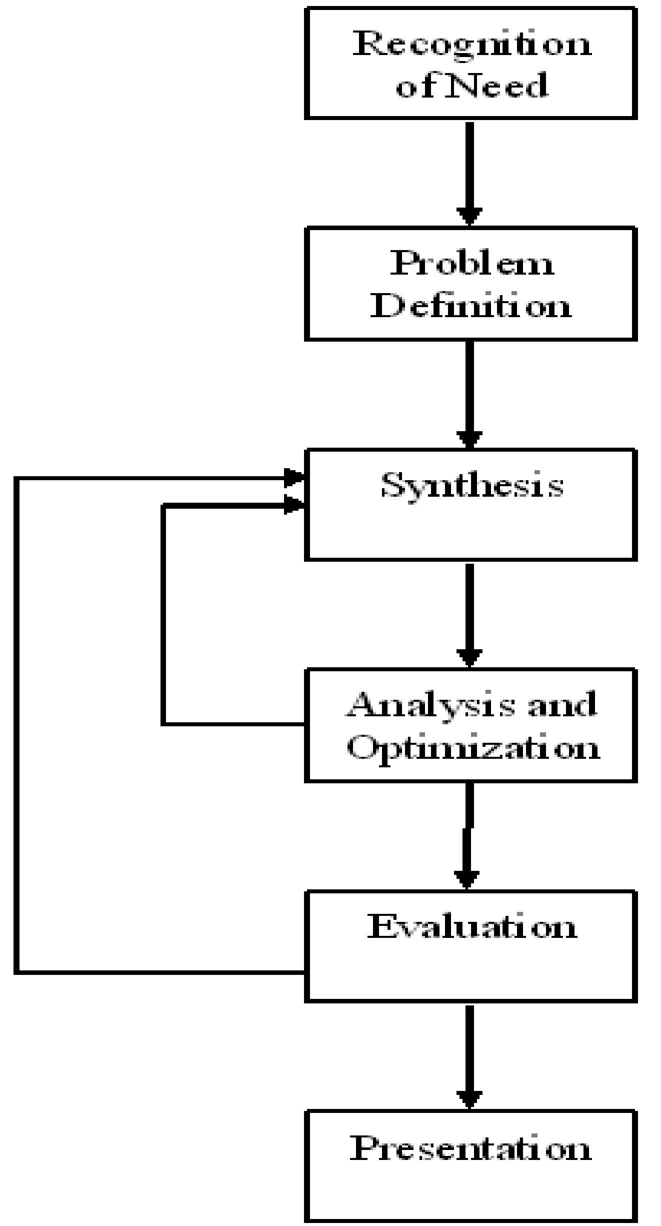
2. Definition of problem

3. Synthesis

4. Analysis and optimization

5. Evaluation

6. Presentation



The Design Process

- **Recognition** of need involves the **realization** by someone that a problem exists for which some corrective action should be taken. This might be the **identification of some defect** in a current machine design by an engineer or the perception of a **new product marketing opportunity** by a salesperson.

- **Definition** of the problem involves a thorough **specification** of the item to be designed. This specification includes physical and functional characteristics, cost, quality, and operating performance.

- **Synthesis and analysis** are closely related and highly interactive in the design process. A certain component or subsystem of the overall system is **conceptualized** by the designer, subjected to analysis, improved through this analysis procedure, and redesigned.

- **The process is repeated** until the design has been **optimized** within the constraints imposed on the designer. The components and subsystems are synthesized into the final overall system in a similar interactive manner.

The Design Process

- **Evaluation** is concerned with measuring the design **against the specifications** established in the problem definition phase. This evaluation often requires the fabrication and **testing of a prototype model** to assess operating performance, quality, reliability, and other criteria. The final phase in the design process is the presentation of the design. This includes documentation of the design by means of drawings, material specifications, assembly lists, and so on.
- **Mechanical design includes the drawing** of the complete product as well as its components and subassemblies, and the tools and fixtures required to manufacture the product. Similar manual documentation is required in other engineering design fields (structural design, aircraft design, chemical engineering design, etc.). In each engineering discipline, the approach has traditionally been to synthesize a preliminary design manually and then to subject that design to some form of analysis. The analysis may involve sophisticated engineering calculations or it may involve a very subjective judgment of the aesthete appeal possessed by the design.

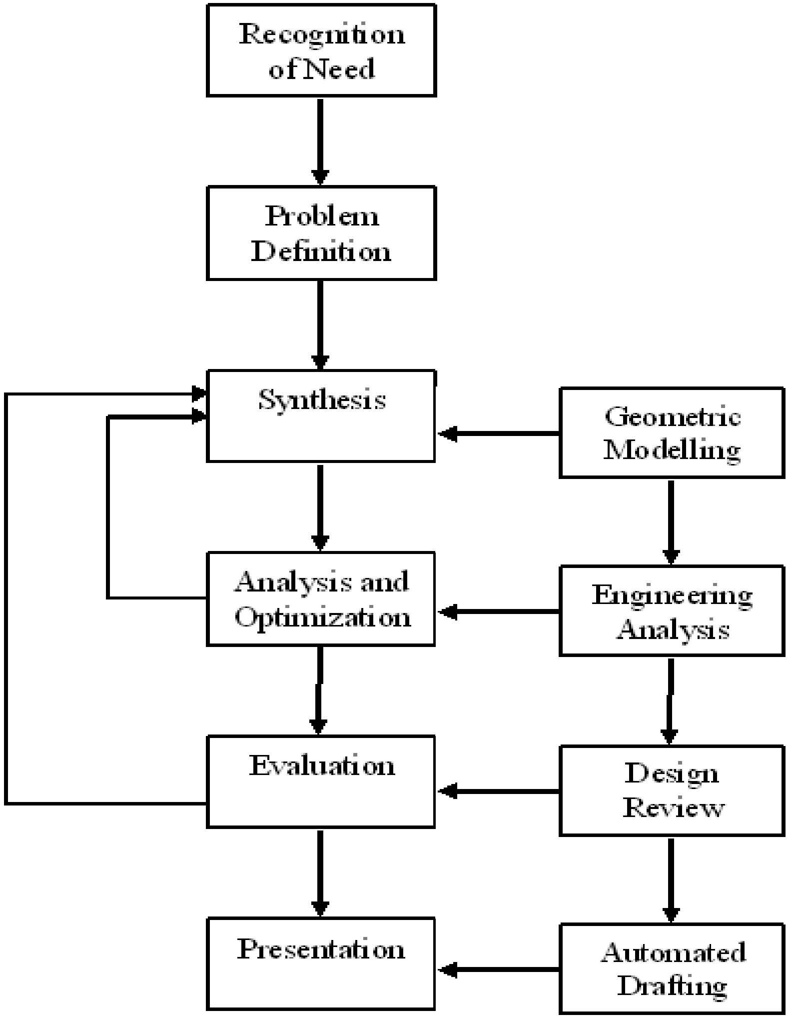
The Application of Computers For Design

l. Geometric modeling

2. Engineering analysis

3. Design review and evaluation

4. Automated drafting



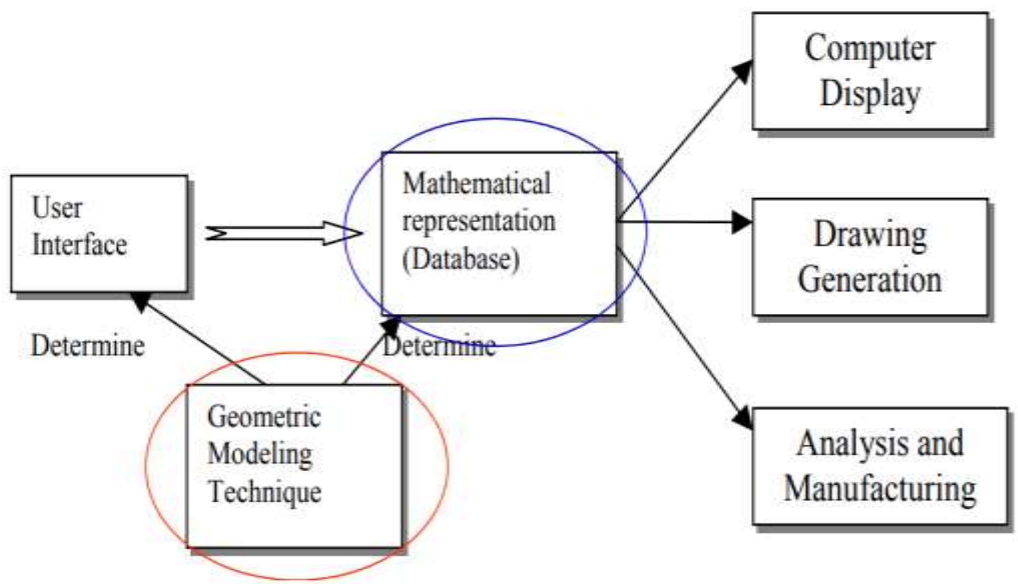
Geometric modeling

- In computer-aided design, geometric modeling is concerned with the **computer-compatible mathematical description of the geometry** of an object. The mathematical description allows the image of the object to be displayed and manipulated on a graphics terminal through signals from the CPU of the CAD system.
- To use geometric modeling, the designer constructs, the graphical image of the object on the CRT screen of the ICG system by inputting three types of commands to the computer.
  - **The first type of command** generates basic geometric elements such as points, lines, and circles.
  - **The second command** type is used to accomplish scaling, rotating, or other transformations of these elements.
  - **The third type of command** causes the various elements to be joined into the desired shape of the object being creaed on the ICG system.
- During the geometric modeling process, the computer converts the commands into a mathematical model, stores it in the computer data files, and displays it as an image on the CRT screen. The model can subsequently be called from the data files for review, analysis, or alteration

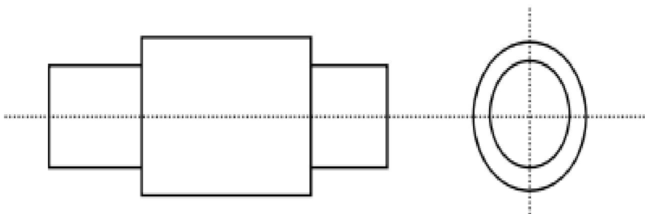
Geometric modeling

Basic Geometric Modeling Techniques:

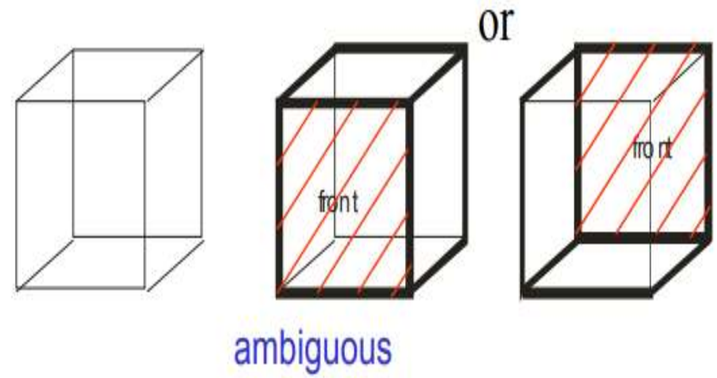
- **2-D Projection (Drawings)**
- **Wireframe Modeling**
- **Surface Modeling**
  - Analytical Surface *f*
  - Free-form, Curved, & Sculptured Surface
- **Solid Modeling *f***
  - Constructive Solid Geometry (CSG)
  - Boundary Representation (B-Rep) *ff*
  - Feature Based Modeling *f*
  - Parametric Modeling

