COURSE HANDOUT

Production Planning and Control

Team of Instructors

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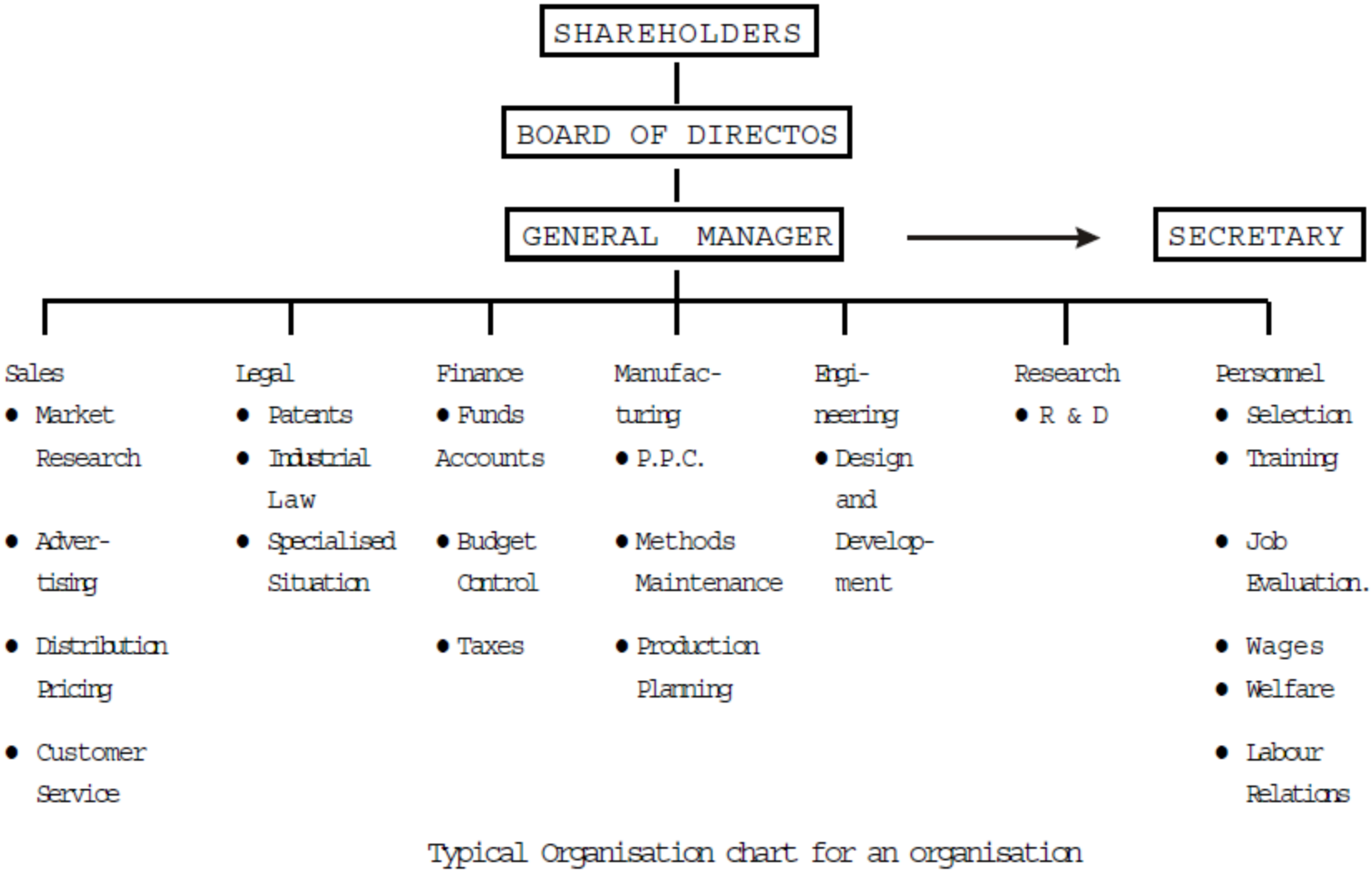
Unit-1

INTRODUCTION TO

PRODUCTION PLANNING AND CONTROL

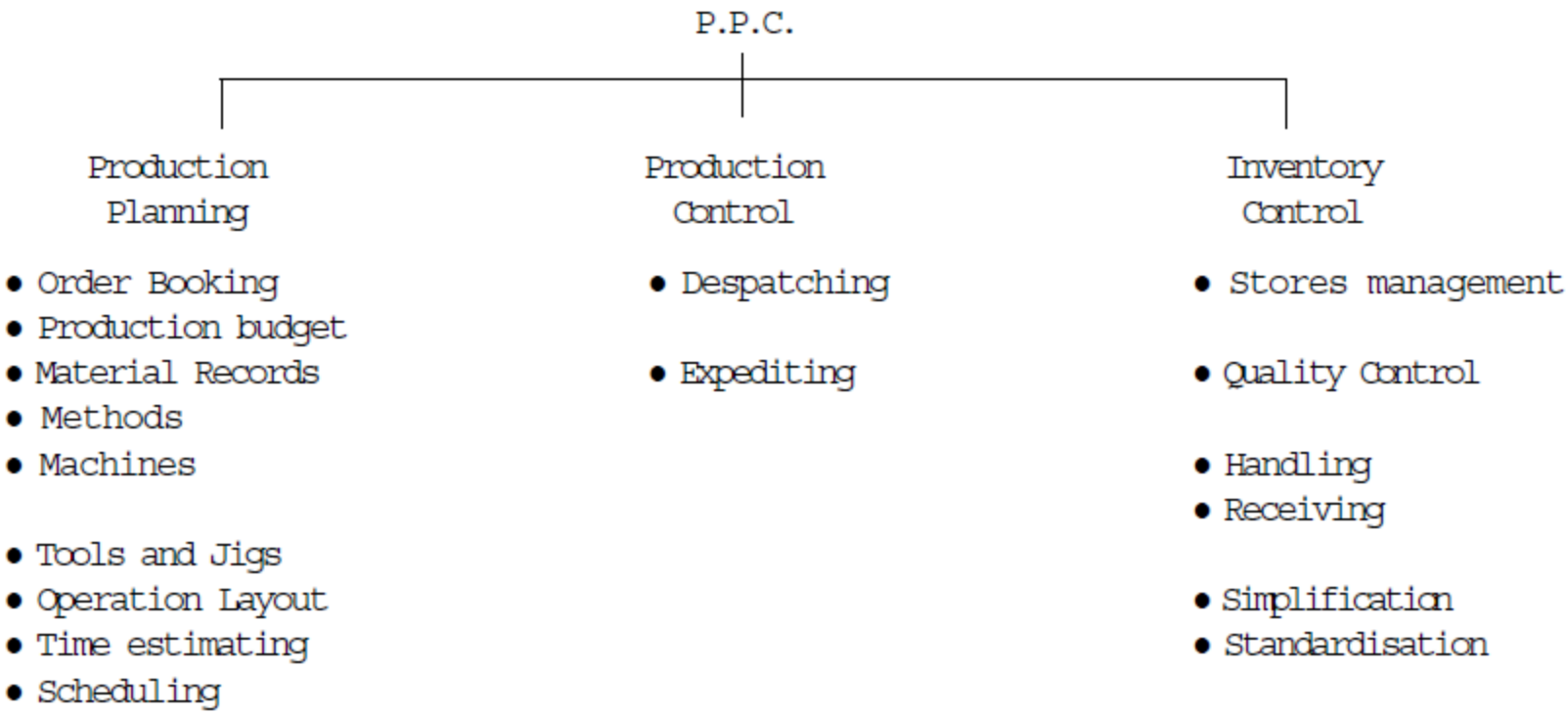
OBJECTIVES AND BENEFITS

- Minimize costs / maximize profits
- Maximize customer service
- Minimize inventory investment
- Minimize changes in production rates
- Minimize changes in work-force levels
- Maximize the utilization of plant and equipment



Typical Organisation chart for an organisation

ORGANISATION CHART FOR P.P.C. DEPARTMENT



An organization chart for production management department.