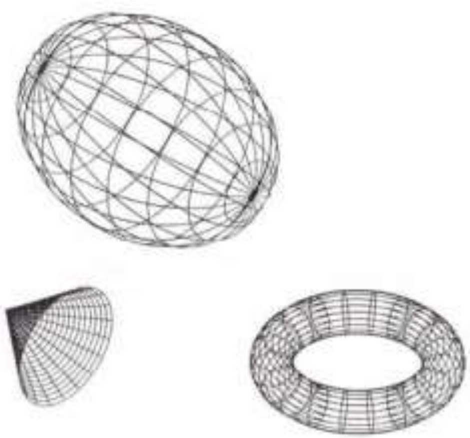


Geometric modeling



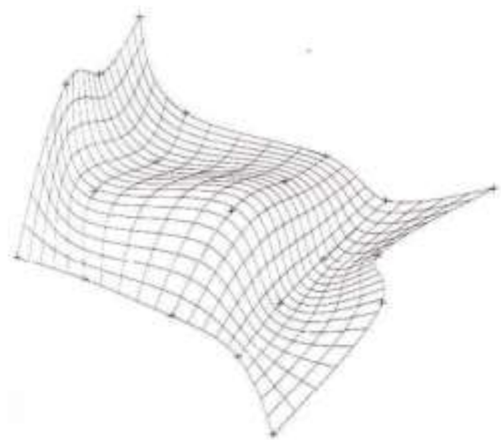
2-D Projection (Drawings)





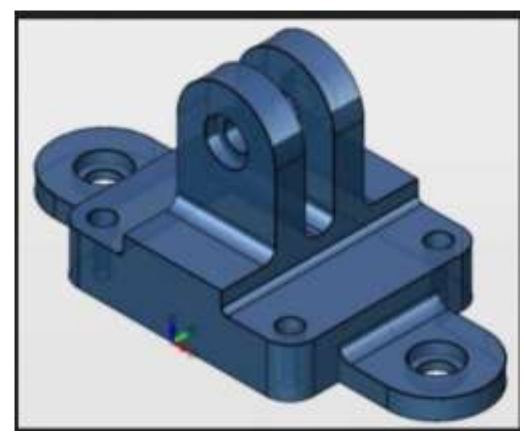
Analytical Surfaces

Wireframe Modeling



Free-form, Curved, or
Sculptured Surface

Surface Modeling



Solid Modeling

Geometric modeling

- **Wireframe models** consist entirely of points, lines, and curves. Since wireframe models do not have Since wireframe models do not have “body knowledge body knowledge ” , topological data are not needed in construction.

- **Surface models** store topological information of their corresponding objects corresponding objects. Both surface models and solid models support shading. Surface models is still ambiguous and thus cannot support a full range of engineering activities such as stress analysis full range of engineering activities such as stress analysis.

- **Solid models** have complete, valid and unambiguous spatial addressability. In general a wireframe model can be extracted from a In general, a wireframe model can be extracted from a surface or a solid model.

Geometric modeling

Wireframe Modeling

Advantages ƒ

- Simple to construct ƒ
- Does not require as much as computer time and memory as does surface or solid modeling (manufacturing display) ƒ
- As a natural extension of drafting, it does not require extensive training of users. ƒ
- Form the basis for surface modeling as most surface algorithms require wireframe entities (such as points, lines and curves)

Disadvantages ƒ

- The input time is substantial and increases rapidly with the complexity of the object ƒ
- Both topological and geometric data need to be user-input; while solid modeling requires only the input of geometric data. ƒ
- Unless the object is two-and-a-half dimensional, volume and mass properties, N C tool path generation, cross-sectioning, and interference cannot be calculated.

Geometric modeling

Surface Modeling

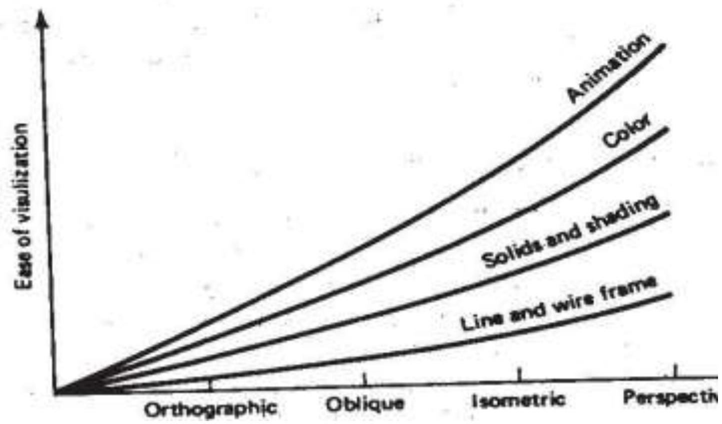
Advantages: ƒ

- Less ambiguous ƒ
- Provide hidden line and surface algorithms to add realism to the displayed geometry ƒ
- Support shading ƒ Support volume and mass calculation, finite element modeling, NC path generation, cross sectioning, and interference detection.

Disadvantages ƒ

- Require more training and mathematical background of the users the users ƒ
- Require more CPU time and memory ƒ
- Still ambiguous; no topological information ƒ

Geometric modeling



Why Solid Modeling?

Solid Modeling Support

- **Using volume information**

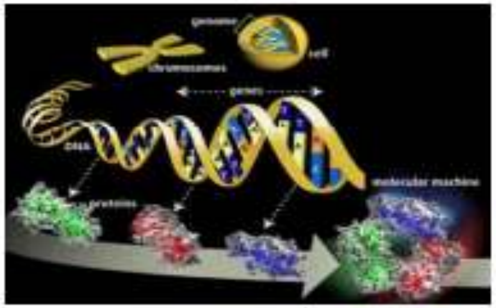
– weight or volume calculation, centroids, moments of inertia calculation,

– stress analysis (finite elements analysis), heat conduction calculations, dynamic analysis,

– system dynamics analysis

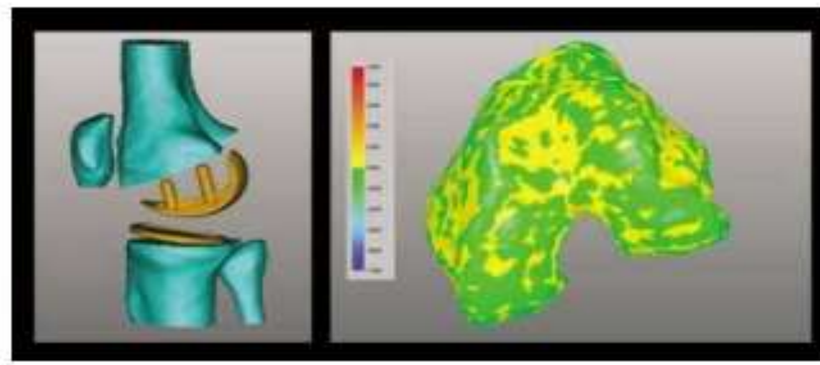
- **Using volume an d boundary in formation**

– generation of CNC codes, and robotic and assembly simulation



New Challenges to Geometric Modeling

- Modeling Porous Medium
- Modeling Non-homogeneous Materials
  - varying density
  - changing composition
  - multiple phases (solid, liquid)
  - …



- Biomedical Applications (geometry, materials, motion and mechanics)
  - Medical Images (surgical operation simulator, training and planning)
  - Computer models from CT scans (quantify motion in actual knees)

Engineering analysis

- In the formulation of nearly any engineering design project, some type of analysis is required.
- The analysis may involve stress-strain calculations, heat-transfer computations, or the use of differential equations to describe the dynamic behavior of the system being designed.
- The computer can be used to aid in this analysis work. It is often necessary that specific programs be developed internally by the engineering analysis group to solve a particular design problem.
- In other situations, commercially available general-purpose programs can be used to perform the engineering analysis. two important examples of this type
  - **Analysis of mass properties**
  - **Finite-element analysis**

Engineering analysis

Analysis of mass properties

- The analysis of mass properties is the analysis feature of a CAD system that has probably the widest application.
- It provides properties of a solid object being analyzed, such as the surface area, weight, volume, center of gravity, and moment of inertia.
- For a plane surface (or a cross section of a solid object) the corresponding computations include the perimeter, area, and inertia properties.

Finite-element analysis

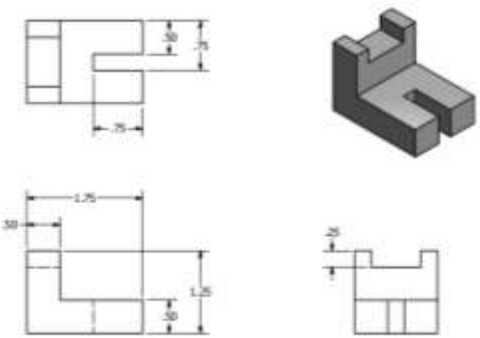
- Probably the most powerful analysis feature of a CAD system is the finite- element method. With this technique, the object is divided into a large number of finite elements (usually rectangular or triangular shapes) which form an interconnecting network of concentrated nodes.
- By using a computer with significant computational capabilities, the entire Object can be analyzed for stress-strain, heat transfer, and other characteristics by calculating the behavior of each node.
- By determining the interrelating behaviors of all the nodes in the system, the behavior of the entire object can be assessed.
- If the finite-element analysis indicates behavior of the design which is undesirable, the designer can modify the shape and recompute the finite- element analysis for the revised design.

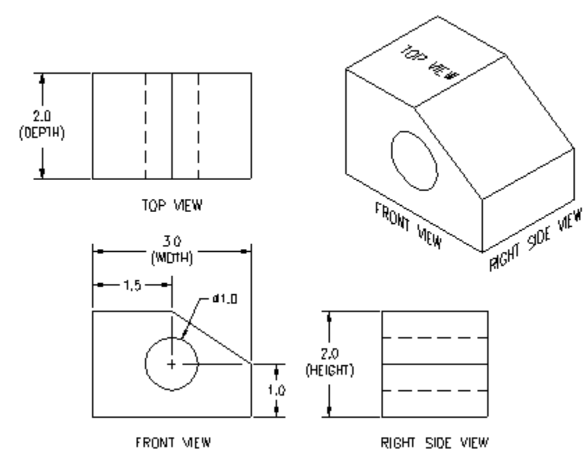
Design review and evaluation

- Checking the accuracy of the design can be accomplished conveniently on the graphics terminal. Semiautomatic dimensioning and tolerancing routines which assign size specifications to surfaces indicated by the user help to reduce the possibility of dimensioning errors. The designer can zoom in on part design details and magnify the image on the graphics screen for close scrutiny
- A procedure called layering is often helpful in design review. For example, a good application of layering involves overlaying the geometric image of the final shape of the machined part on top of the image of the rough casting. This ensures that sufficient material is available on the casting to acccomplish the final machined dimensions. This procedure can be performed in stages to check each successive step in the processing of the part.
- Another related procedure for design review is interference checking. This involves the analysis of an assembled structure in which there is a risk that the components of the assembly may occupy the same space. This risk occurs in the design of large chemical plants, air-separation cold boxes, and other complicated piping structures.
- One of the most interesting evaluation features available on some computer- aided design systems is kinematics. The available kinematics packages provide the capability to animate the motion of simple designed mechanisms such as hinged components and linkages. This capability enhances the designer_s visualization of the operation of the mechanism and helps to ensure against interference with other components.