FUNCTIONS OF PRODUCTION CONTROL

- Production function encompasses the activities of procurement, allocation and utilization of resources.
- The main objective of production function is to produce the goods and services demanded by the customers in the most efficient and economical way.
- Therefore efficient management of the production function is of utmost importance in order to achieve this objective.

TYPES OF PRODUCTION

- Continuous production
- Job or unit production
- Intermittent production

Continuous production

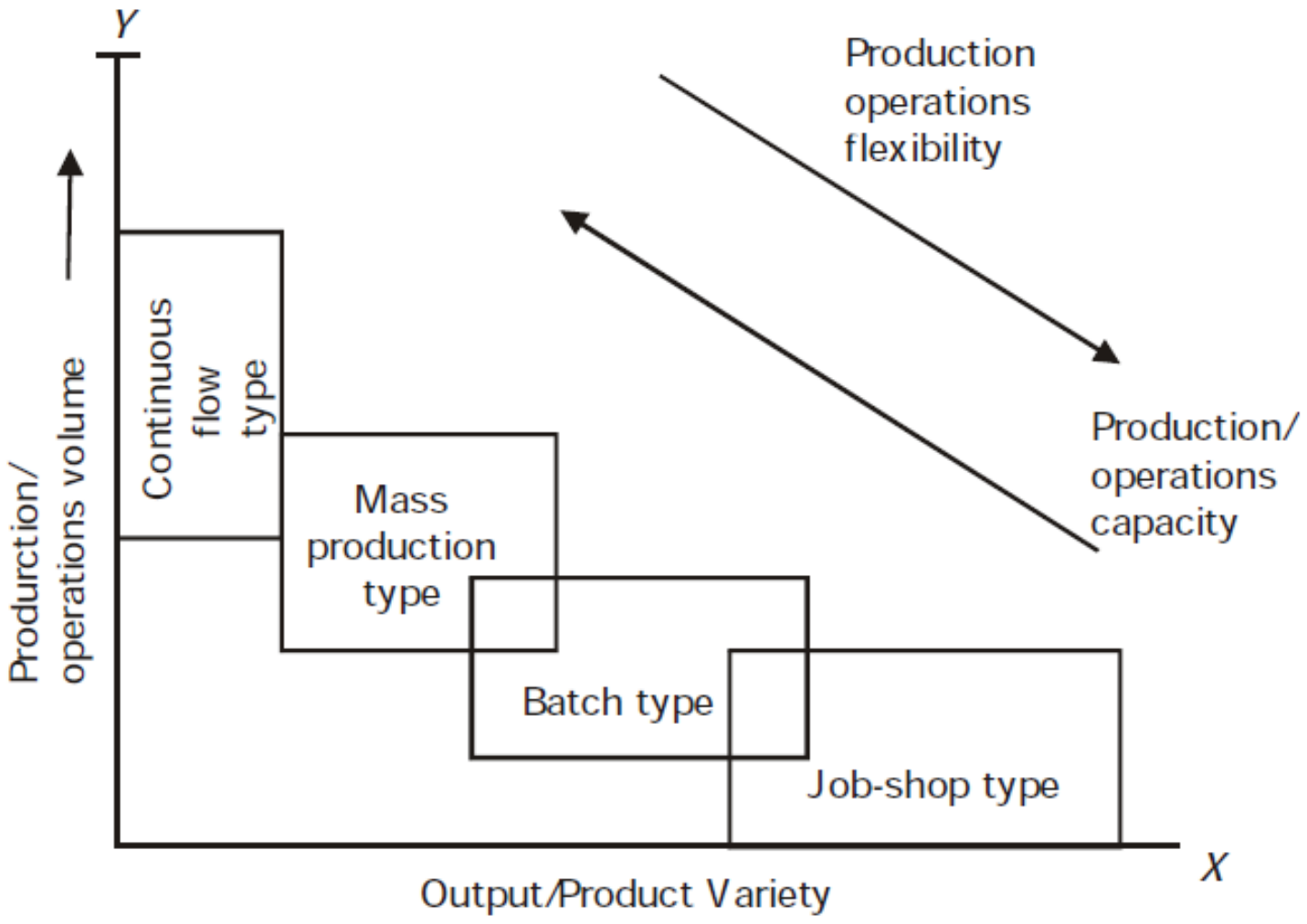
- It refers to the production of standardized products with a standard set of process and operation sequence in anticipation of demand.
- It is also known as mass flow production or assembly line production.
- This system ensures less work in process inventory and high product quality but involves large investment in machinery and equipment.

Job or unit production

- It involves production as per customer‘s specification each batch or order consists of a small lot of identical products and is different from other batches.
- The system requires comparatively smaller investment in machines and equipment.
- It is flexible and can be adapted to changes in product design and order size without much inconvenience.

Intermittent production

- Under this system the goods are produced partly for inventory and partly for customer's orders.
- E.g. components are made for inventory but they are combined differently for different customers. .
- Automobile plants, printing presses, electrical goods plant

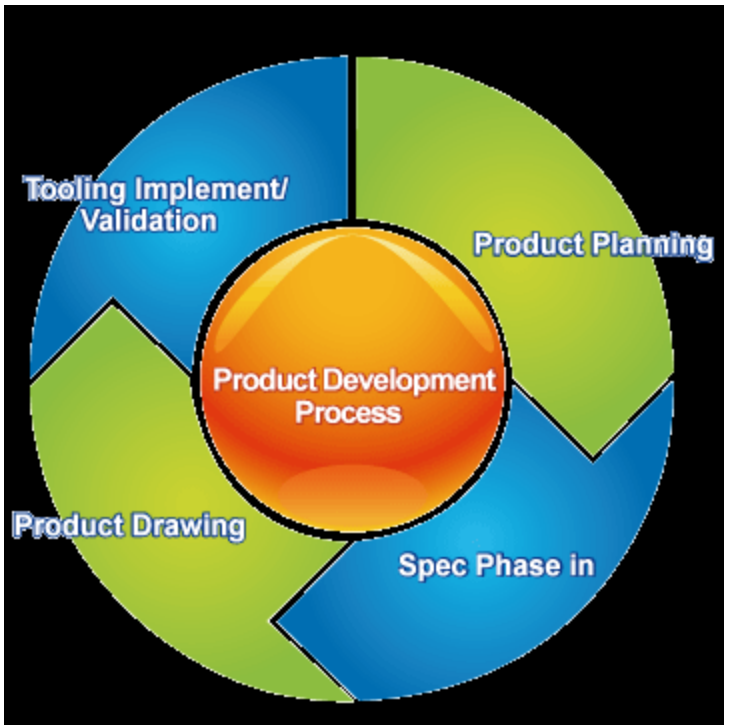


Production and operations system.

PRODUCT DESIGN

- Product design is a strategic decision as the image and profit earning capacity of a small firm depends largely on product design.
- Once the product to be produced is decided by the entrepreneur the next step is to prepare its design
- Product design consists of form and function. The form designing includes decisions regarding its shape, size, color and appearance of the product.
- The functional design involves the working conditions of the product.

PRODUCT DEVELOPMENT



(a) Standardization

(b) Reliability

(c) Maintainability

(d) Servicing

(e) Reproducibility

(f) Sustainability

(g) Product simplification

(h) Quality Commensuration with cost

(i) Product value

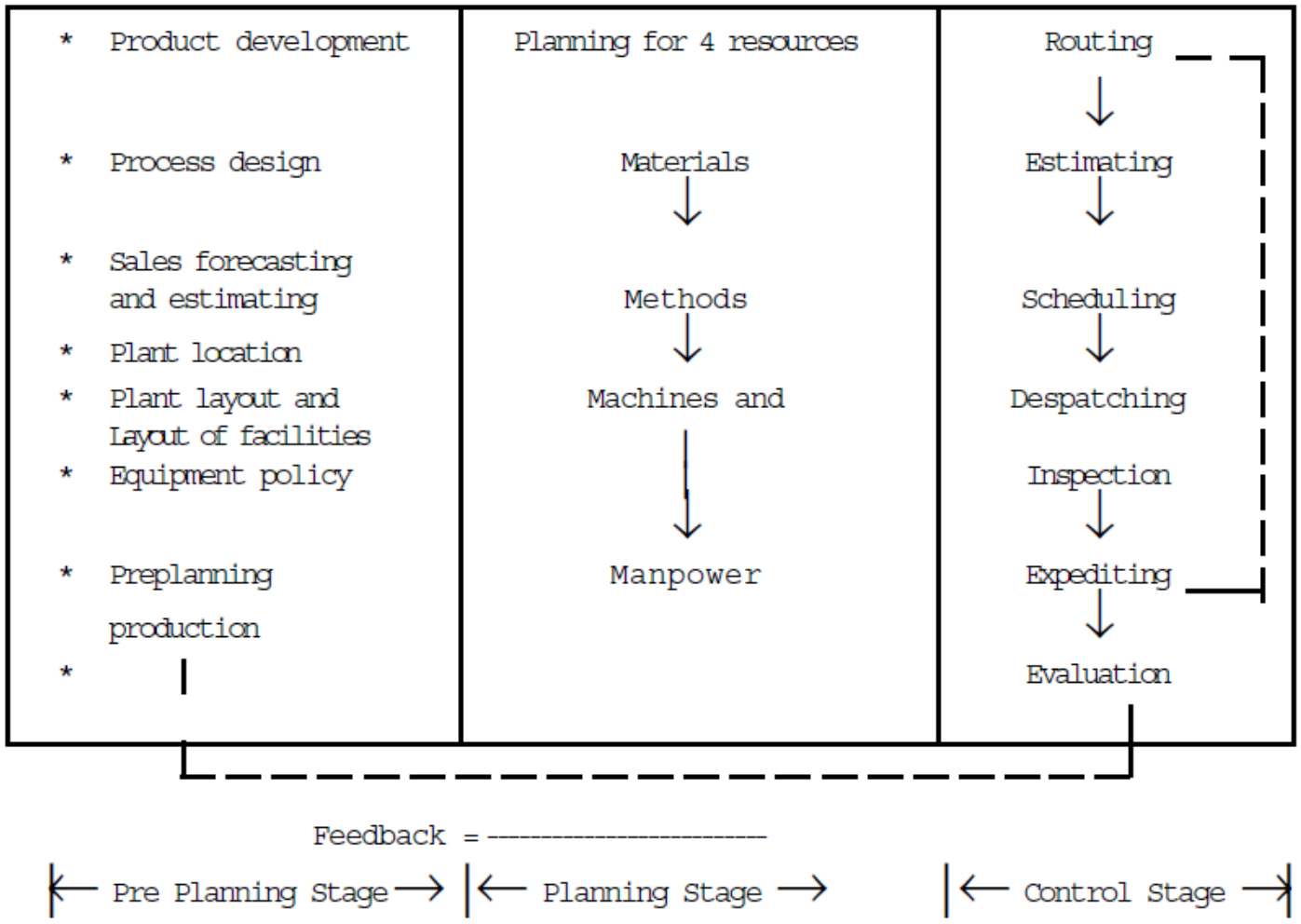
(j) Consumer quality

(k) Needs and tastes of consumers.

MARKETING ASPECT

- Sales and Marketing is a key function whose participation is often hard to enlist.
- Sales and Marketing are critical functions in this process, since they provide the starting point of the planning and scheduling process -- the forecasts and customer order demands
- They are also vital from the viewpoint of providing the proper customer perspective whenever changes need to be made to plans and schedules based on mismatches of resources to customer demands.
- Only with a proper level of participation in Planning and Scheduling, can Sales and Marketing optimally leverage its performance and create a trusting and consensus-based working relationship with Manufacturing, Purchasing, Planning, Engineering and all other functions in the company.

FUNCTIONAL AND OPERATIONAL ASPECT



DURABILITY AND DEPENDABILITY

Dependability for a system gathers the following attributes or non-functional requirements:

Availability: readiness for correct service

Reliability: continuity of correct service

Maintainability: to undergo modifications and repairs

Durability aspects concerns about the way the production is going to serve the purpose with out any hurdles for a prolonged period of time scale

AESTHETIC ASPECT

Difference between

aesthetic and non aesthetic effect

Profit consideration

- taking the time to calculate the profit margin for a product line or even for a company as a whole is essential to determining if a company is growing, maintaining its current market share, or is losing customers and is in danger of not making a profit.
- Many companies choose to look at profit margin ratios on a regular basis, just to make sure that sales are headed in the right direction, and that expenses are being contained in order to maximize the returns from those sales.