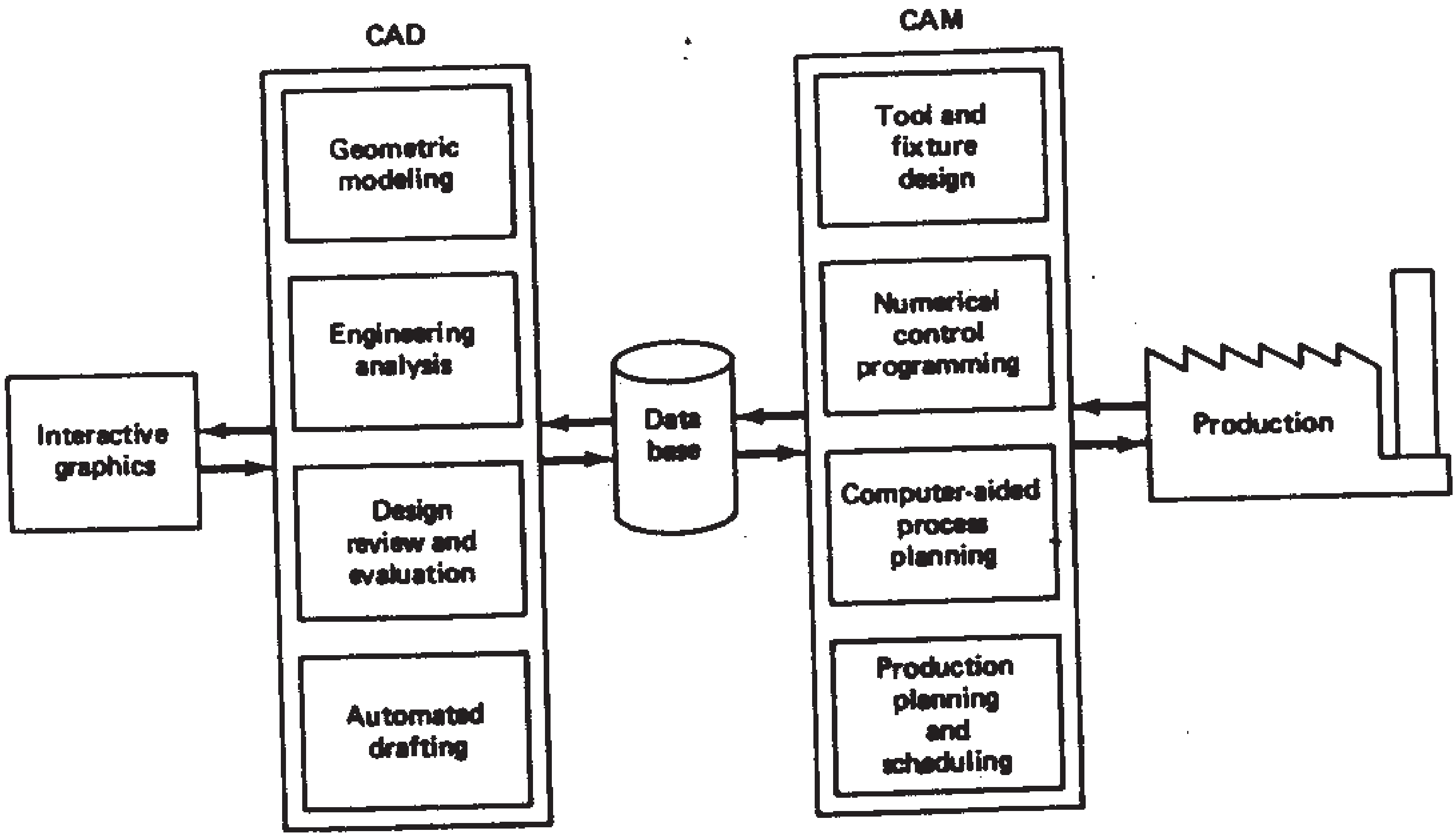
Automated Drafting

- Automated drafting involves the creation of hard-copy engineering drawings directly from the CAD data base.
- These features include automatic dimensioning, generation of crosshatched areas, scaling of the drawing, and the capability to develop sectional views and enlarged views of particular path details.
- The ability to rotate the part or to perform other transformations of the image (e.g., oblique, isometric, or perspective views), can be of significant assistance in drafting.
- Most CAD systems are capable of generating as many as six views of the part. Engineering drawings can be made to adhere to company drafting standards by programming the standards into the CAD system.





Desirable relationship of CAD/CAM data base to CAD and CAM



Benefits of Computer-Aided Design

l. Improved engineering productivity

2. Shorter lead times

3. Reduced engineering personnel requirements

4. Customer modifications are easier to make

5. Faster response to requests for quotations

6. Avoidance of subcontracting to meet schedules

7. Minimized transcription errors

8. Improved accuracy of design

9. In analysis, easier recognition of component interactions

lO. Provides better functional analysis to reduce prototype testing

ll. Assistance in preparation of documentation

l2. Designs have more standardization

Benefits of Computer-Aided Design

l3. Better designs provided

l4. Improved productivity in tool design

l5. Better knowledge of costs provided

l6. Reduced training time for routine drafting tasks and NC part programming

l7. Fewer errors in NC part programming

l8. Provides the potential for using more existing parts and tooling

l9. Helps ensure designs are appropriate to existing manufacturing techniques

20. Saves materials and machining time by optimization algorithms
21. Provides operational results on the status of work in progress
22. Makes the management of design personnel on projects more effective
23. Assistance in inspection of complicated parts
24. Better communication interfaces and greater understanding among engineers, designers, drafters, management, and different project groups.

Computer Graphics Software and Data Base

- The graphics software is the collection of programs written to make it convenient for a user to operate the computer graphics system. It includes Programmes to generate images on the CRT screen, to manipulate the images, and to accomplish various types of interaction between the user and the system.

- The graphics software for a particular computer graphics system is very much a function of the type of hardware used in the system. The software must be written specifically for the type of CRT and the types of input devices used in the system.

Newman and Spoull list six ground rules that should be considered in designing graphics software

l. **Simplicity**. The graphics software should be easy to use.

2. **Consistency** . The package should operate in a consistent and predict- able way to the user.

3. **Completeness**. There should be no inconvenient omissions in the set of graphics functions.

4**. Robustness**. The graphics system should be tolerant of minor instances of misuse by the operator.

5**. Performance**. Within limitations imposed by the system hardware, the performance should be exploited as much as possible by software. Graphics programs should be efficient and speed of response should be fast and consistent.

6. **Economy.** Graphics programs should not be so large or expensive as to make their use prohibitive.

The Software Configuration of a Graphics System

In the operation of the graphics system by the user, a variety of activities take place, which can be divided into three categories:

l. Interact with the graphics terminal to create and alter images on the screen

2. Construct a model of something physical out of the images on the screen. the models are sometimes called application models.

3. Enter the model into computer memory and/or secondary storage.

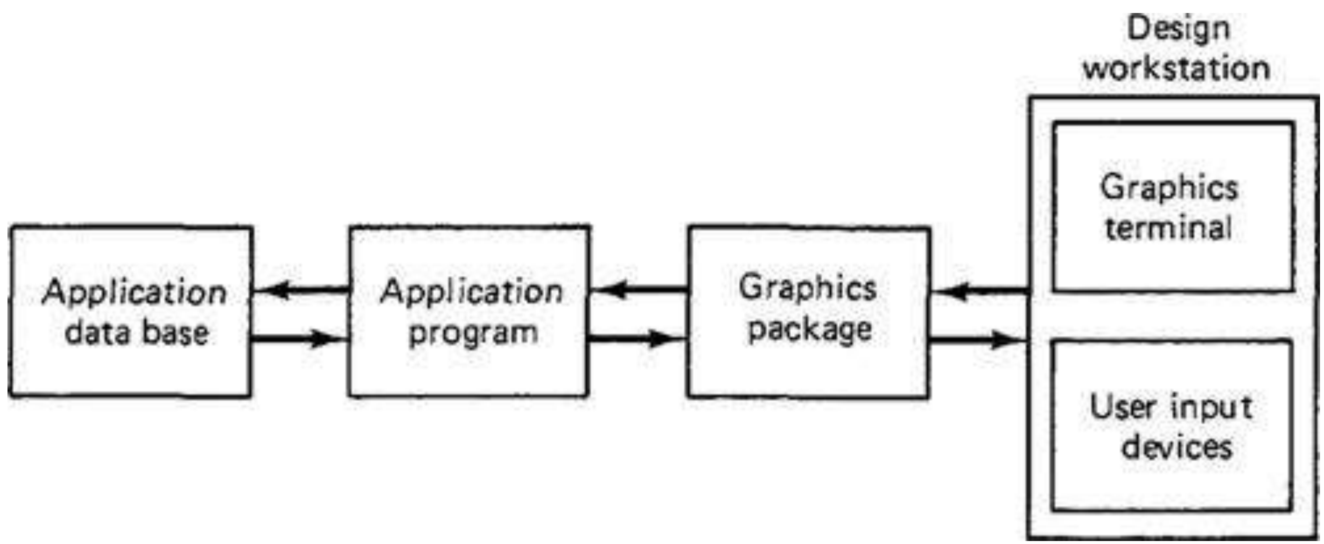
The Software Configuration of a Graphics System

The graphics software can be divided into three modules according to a conceptual model suggested by Foley and Van Dam:

l. The graphics package (Foley and Van Dam called this the graphics system)

2. The application program

3. The application data base



The Software Configuration of a Graphics System

- The central module is **the application program**. It controls the storage of data into and retrieves data out of the application data base. The application program is driven by the user through the graphics package. The application program is implemented by the user to construct the model of a physical entity whose image 'is to be viewed on the graphics-screen. Application programs are written for particular problem areas. Problem areas in engineering design would include architecture, construction, mechanical components, electronics, chemical engineering, and aerospace engineering. Problem areas other than design would include flight simulators, graphical display of data, mathematical analysis, and even artwork. In each case, the application software is developed to deal with images and conventions which are appropriate for that field.

The Software Configuration of a Graphics System

- **The graphics package** is the software support between the user and the graphics terminal. It manages the graphical interaction between the user and the system. It also serves as the interface between the user and the application software. The graphics package consists of input subroutines and output subroutines. The input routines accept input commands and data from the user and forward them to the application program. The output subroutines control the display terminal (or other output device) and converts the application models into two-dimensional or three-dimensional graphical pictures.

- The third module in the **ICG software is the data base**. The data base contains mathematical, numerical, and logical definitions of the application models, such as electronic circuits, mechanical components, automobile bodies, and so forth. It also includes alphanumeric information associated with the models, such as bills of materials, mass properties, and other data. The contents of the data base can be readily displayed on the CRT or plotted out in hard-copy form.

Functions of a Graphics Package

To fulfill its role in the software configuration, the graphics package must perform a variety of different functions. these functions can be grouped into function sets. Each set accomplishes a certain kind of interaction between the user and the system. Some of the common function sets are:

- **Generation of graphic elements**
- **Transformations**
- **Display control and windowing functions**
- **Segmenting functions**
- **User input functions**

Functions of a Graphics Package

- **Generation of graphic elements:** A graphics element in computer is a basic image entity such as a dot or point, line segment, circle and so forth. The collection of element in the system could also include alphanumerical characters and special symbols.
- **Transformations**
- **Display control and windowing functions**
- **Segmenting functions**
- **User input functions**

TRANSFORMATIONS

- Many of the editing features involve transformations of the graphics elements or cells composed of elements or even the entire model.
- Certain changes in these drawings can be made by performing some mathematical operations on these co-ordinates. The basic transformations are
  - **Scaling,**
  - **Translation**
  - **Rotation**

- https://nptel.ac.in/syllabus/112102101/

2.Computerized Manufacturing Planning and Control System

PROCESS PLANNING

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

Or

Process planning involves in determining the sequence of processing and assembly steps that must be accomplished to make the product.

PROCESS PLANNING

- Process planning is concerned with determining the sequence of individual manufacturing operations needed to produce a given part or product.
- The resulting operation sequence is documented on a form typically referred to as a route sheet.
- The route sheet is a listing of the production operations and associated machine tools for a work part or assembly.

Route Sheet for Process Planning

the processing sequence is documented on the *route sheet*

Route Sheet	XYZ Machine Shop, Inc.					
Part no. 081099	Part name Shaft, generator	Planner MP Groover	Checked by N. Needed	Date 08/12/XX	Page 1/1	
Material 1050 H18 Al	Stock size 60 mm diam., 206 mm length	Comments				

No.	Operation description	Dept	Machine	Tooling	Setup	Std.
10	Face end (approx. 3 mm). Rough turn to 52.00 mm diam. Finish turn to 50.00 mm diam. Face and turn shoulder to 42.00 mm diam. and 15.00 mm length.	Lathe	L45	G0810	1.0 hr	5.2 min.
20	Reverse end. Face end to 200.00 mm length. Rough turn to 52.00 mm diam. Finish turn to 50.00 mm diam.	Lathe	L45	G0810	0.7 hr	3.0 min.
30	Drill 4 radial holes 7.50 mm diam.	Drill	D06	1556	0.5 hr	3.2 min.
40	Mill 6.5 mm deep x 5.00 mm wide slot.	Mill	M02	F662	0.7 hr	5.2 min.
50	Mill 10.00 mm wide flat, opposite side.	Mill	M03	F630	1.5 hr	4.8 min.

Route Sheet

ROUTE SHEET

PRODUCT
ENGINE TR6
2500 CC

Work Center	Operation	Description	Standard Time/Unit Set Up	Standard Time/Unit Process
101	1a	Mill block and fit studs	.6	1.6
153	4a	Clean block and fit crank	.3	1.5
154	1	Fit pistons and bearings	.1	.7
340	2	Fit water pump, fuel pump, oil pump, and cylinder head	.1	1.4

Contents of process plan

1. Identification of the purpose of the product
2. List of operations required to manufacture the product
3. Specification required to make each operation
4. Specification of methods,machines,tools and equipment required to produce the product
5. Specification of the performance expected from each operation

Manually Prepared Process Plans

- A skilled individual examines a part drawing to develop the necessary instructions for the process plan
- Requires knowledge of the manufacturing capabilities of the factory (many times undocumented)
  - Machine and process capabilities, tooling, materials, standard practices, and associated costs
- Widely used, time consuming, plans developed over a period of time may not be consistent nor objective
- Excessive time and cost may be required to develop necessary skills for successful planners

COMPUTER-AIDED PROCESS PLANNING

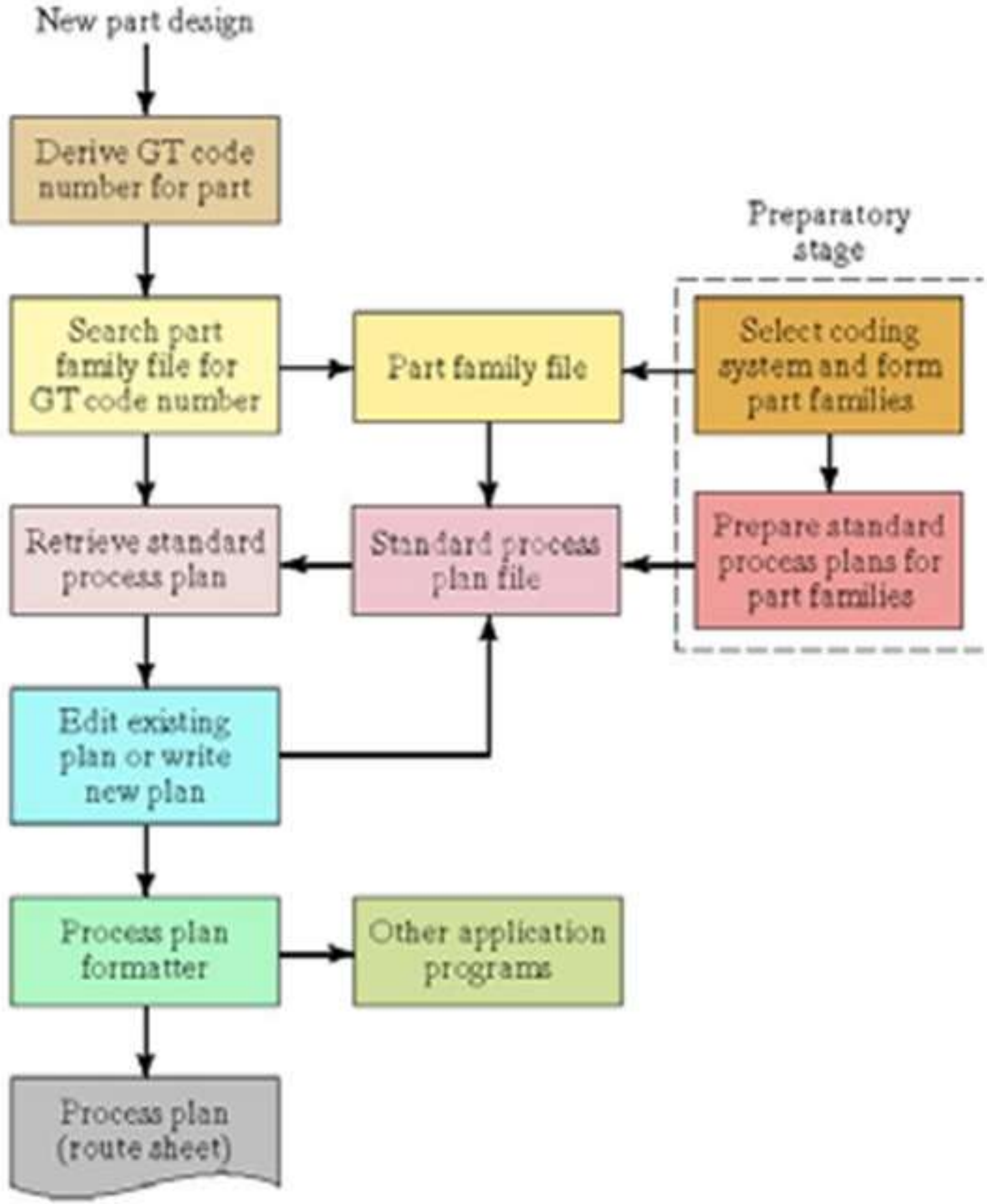
- Based on the characteristics of a given part, the program automatically generates the manufacturing operation sequence.
- A computer-aided process planning (CAPP) system offers the potential for reducing the routine clerical work of manufacturing engineers. At the same time, it provides the opportunity to generate production routings which are rational, consistent, and perhaps even optimal.

Two alternative approaches to computer-aided process planning have been developed.

l. Retrieval-type CAPP systems (also called variant systems)

2. Generative CAPP systems

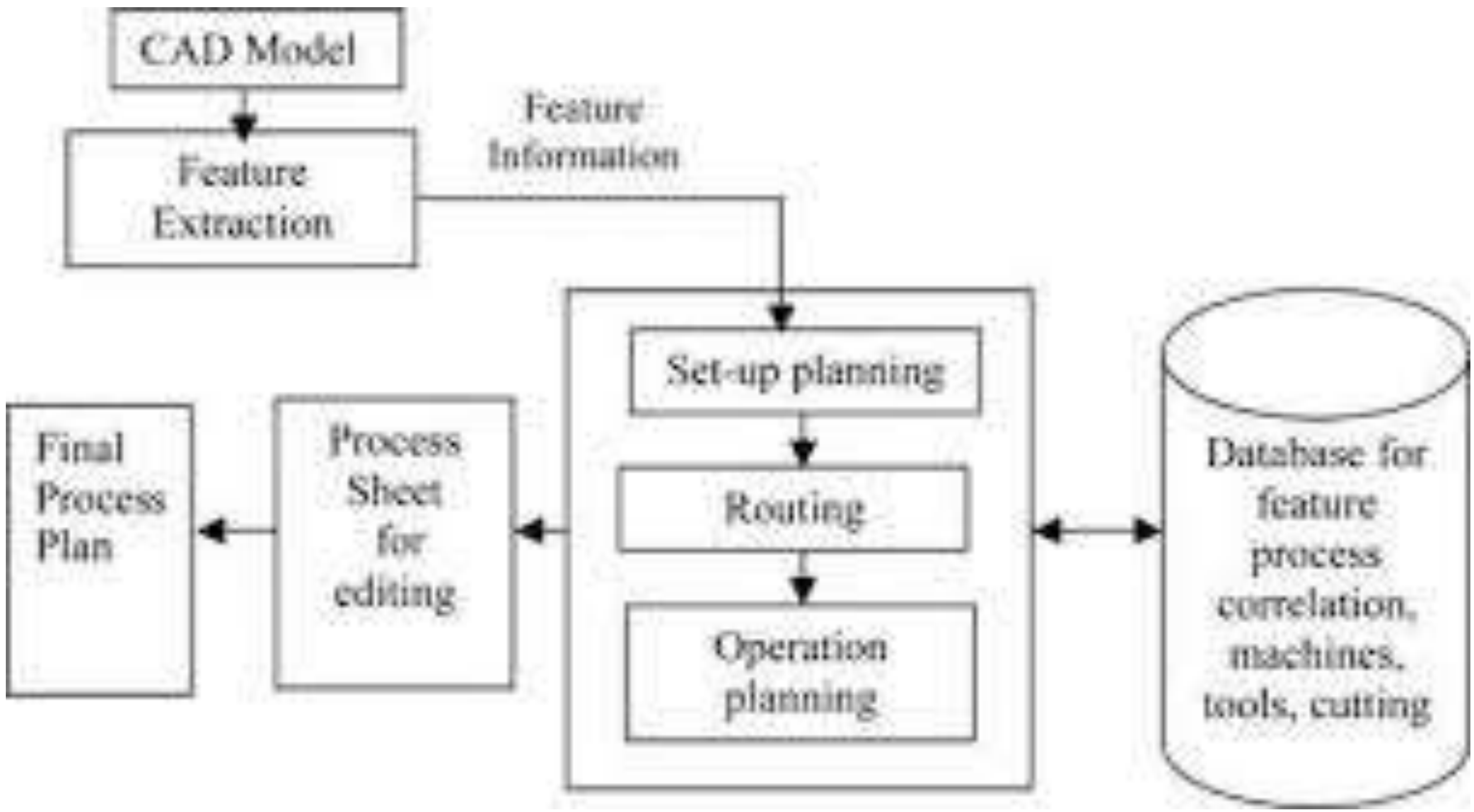
Retrieval-type CAPP systems (also called variant systems)