Standardization

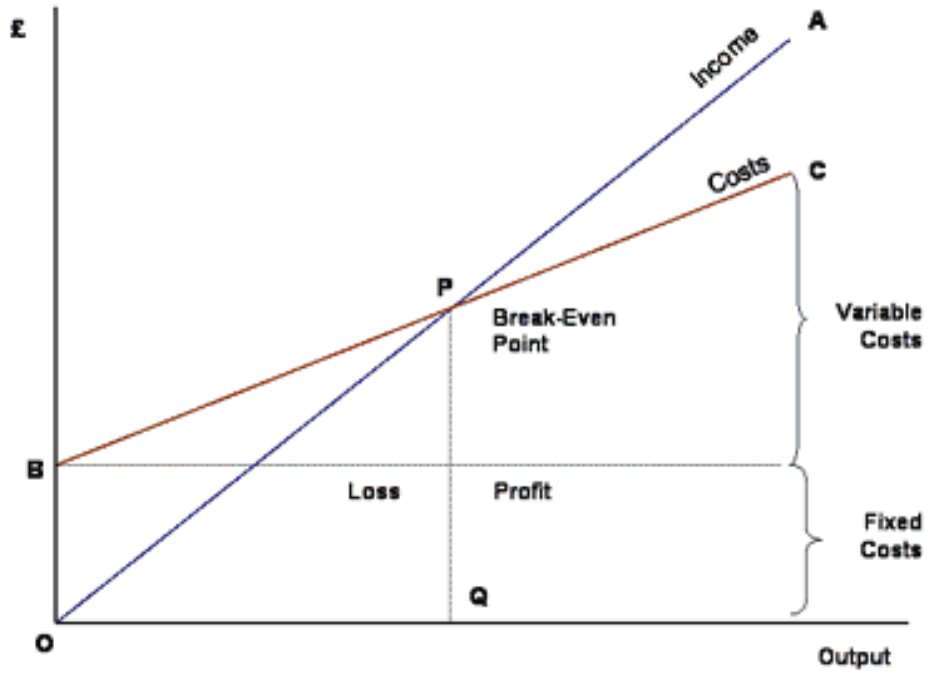
- Sizes for screws, nuts bolts and other threaded fasteners were first standardized based on work of by Joseph Whitworth..
- Pipe sizes
- Shoe size standardization
- The screw base size and thread dimensions of electric lamp bulbs was standardized by Thomas Edison.
- Electrical voltage and frequency
- Electrical wiring and device standards

Simplification and specialization

- The production system should be as simple as possible to make it easy for understanding as well as easy for execution
- Specialization of production infers the special production system for specific products or services.

Break even analysis

The break-even chart is a graphical representation of costs at various levels of activity shown on the same chart as the variation of income (or sales, revenue) with the same variation in activity. The point at which neither profit nor loss is made is known as the "break-even point"



Unit-2

Work study

Work study

- Work study investigates the work done in an organization and aims at finding the best and the most efficient way of utilizing the available resources (man, material, money and machinery) to achieve best possible quality work in minimum possible time.

Method Study

- Method Study is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs.
- Can be used to
  - the design of a new plant,
  - the design of a new product,
  - the design of a new process,
  - the improvement of an existing process,
  - the improvement of an existing workplace

Objectives of Method Study

1. Improvement of manufacturing processes and procedures.
2. Improvement of working conditions.
3. Improvement of plant layout and work place layout.
4. Reducing the human effort and fatigue.
5. Reducing material handling
6. Improvement of plant and equipment design.
7. Improvement in the utility of material, machines and manpower.
8. Standardization of method.
9. Improvement in safety standard.

Approach to Methods Design

Charles E. Geisel States that in order to design a system (method) thoroughly, eight elements must be considered.

1. Purpose: The function, mission, aim or need for the system.
2. Input: The physical items, people, and/or information that enter the system to be processed into the output.
3. Output: That which the system produces to accomplish its purpose, such as finished steel, assembled toasters, boxes, and so forth.
4. Sequence: The steps required to convert, transform, or process the input to the output.
5. Environment: The condition under which the system operates, including physical, attitudinal, organizational, contractual, cultural, political, and legal environment.
6. Human agents: The people who aid in the steps of the sequence without becoming a part of the output.
7. Physical catalysts: The equipment and physical resources that aid in the steps of the sequence without becoming part of the output.
8. Information aids: Knowledge and information resources that aid in the steps of the sequence without becoming part of the output.

BASIC PROCEDURE FOR METHOD STUDY

1. Select the work to be studied.
2. Record all facts about the method by direct observation.
3. Examine the above facts critically.
4. Develop the most efficient and economic method.
5. Define the new method.
6. Install the new method
7. Maintain the new method by regular checking.

Select

While selecting a job for doing method study, the following factors are considered:

Economical Factors

- The money saved as a result of method study should be sufficiently more. Then only the study will be worthwhile.
- Based on the economical factors, generally the following jobs are selected.
  - Operations having bottlenecks (which holds up other production activities).
  - Operations done repetitively.
  - Operations having a great amount of manual work.
  - Operations where materials are moved for a long distance.

Human Factors

- The method study will be successful only with the co-operation of all people concerned viz., workers, supervisor, trade unions etc. Workers may resist method study due to
  1. The fear of unemployment.
  2. The fear of reduction in wages.
  3. The fear of increased work load

Technical Factors

- To improve the method of work all the technical details about the job should be available. Every machine tool will have its own capacity

Record

- All the details about the existing method are recorded. This is done by directly observing the work. Symbols are used to represent the activities like operation, inspection, transport, storage and delay. Different charts and diagrams are used in recording.
- They are:

1. Operation process chart: All the operations and inspections are recorded.
2. Flow process chart
   - *(a)* Man type All the activities of man are recorded
   - *(b)* Material type All the activities of the material are recorded
   - *(c)* Equipment type All the activities of equipment or machine are recorded.
3. Two-handed process chart: Motions of both lands of worker are Right hand-Left hand chart recorded independently.
4. Multiple activity chart: Activities of a group of workers doing a single job or the activities of a single worker operating a number of machines are recorded.
5. Flow diagram: This is drawn to suitable scale. Path of flow of material in the shop is recorded.
6. String diagram: The movements of workers are recorded using a string in a diagram drawn to scale.

Examine

- Critical examination is done by questioning technique.
- This step comes after the method is recorded by suitable charts and diagrams.
- The individual activity is examined by putting a number of questions.
- The following factors are questioned

1. Purpose – To eliminate the activity, if possible.
2. Place – To combine or re-arrange the activities.
3. Sequence – -do-
4. Person – -do-
5. Means – To simplify the activity.

Develop

- The answer to the questions given below will result in the development of a better method.

1. Purpose – What should be done?
2. Place – Where should it be done?
3. Sequence – When should it be done?
4. Person – Who should do it?
5. Means – How should it be done?

DEFINE

- The report should show

  (a) Brief description of the old method

  (b) Brief description of the new method.

  (c) Reasons for change.

  (d) Advantages and limitations of the new method.

  (e) Savings expected in material, labour and overheads.

  (f) Tools and equipment required for the new method.

  (g) The cost of installing the new method including.

  1. Cost of new tools and equipment.
  2. Cost of re-layout of the shop.
  3. Cost of training the workers in the new method.
  4. Cost of improving the working conditions.

Install

- This step is the most difficult stage in method study. Here the active support of both management and trade union is required.
- Here the work study man requires skill in getting along with other people and winning their trust
- Install stage consists of

  (a) Gaining acceptance of the change by supervisor.

  (b) Getting approval of management.

  (c) Gaining the acceptance of change by workers and trade unions.

  (d) Giving training to operators in the new method.

  (e) To be in close contact with the progress of the job until it is satisfactorily executed.

Maintain

- The work study man must see that the new method introduced is followed.
- The workers after some time may slip back to the old methods. This should not be allowed.
- The new method may have defects. There may be difficulties also. This should be rectified in time by the work study man.
- Periodical review is made. The reactions and suggestions from workers and supervisors are noted. This may lead to further improvement.
- The differences between the new written standard practice and the actual practice are found out.
- Reasons for variations are analysed. Changes due to valid reasons are accepted.

Process chart

- A process chart is setting out the sequence of flow of a product or a procedure by recording all events under review using appropriate process chart-symbols.
- This chart gives a record of all events associated with the worker.
  - Operation,
  - inspection,
  - movement and
  - delay

Application-Process charts

- Generally used as a principal means of recording work methods
- Helps to understand the overall nature of the system being studied
- Helps to eliminate flow patterns that are not suitable
- Helps to allow storage space adequate to support the production rate
- Helps to eliminate costly errors by analyzing the material flow
- Helps to allow adequate space to avoid safety problems
- Helps to locate and size aisles appropriate for product handled
- Helps to avoid backtracking of the material
- Helps to identify the possibility of combining operations by grouping different machines or operations to avoid handling, storage, and delays
- Helps to decide whether product flow or process flow layout of factory will be useful

CHARTS FOR PROCESS

1. Outline process charts
2. Flow process chart: man type, material type, equipment type
3. Two handed process chart
4. Multiple activity chart: using time scale
5. Simo chart: using time scale
6. Flow diagrams
7. String diagrams
8. Cyclograph
9. Chronocyclegraph
10. Travel Chart

METHOD STUDY CHARTS AND DIAGRAMS

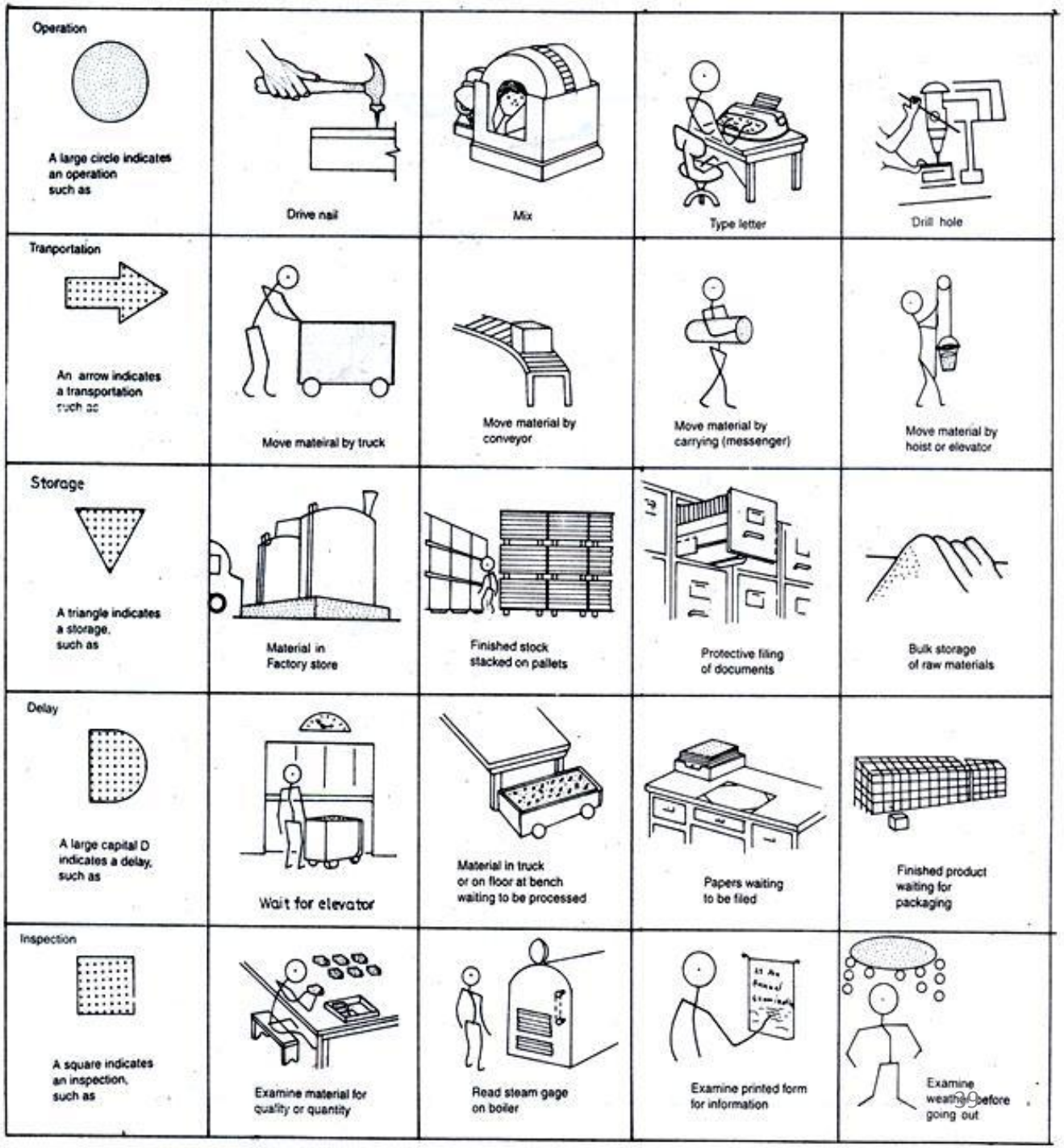
- **Charts indicating process sequence**
  - Outline process chart
  - Flow process chart – Man, Material and Equipment type
  - Two-handed process chart

- **Charts using a time scale**
  - Multiple activity chart
  - Simo chart
  - PMTS chart

- Diagrams indicating movement
  - Flow diagram
  - Sting diagram
  - Cyclograph
  - Chronocyclegraph
  - Travel chart