Retrieval-type CAPP systems (also called variant systems)

- Retrieval-type CAPP systems use parts classification and coding and group technology as a foundation.
- In this approach, the parts produced in the plant are grouped into part families, distinguished according to their manufacturing characteristics.
- For each part family, a standard process plan is established. The standard process plan is stored in computer files and then retrieved for new workparts which belong to that family.
- Some form of parts classification and coding system is required to organize the computer files and to permit efficient retrieval of the appropriate process plan for a new work part.
- For some new parts, editing of the existing process plan may be required. This is done when the manufacturing requirements of the new part are slightly different from the standard.
- The machine routing may be the same for the new part, but the specific operations required at each machine may be different.
- The complete process plan must document the operations as well as the sequence of machines through which the part must be routed. Because of the alterations that are made in the retrieved process plan, these CAPP systems are sometimes also called by the name' 'variant system."

GENERATIVE PROCESS PLANNING SYSTEMS



GENERATIVE PROCESS PLANNING SYSTEMS

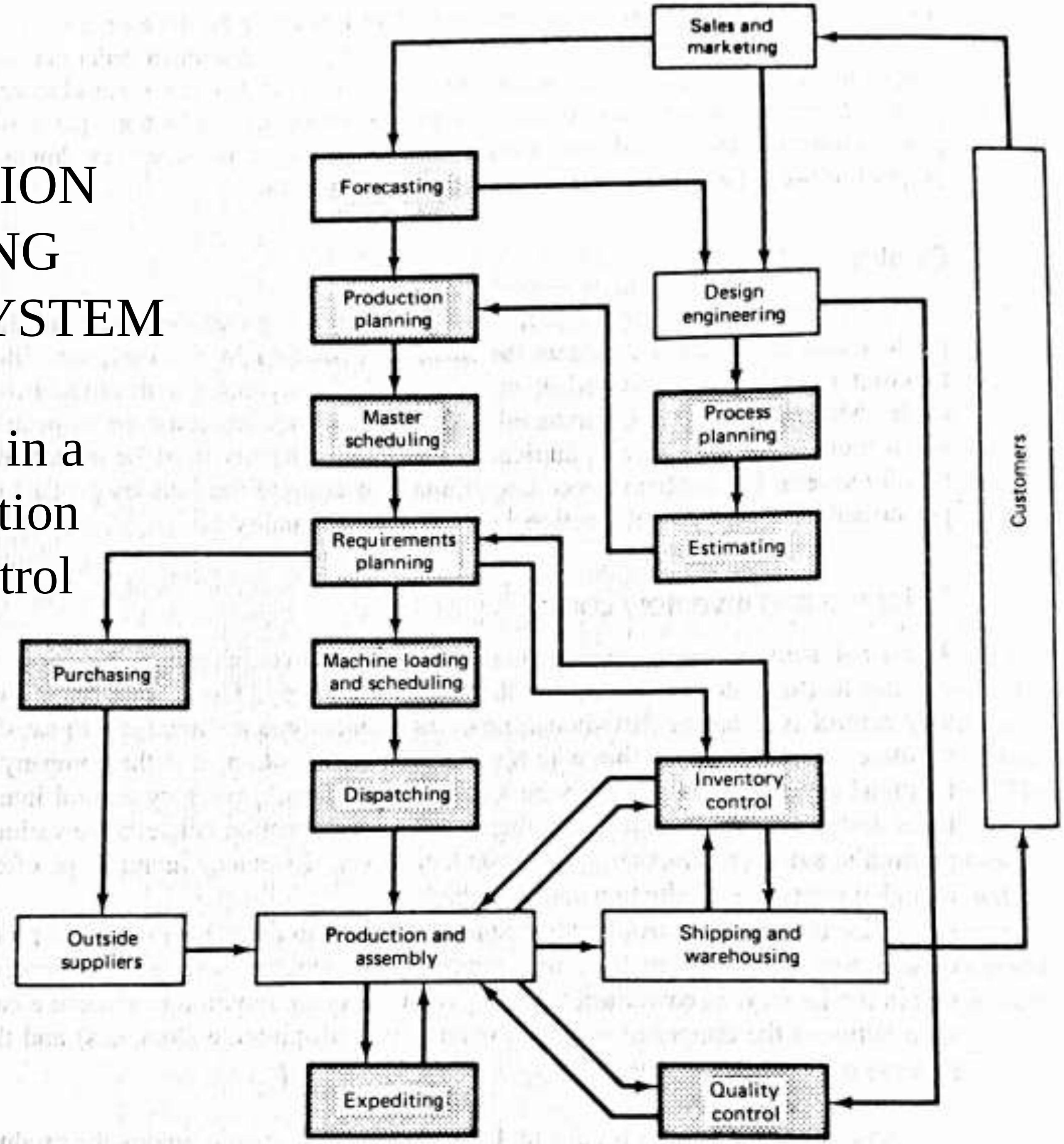
- Generative process planning involves the use of the computer to create an individual process plan from scratch, automatically and without human assistance.
- The computer would employ a set of algorithms to progress through the various technical and logical decisions toward a final plan for manufacturing.
- Inputs to the system would include a comprehensive description of the work part. This may involve the use of some form of part code number to summarize the work part data, but does not involve the retrieval of existing standard plans.
- Instead, the general CAPP system synthesizes the design of the optimum process sequence, based an analysis of part geometry, material, and other factors which would influence manufacturing decisions.
- In the ideal generative process planning package, any part design could presented to the system for creation of the optimal plan. In practice, generative- type systems are far from universal in their applicability. They tend to fall short of a truly generative capability, and they are developed for a some limited range of manufacturing processes.

BENEFITS OF CAPP

- **Process rationalization.** Computer-automated preparation of operation routings is more likely to be consistent, logical, and optimal than its manual counterpart. The process plans will be consistent because the same computer software is being used by all planners. We avoid the tendency for drastically different process plans from different planners. The process plans tend to be more logical and optimal because the company has presumably incorporated the experience and judgment of its best manufacturing people into the process planning computer software.
- **Increased productivity of process planners.** With computer-aided process planning, there is reduced clerical effort, fewer errors are made, and the planners have immediate access to the process planning data base. These benefits translate into higher productivity of the process planners. One system was reported to increase productivity by 60% in the process planning function [l0].
- **Reduced turnaround time.** Working with the CAPP system, the process planner is able to prepare a route sheet for a new part in less time compared to manual preparation.
- **Improved legibility.** The computer-prepared document is neater and easier to read than manually written route sheets. CAPP systems employ standard text, which facilitates interpretation of the process plan in the factory.
- **Incorporation of other application programs.** The process planning system can be designed to operate in conjunction with other software packages to automate many of the time-consuming manufacturing support functions.