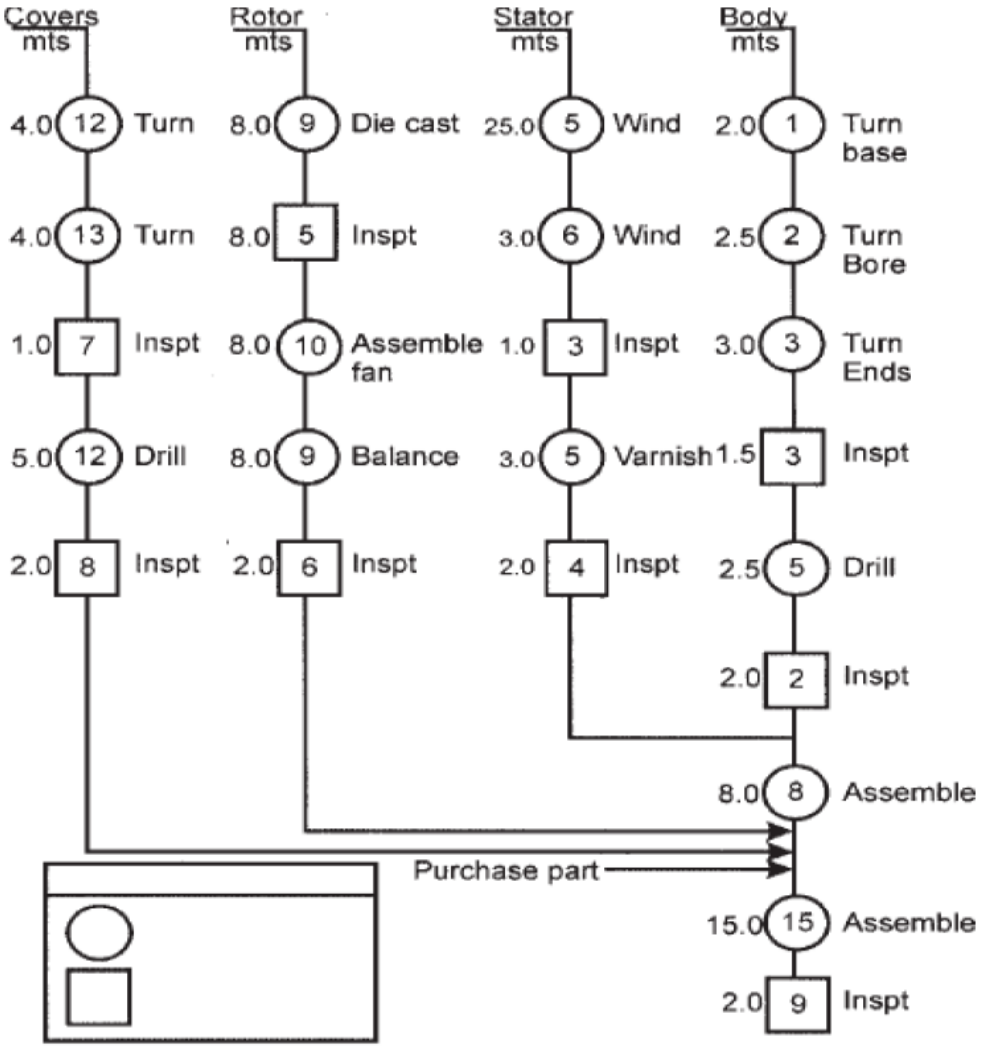
SYMBOLS USED IN PROCESS CHARTS

Process charts use five common symbols for recording the nature of events. These were developed by ASME (American Society of Mechanical Engineers) in 1947.



Operation Process Chart

- An operation process chart is a graphic representation of the sequence of all operations and inspections taking place in a process.
- It is also known as outline process chart.
- It gives a bird‘s eye view of the overall activities.
- Entry points of all material are noted in the chart.
- The fig. shows operation process chart of a motor assembly unit



Flow Process Chart

There are three types of flow process charts. They are

1. Man type flow process chart

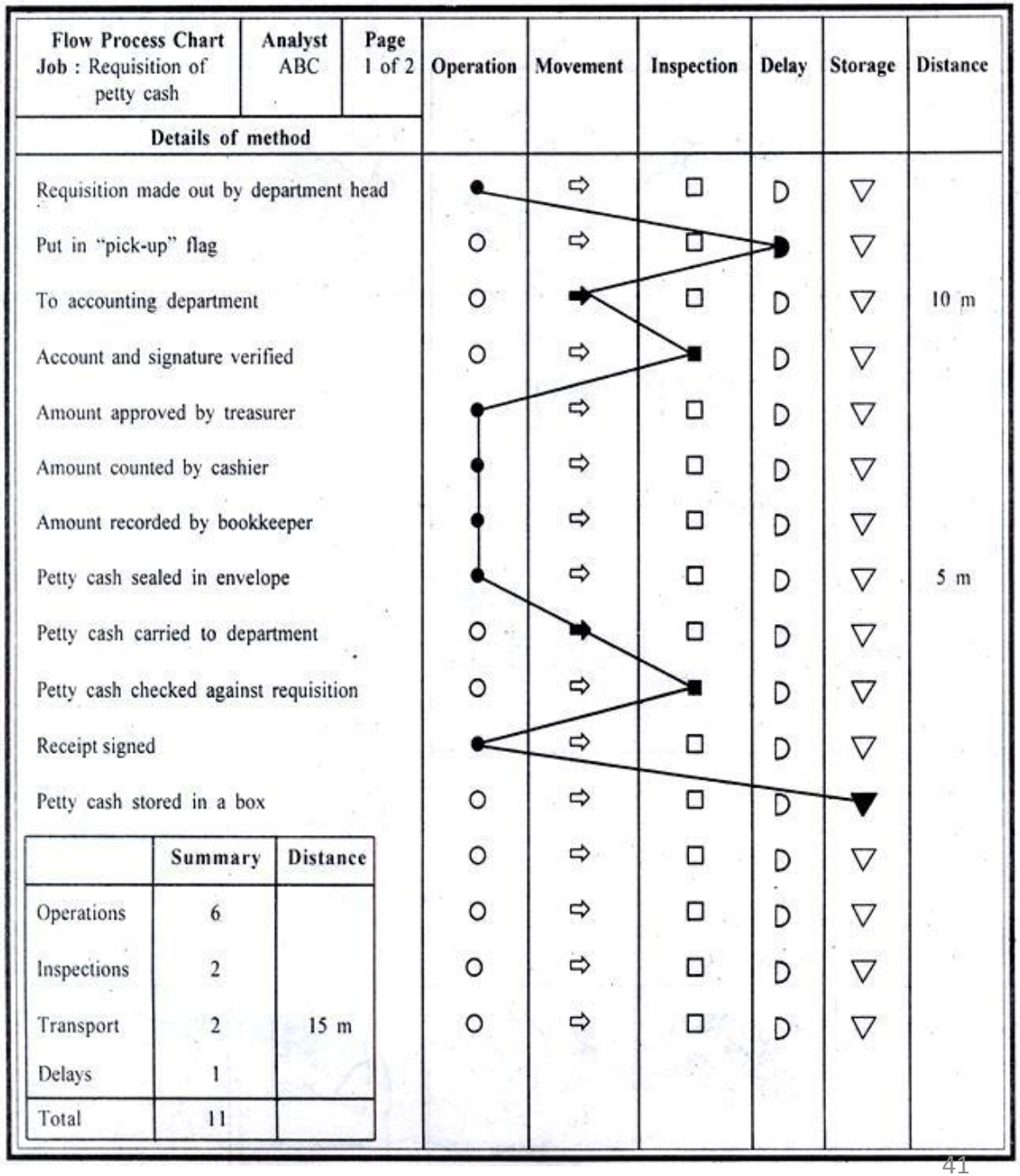
This flow process chart records what the worker does.

2. Material type flow process chart

This flow process chart records how the material is handled or treated.

3. Equipment type flow process chart

This flow process chart records how the equipment or machine is used.