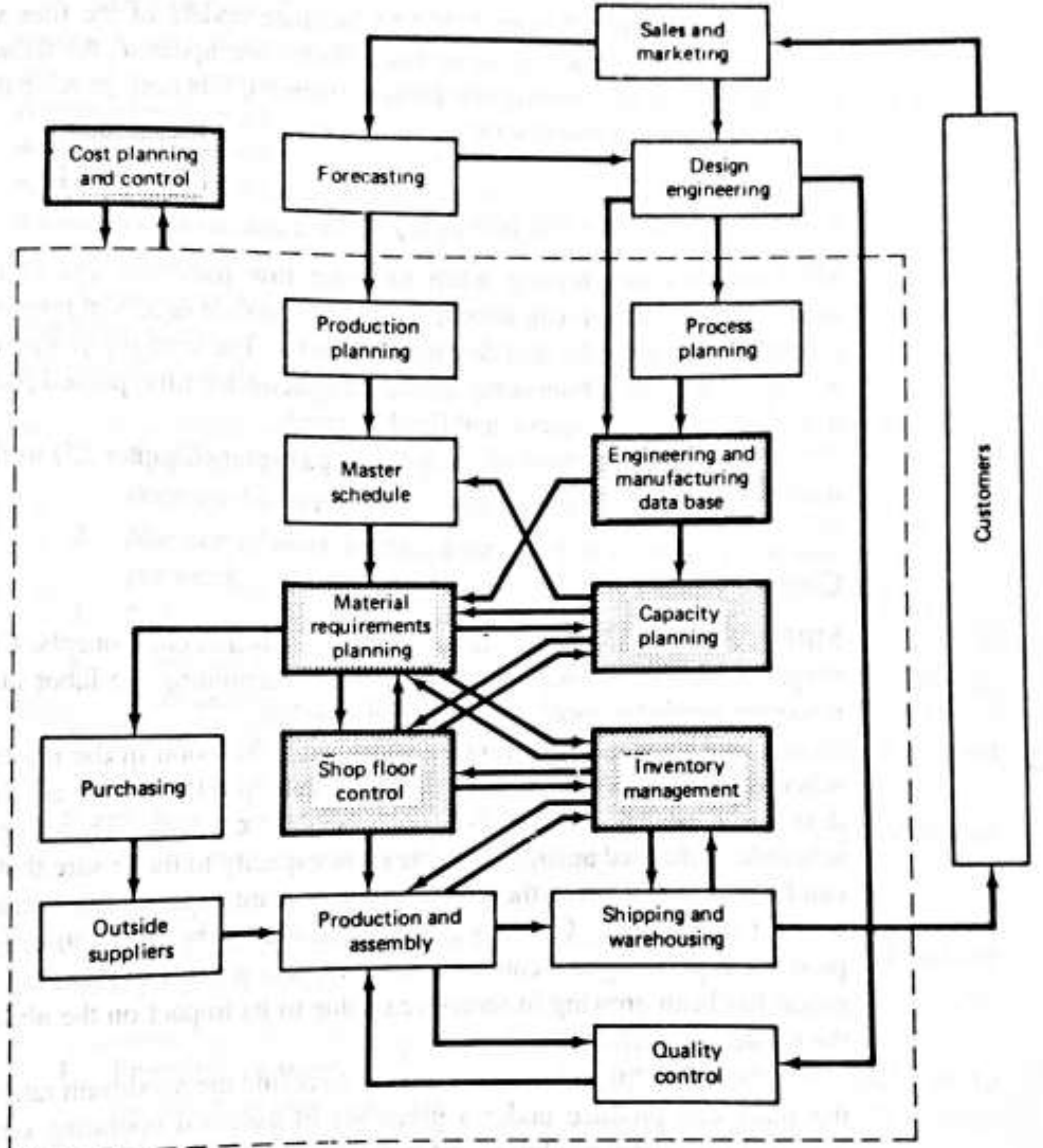
PRODUCTION PLANNING CONTROL SYSTEM

Cycle of Activities in a Traditional Production Planning and Control System



PRODUCTION PLANNING CONTROL SYSTEM

Cycle of Activities in a Computer Integrated Production Managment System



PRODUCTION PLANNING CONTROL SYSTEM

Activities of Production Planning Control System

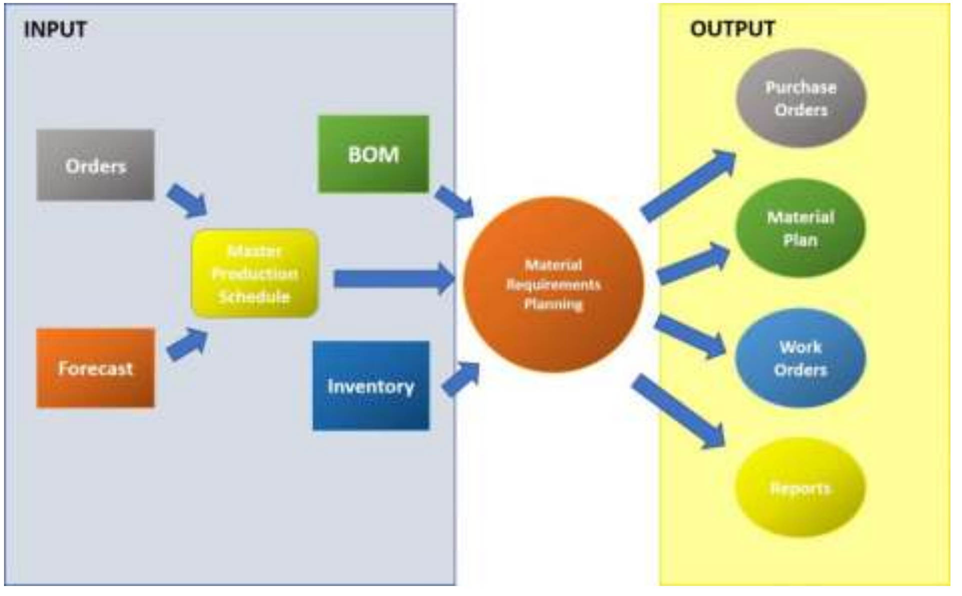
- Aggregate Production Planning(APP)
- Master Production Schedule (MPS)
- Material Requirement Planning (MRP)
- Capacity Planning
- Engineering and Manufacturing Database
- Inventory Control
- Shop floor Control (SFC)
- Purchase Department

PRODUCTION PLANNING CONTROL SYSTEM

- **Aggregate Production Planning (APP)**: It is a high-level corporate planning activity. The aggregate production plan indicates production output levels for the major product lines of the company. The aggregate plan must be coordinated with the plans of the sales & marketing departments. Because the aggregate production plan includes products that are currently in production, it must also consider the present & future inventory levels of those products & their component parts.
- **Master Production Schedule (MPS):**The production quantities of the major product lines listed in the aggregate plan must be converted into a very specific schedule of individual products, known as the master production schedule (MPS). It is a list of products to be manufactured, when they should be completed & delivered, & it what quantities. Products included in the MPS divide into 3 categories: (1) firm customer orders, (2) forecasted demand, & (3) spare parts.

MATERIAL REQUIREMENTS PLANNING-MRP 1

- Material Requirements Planning (MRP) is a computational technique that converts the master schedule for end products into a detailed schedule for the raw materials & components used in the end products.
- The detailed schedule identifies the quantities of each raw material & component item. It also indicates when each item must be ordered & delivered to meet the master schedule for final products.
- MRP is often thought of as a method of inventory control. It is both an effective tool for minimizing unnecessary inventory investment & a useful method in production scheduling & purchasing of materials.

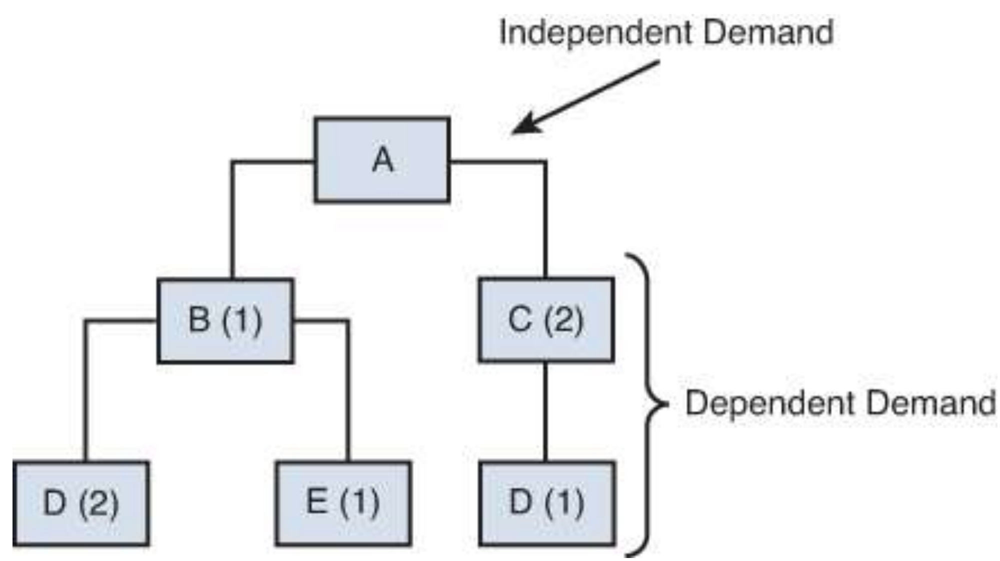


MATERIAL REQUIREMENTS PLANNING

- The concept of MRP is relatively straightforward. Its implementation is complicated by the sheer magnitude of the data to be processed.
- The master schedule provides the overall production plan for the final products in terms of month-by-month deliveries. Each product may contain hundreds of individual components.
- These components are produced from raw materials, some of which are common among the components. For example, several components may be made out of the same gauge sheet steel.
- The components are assembled into simple subassemblies, & these subassemblies are put together into more complex subassemblies, & so on, until the final products are assembled. Each step in the manufacturing & assembly sequence takes time.
- All of these factors must be incorporated into the MRP calculations. Although each calculation is uncomplicated, the magnitude of the date is so large that the application of MRP is practically impossible except by computer processing.

BASIC MRP CONCEPTS

1. Independent versus dependent demand
2. Lumpy demand
3. Lead times
4. Common use items



BASIC MRP CONCEPTS

Independent Demand	**Dependent** Demand
➢ It is a demand which is important but can't be calculated.	➢ It is a demand which can be calculated from the demand of the parent product.
➢ It is not related to demand for other things.	➢ It is caused by an independent demand.
Example : Demand for bicycles in New York City from June 2017 to September 2017.	Example : Demand for number of tyres, cycle frames, seats, helmets depend on the demand for bicycles.
	If demand is for 2,000 bicycles Then
	Cycle tyres= 2,000 X 2 = 4,000 units. Seats = 2,000 X 1 = 2,000 units Helmets = 2,000 X 1 = 2,000 units

Lumpy demand

- In some cases of manufacturing the demand for the raw material will occur in large increments rather than in a continuous constant rate.
- The large increments corresponds to a contain batch of the final product, such demand is called lumpy demand.

INPUTS to MRP

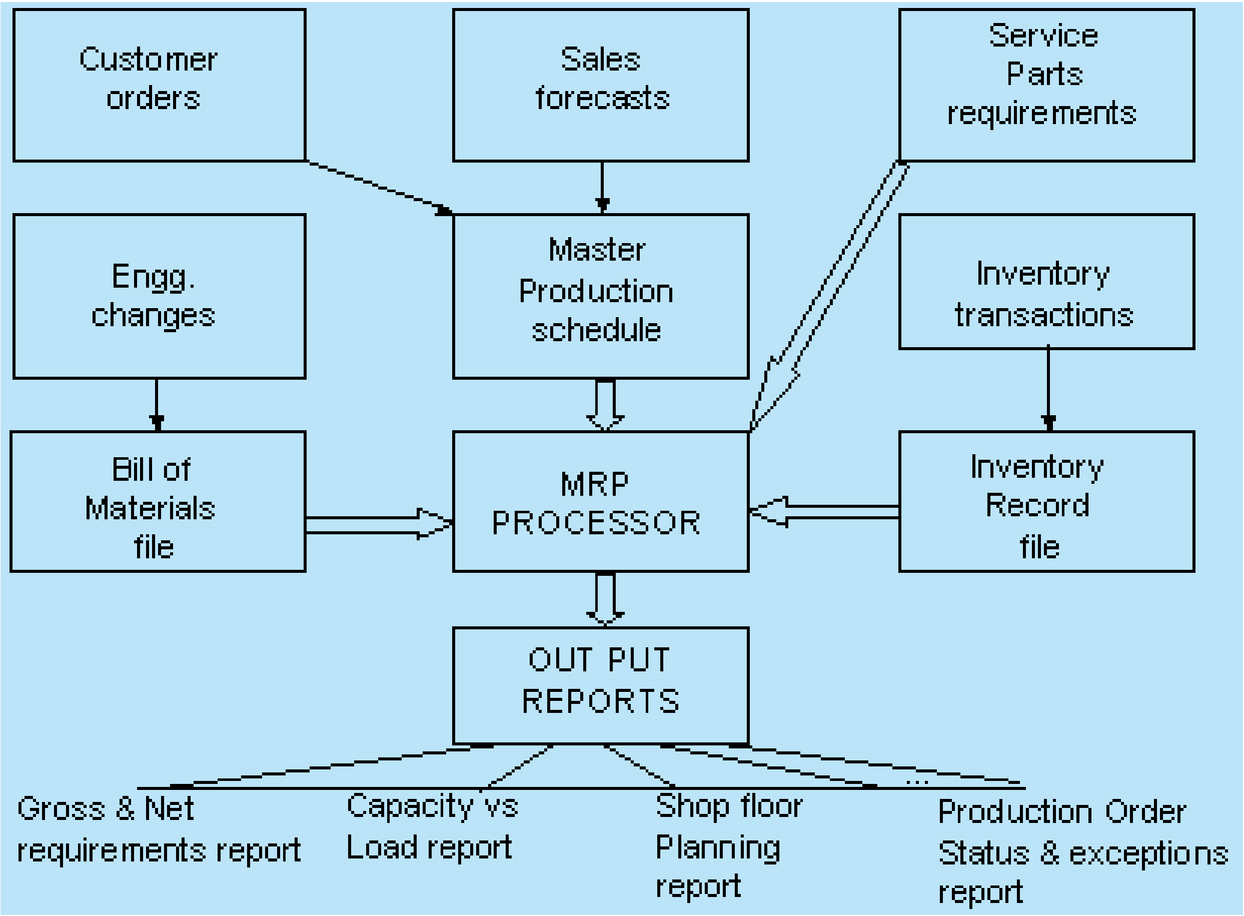
- To function, the MRP program needs data contained in several files. These files server as inputs to the MRP processor. They are

(1)The Master Production Schedule

(2) The Bill Of Materials file and other engineering and manufacturing data,

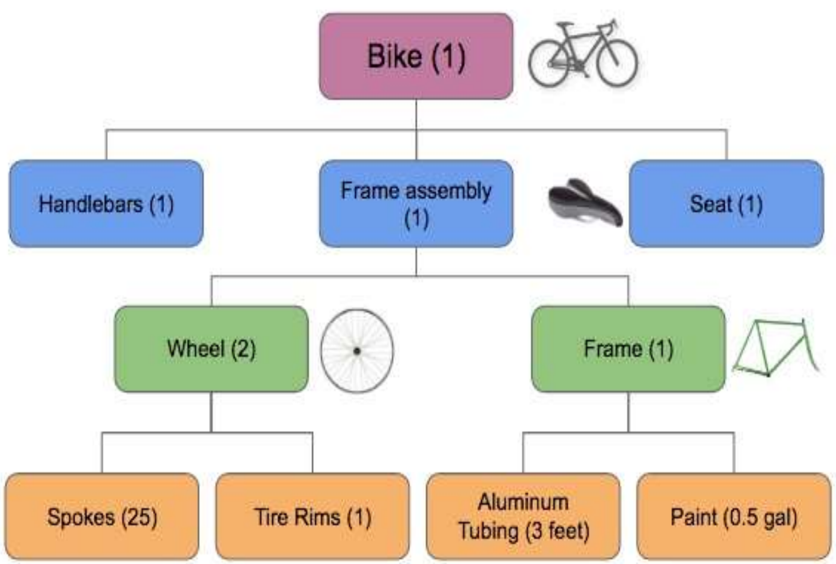
(3) The inventory record file.

INPUTS to MRP



BILL OF MATERIAL (BOM)

- The bill of material (BOM) file provides information the product structure by listing the components parts and subassemblies that make up each product, It is use to computer the raw material and components requirement for end products listed in the master schedule.

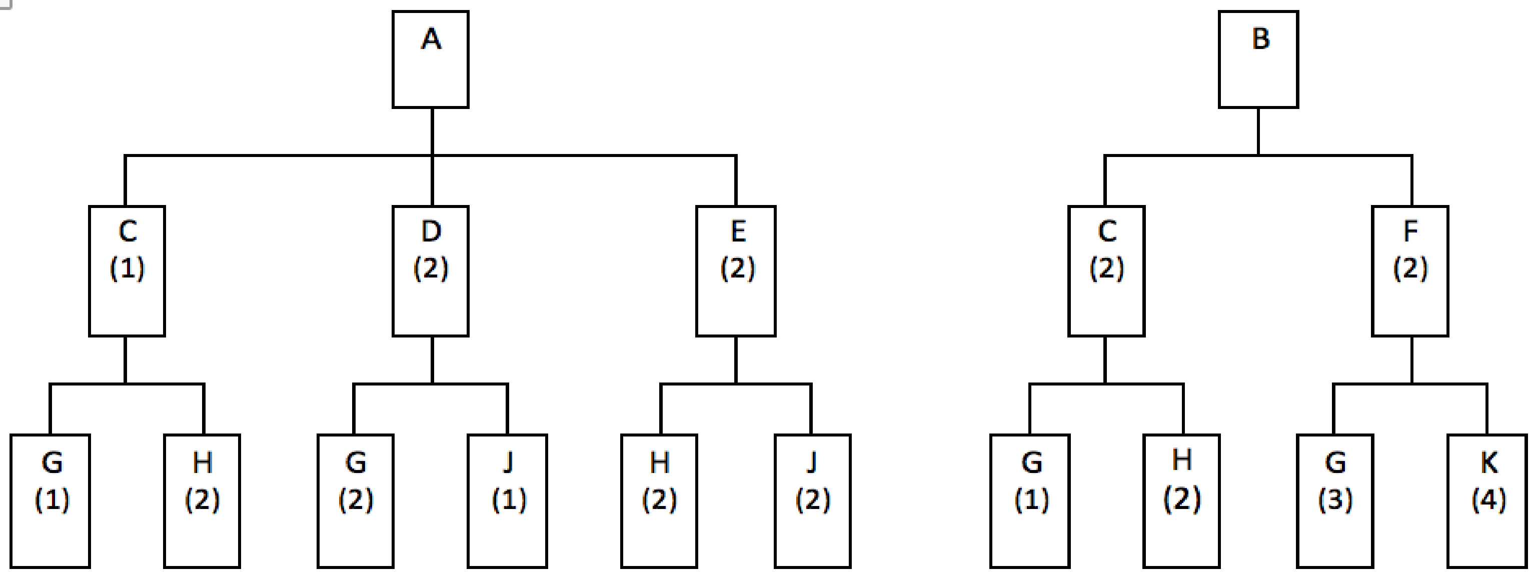


BILL OF MATERIALS

ITEM NO.	DESCRIPTION	UNIT	ASSEMBLY OR FSN NO.	QUANTITIES TROP	QUANTITIES NORTH
3-1	LIGHTING CIRCUIT - NAVFAC DWG. NO. 203414	EA	3016	3	3
3-2	POWER BUS, 100A - NAVFAC DWG. NO. 304131	EA	3047	1	1
3-3	RECEPTACLE CKT - NAVFAC DWG. NO. 303660	EA	3019	2	2
3-4	BOX, RECEPTACLE W/CLAMP FOR NONMETALLIC SHEATH WIRE	EA	5325-102-604	3	3
3-5	LAMP ELECTRIC, MED. BASE, INSIDE FROSTED, 200W, 120V	EA	6240-180-314	60	60
3-6	PLUG : ATTACHMENT, 3 WIRE, 15 AMP, 125 V	EA	5935-102-309	10	10
3-7	PLATE : BRASS, DUPLEX RECEPTACLE	EA	3325-800-101	5	5
3-8	RECEPTACLE, DUPLEX, 3 WIRE, 15 AMP, 125 V	EA	5325-100-102	5	5
3-9	ROD, GROUND, 3/4" X 10'- 0"	EA	5306-200-180	12	12
3-10	WIRE, NO. 2 1/C STRANDED, HARD DRAWN, BARE	LB	6143-134-200	52	52
3-11	SWITCH, SAFETY, 2 P, ST 30 AMP, 250 V, PLUS FUSE	EA	5930-142-401	2	2
3-12	CLAMP, GROUND ROD	EA	5209-100-101	13	13
3-13	SWITCH, SAFETY, 200 AMP, 250 V, 3 P	EA	5930-201-903	1	1
3-14	FUSE, RENEWABLE, 200 AMP, 250V	EA	5920-100-000	6	6
3-15	LINK, FUSE, 200 AMP, 250 V	EA	5920-100-001	6	6
	FUSE PLUG, 30 AMP, 125 V	EA	5920-100-102	12	12

ZZ84M004

1. A manufacturing company is producing two end items, A and B. The bill of materials (product structure tree) for each end item is as follows:



Inventory records for the ten items indicate the following:

Item	A	B	C	D	E	F	G	H	J	K
On-hand			30				30	20	240	260
Scheduled (in week)							750 1	20 1	380 1	500 2
Lead time (weeks)	2	1	2	1	2	1	2	1	2	3
Lot size	L4L	L4L	L4L	L4L	Min 100	L4L	Mult 250	POQ*	L4L	Max 500

* The periodic order quantity for part H allows orders only in even numbered weeks (2, 4, 6,...)

The master production schedule calls for gross requirements of 100 units of A in week 5 and 120 units in week 8, and for 80 units of B in week 4 and 150 in week 7.

MRP OUTPUT REPORTS

Primary Outputs

1. Order release notice, to place order that have been planned by the MRP system.
2. Reports showing planned orders to be released in future periods.
3. Rescheduling notices, indicating changes in due dates for open order.
4. Cancellation notices, indicating cancellation of open order because of changes in the master schedule.
5. Reports on inventory status.

Secondary Outputs

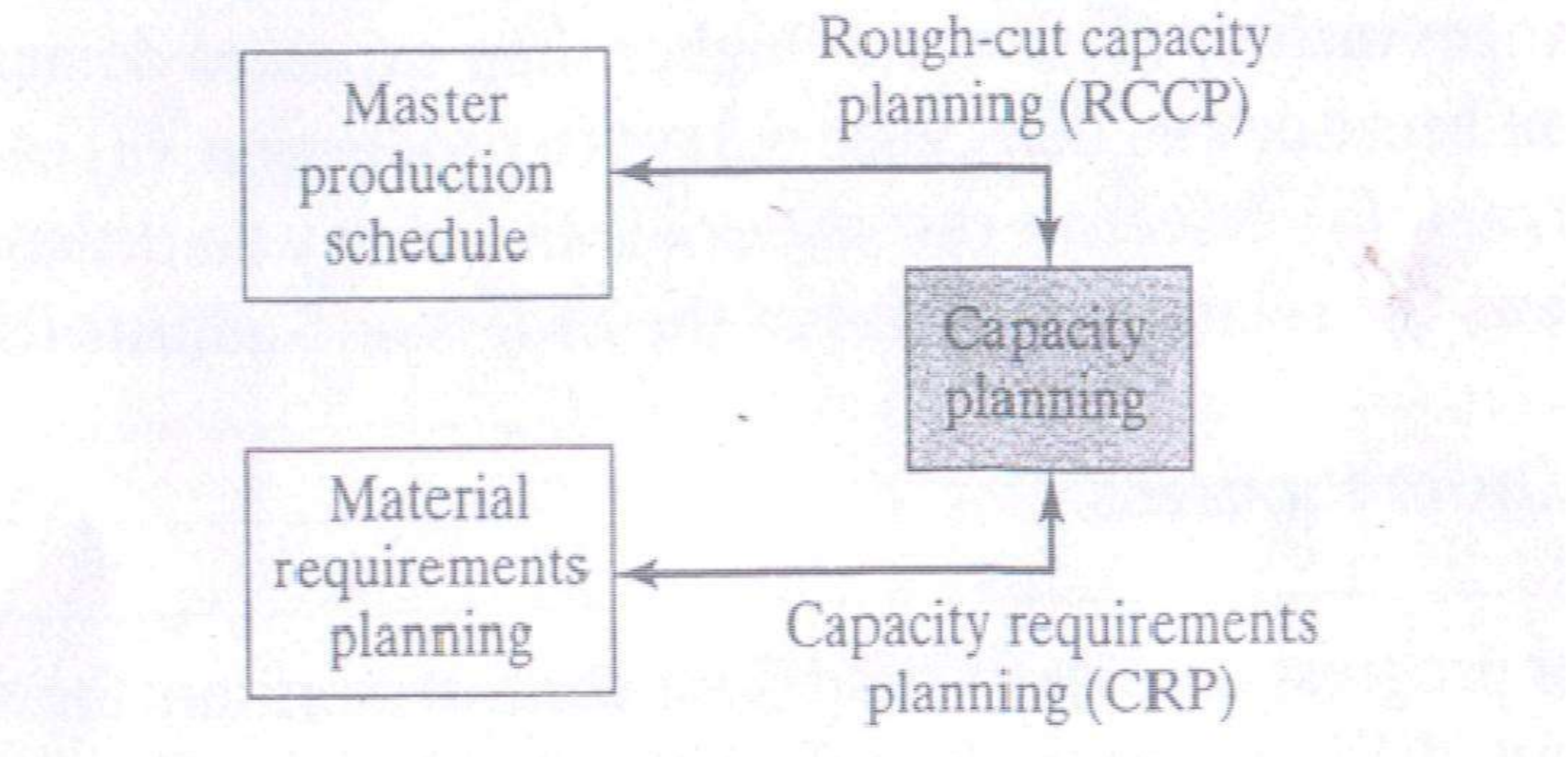
1. Performance reports of various types, indicating costs, item usage, actual versus planned lead times and other measures of performance.
2. Exception reports, showing deviations from schedule, orders that are overdue, scrap and so on.
3. Inventory forecast, indicating projected inventory levels in future periods

BENEFITS OF MRP

- Reduction in inventory
- Quicker response to changes in demand than is possible with a manual requirements planning systems
- Reduced setup and product changeover costs
- Better Machine utilization
- Improved capacity to respond to changes in the master schedule
- Aid in developing the Master Schedule.
- Increased production efficiency
- Ability to react with changes in customer order

CAPACITY PLANNING

- **Capacity planning** consists of determining what labor and equipment resources are required to meet the current MPS as well as long term future production needs of the firm.
- Capacity planning also identifies the limitations of the available production resources to prevent the MRP program from planning an un realistic master schedule.