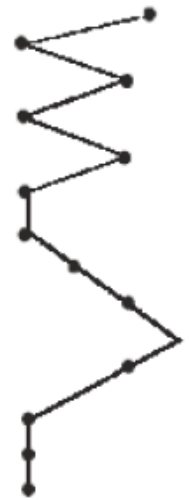
Flow Process Chart Job : Requisition of petty cash	Analyst ABC	Page 1 of 2

Details of method	Operation	Movement	Inspection	Delay	Storage	Distance
Requisition made out by department head	●	⇨	□	D	▽	
Put in "pick-up" flag	○	⇨	□	D	▽	
To accounting department	○	⇨	□	D	▽	10 m
Account and signature verified	○	⇨	■	D	▽	
Amount approved by treasurer	●	⇨	□	D	▽	
Amount counted by cashier	●	⇨	□	D	▽	
Amount recorded by bookkeeper	●	⇨	□	D	▽	
Petty cash sealed in envelope	●	⇨	□	D	▽	5 m
Petty cash carried to department	○	⇨	□	D	▽	
Petty cash checked against requisition	○	⇨	■	D	▽	
Receipt signed	●	⇨	□	D	▽	
Petty cash stored in a box	○	⇨	□	D	▼	
	○	⇨	□	D	▽	
	○	⇨	□	D	▽	
	○	⇨	□	D	▽	
	○	⇨	□	D	▽	

	Summary	Distance
Operations	6	
Inspections	2	
Transport	2	15 m
Delays	1	
Total	11	

Flow chart-Operator type

Chart No.	: 001	Date :	
Job	: Typing A letter	Charted by:	.....
Chart begins	: Steno in her seat	Chart ends-putting the typed letter in the way	
Method	: Present/Proposed		

Sl. No.	*Description of the activities*	*Distance*	*Time in Sec.*	*Symbols*	*Remarks*
				O □ ⇒ D ∇	
1.	Steno in her seat	-	-		
2.	Hears the bell	-	3		
3.	Goes to manager's room	6m	10		
4.	Takes down dictation	-	120		
5.	Returns to her seat	6m	10		
6.	Prepares typewriter	-	15		
7.	Types the letter	-	150		
8.	Checks the matter	-	40		
9.	Goes to manager's room	6m	10		
10.	Waits till the manager signs	-	20		
11.	Returns to her seat	6m	10		
12.	Types envelope	-	20		
13.	Puts the letter inside envelope	-	5		
14.	Puts the envelope in dispatch tray	-	5		

Two-Handed Process Chart (or) Right Hand, Left Hand Chart

- It is the process chart in which the activities of two hands of the operator are recorded.
- It shows whether the two hands of the operator are idle or moving in relation to one another, in a timescale.
- It is generally used for repetitive operations.

Job	:	Assembly of washer and nut to a bolt					
Chart begins	:	Both hands free before assembly	Assembly	Bolt	Washer	Nut	
Chart ends	:	Both hands free after assembly					
Chart	:	Existing method/Proposed method	Date	:		Operator	
Operator	:		Chart No	:			

	Left hand			**Right hand**	
Sl. No.	*Description of the activities*	*Symbols*	*Sl. No.*	*Description of the activities*	*Symbols*
1.	To the bolt tray		1.	To the washer tray	
2.	Picks up one bolt		2.	Picks up one washer	
3.	Returns to original position		3.	Returns to the initial position	
4.	Holding the bolt		4.	Assembles washer over bolt	
5.	Idle		5.	To the nut tray	
6.	Idle		6.	Picks up one nut	
7.	Idle		7.	Returns to initial position	
8.	Idle		8.	Assemble nut to the bolt	
9.	To the assembly tray		9.	Idle	
10.	Puts the bolt in the tray		10.	Idle	
11.	Returns to the original position		11.	Idle	

TWO HANDED PROCESS CHARTS

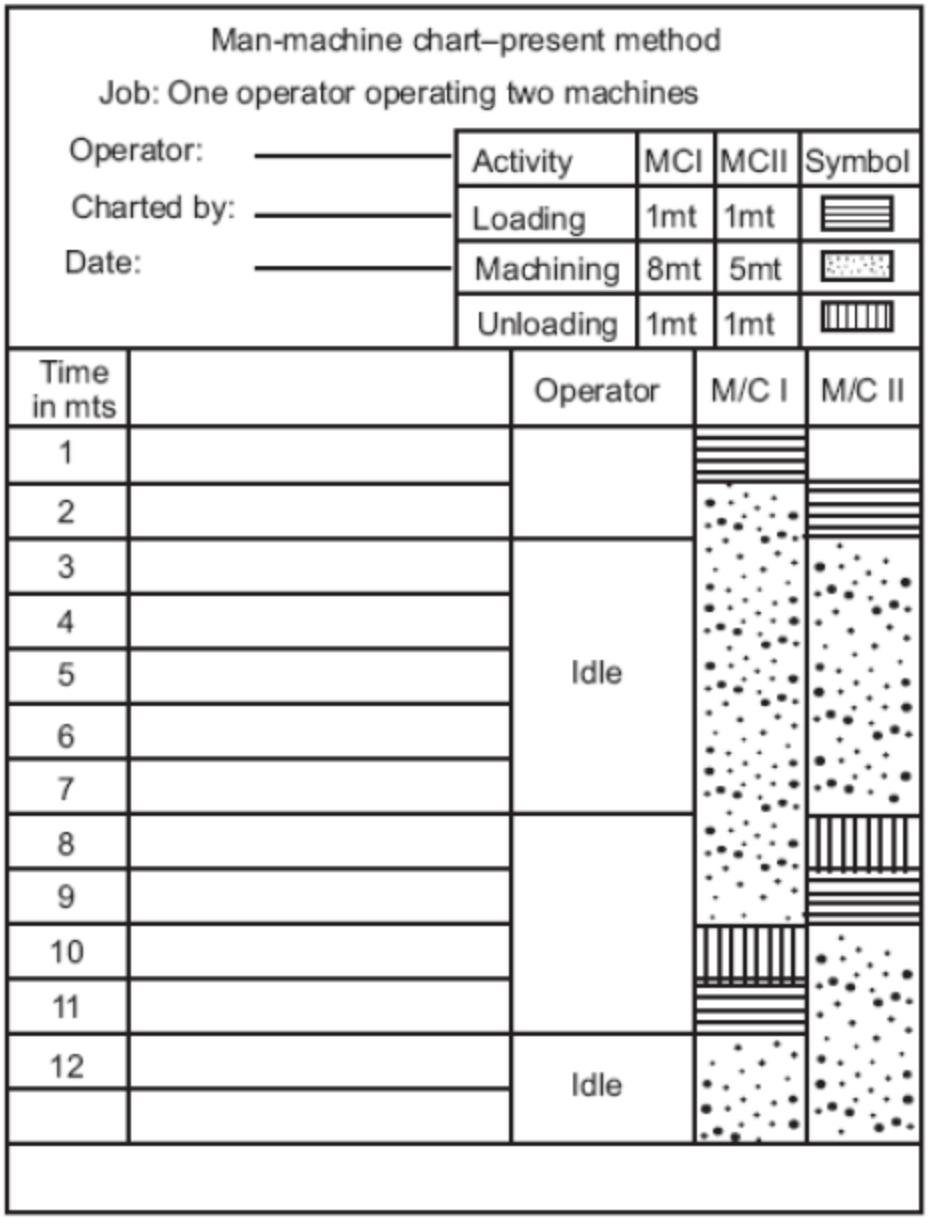
Multiple Activity Chart

- In those operations involving the combination of
  - a person and a machine,
  - a person and several machines,
  - any combination of people and machines
- The multiple activity chart provides a convenient technique for analyzing the combined activity.
- Objectives of this type of analysis are
  - to attain the maximum utilization of a machine,
  - to attain the optimum person to machine relationship,
  - to bring about the best balance of crew activity.