CAPACITY ADJUSTMENTS

Short-term Adjustment

Employment levels : Employment in the plant can be increase or decrease in response to changes in capacity requirements.

Number of temporary workers. Increase in employment level can also be achieved by using workers from temporary agency. When the busy period is passed, these workers move to positions at other companies where their services are needed

Number of work shifts. The numbers of shifts worked per production period can be increased or decreased.

Number of labor hours. The numbers of labor hours per shift can be increased or decreased, through the use of overtime or reduce hours.

Inventory stockpiling. This tactic might be used to maintain steady employment level during slow demand periods.

Order backlogs : Deliveries of the product to the customer could be delayed during busy period when production resources are insufficient to keep up with demand.

Workload through subcontracting. This involves the letting of the jobs to other shops during busy periods , or the taking in of extra work during slack periods.

CAPACITY ADJUSTMENTS

Long-term Adjustments

Investing in new equipment. This involves investing in more machines or more productive machines to meet increased future production requirements, or investing in new types of machines to match changes in product design.

Constructing new plants. Building a new factory represents a major investment for the company. However, it also represents a significant increase in production capacity for the firm.

Purchasing existing plants from other companies.

Acquiring existing companies . This may be done to increase productive capacity. However , there are usually more important reasons for taking over an existing company, such as to achieve economies of scale that result from increase market share and reducing staff.

Closing Plants. This involves the closing of plants that will not be needed in the future.

COMPUTER AIDED QUALITY CONTROL (CAQC)

Subsets of CAQC

- CAI: Computer Aided Inspection
- CAT: Computer Aided Testing

Computer-aided inspection (CAI) and computer aided testing (CAT) are the two major segments of computer-aided quality control. Whereas these activities have been traditionally performed manually (with the help of gauges, measuring devices and testing apparatus), CAI and CAT are performed automatically using computer and sensor technology. Today, CAI and CAT can be well integrated into the overall CIM system.

COMPUTER AIDED QUALITY CONTROL (CAQC)

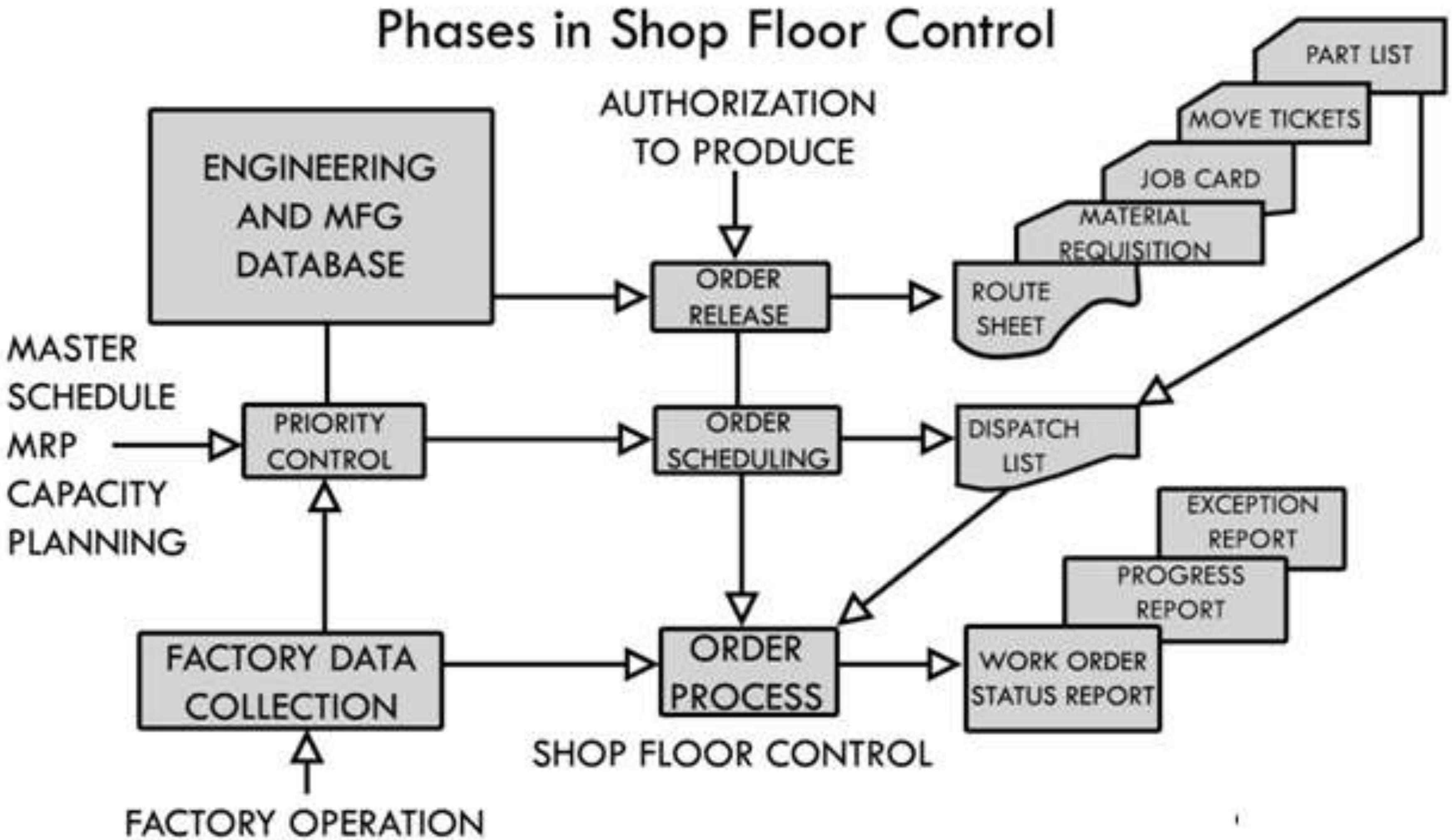
Objectives of CAQC

1. To improve product quality
2. To increase productivity in the inspection process
3. To increase productivity and reduce lead times in manufacturing

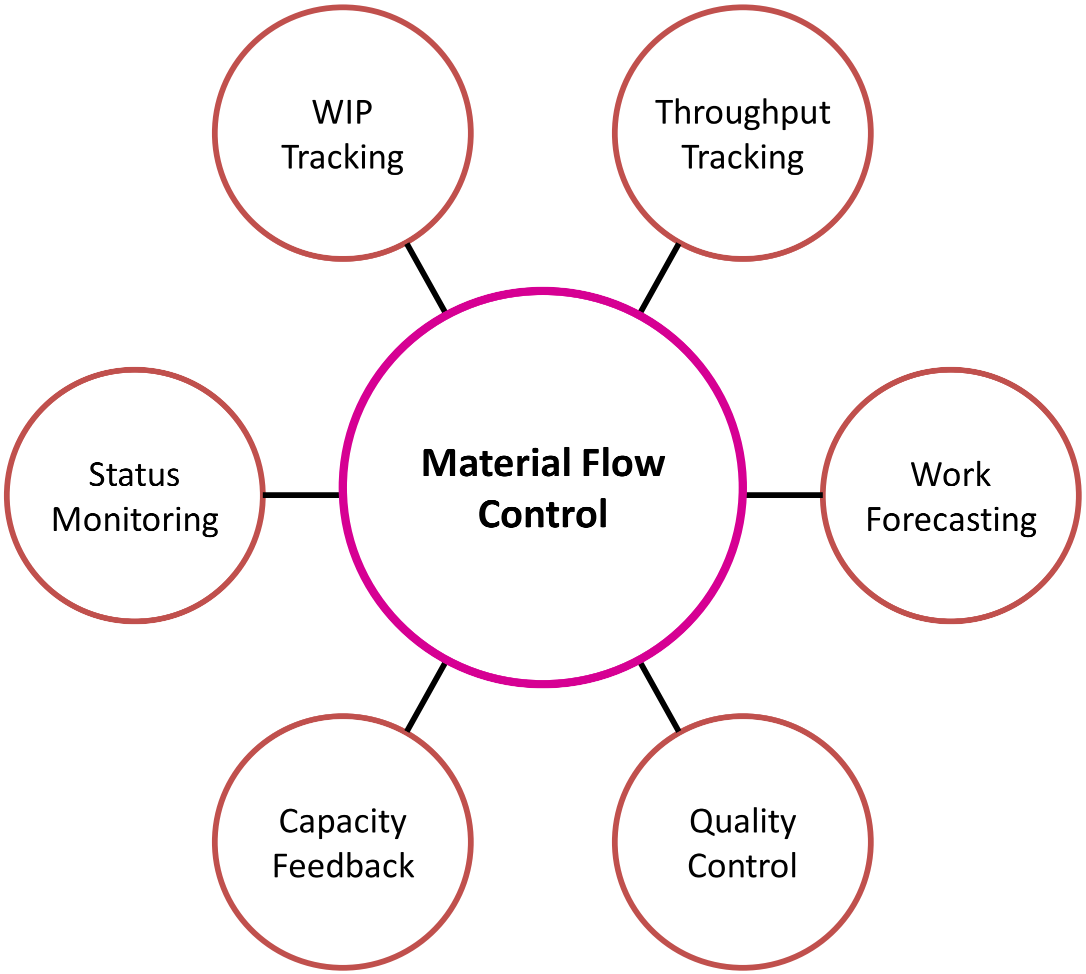
Advantages of CAQC

1. 100% testing and inspection
2. Inspection integrated with manufacturing
3. Use of non contact sensors
4. Computerized feed back control system

SHOP FLOOR CONTROL



SHOP FLOOR CONTROL



THANK YOU