Man-Machine Chart

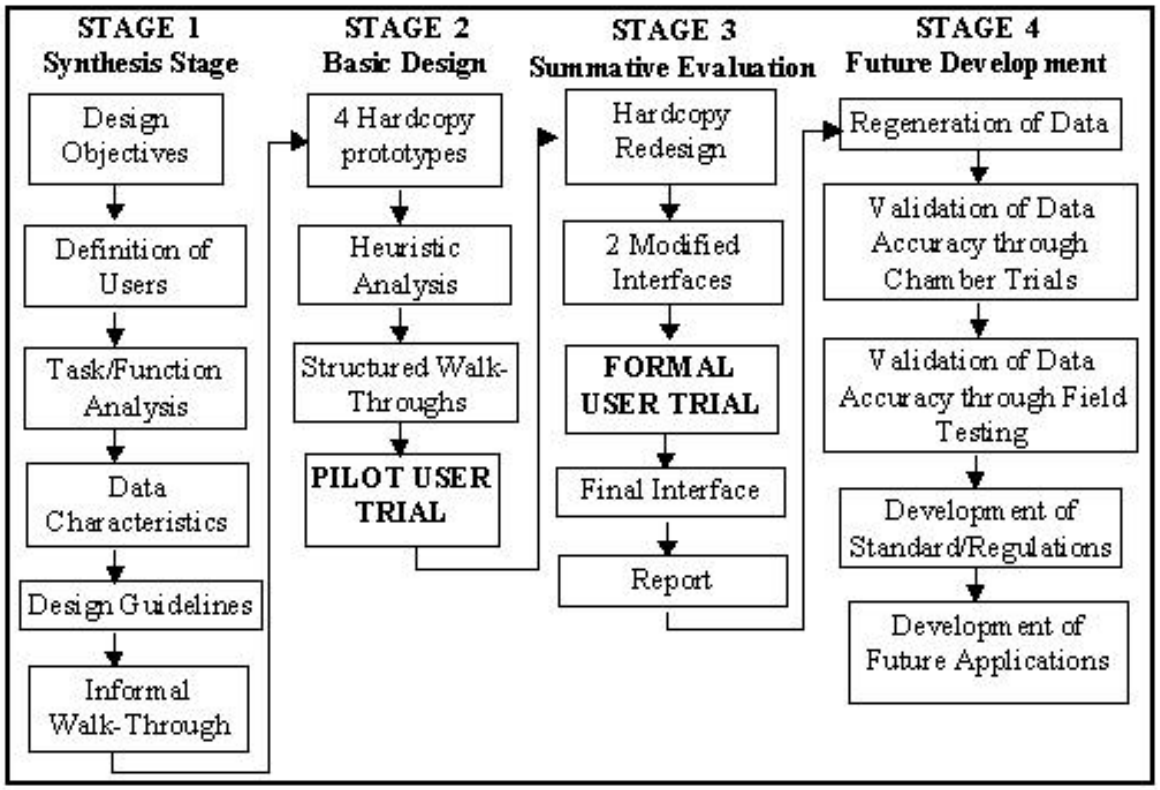
- A man-machine chart is a chart in which the activities of more than one worker or machine are recorded.
- Activities are recorded on a common time scale to show the inter-relationship. It is also known as multiple activity chart.
- It is used when a worker operates a number of machines at a time.
- It is also used when a number of workers jointly do a job.
- Activities of workers or machines are recorded in separate vertical columns (bars) with a horizontal time scale.
- The chart shows the idle time of the worker or machine during the process.

- To record the time, ordinary wrist watch or stop watch is used. High accuracy is not needed.
- Here one operator two semi-automatic machines simultaneously.
- The activities of the operator is recorded in a separate vertical column
- The activities of the two machines are recorded in two separate vertical columns.



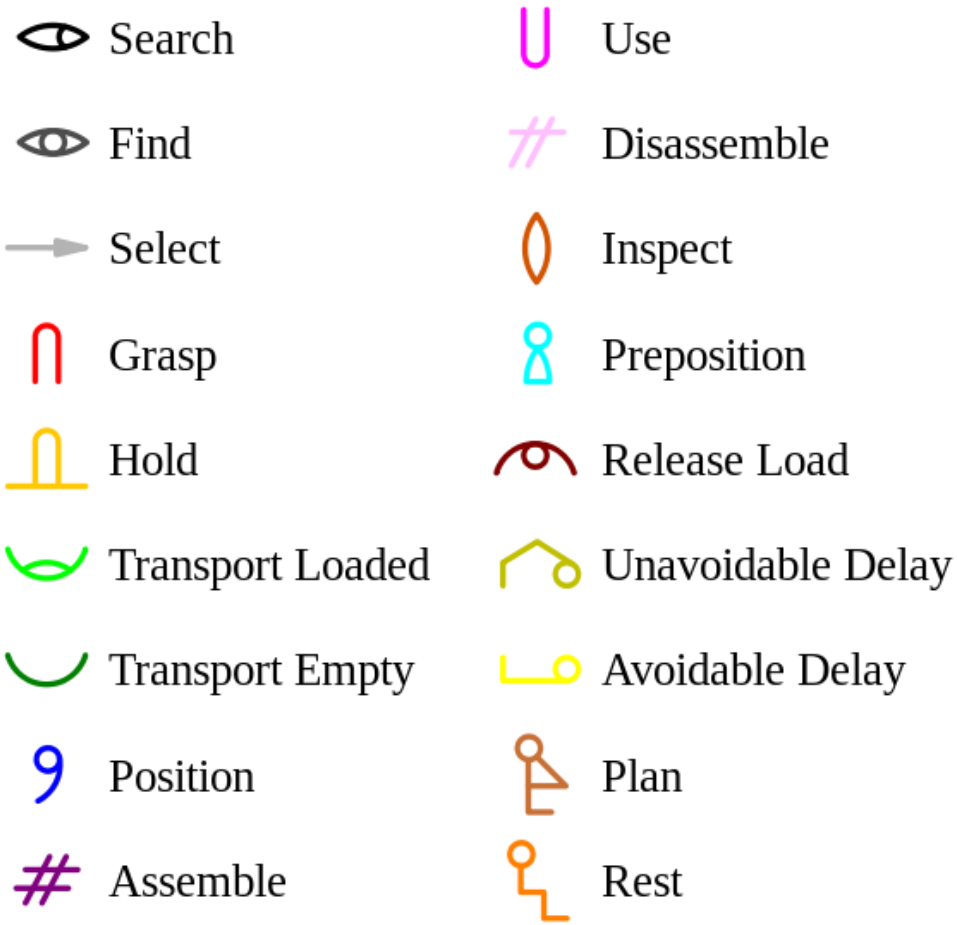
SIMO Charts

- A basic motion-time chart used to show the simultaneous nature of motions;
- Commonly a therblig chart for two-hand work with motion symbols plotted vertically with respect to time, showing the therblig abbreviation and a brief description for each activity, and individual times values and body-member detail.
- Also known as simultaneous motion-cycle chart.



Therbligs

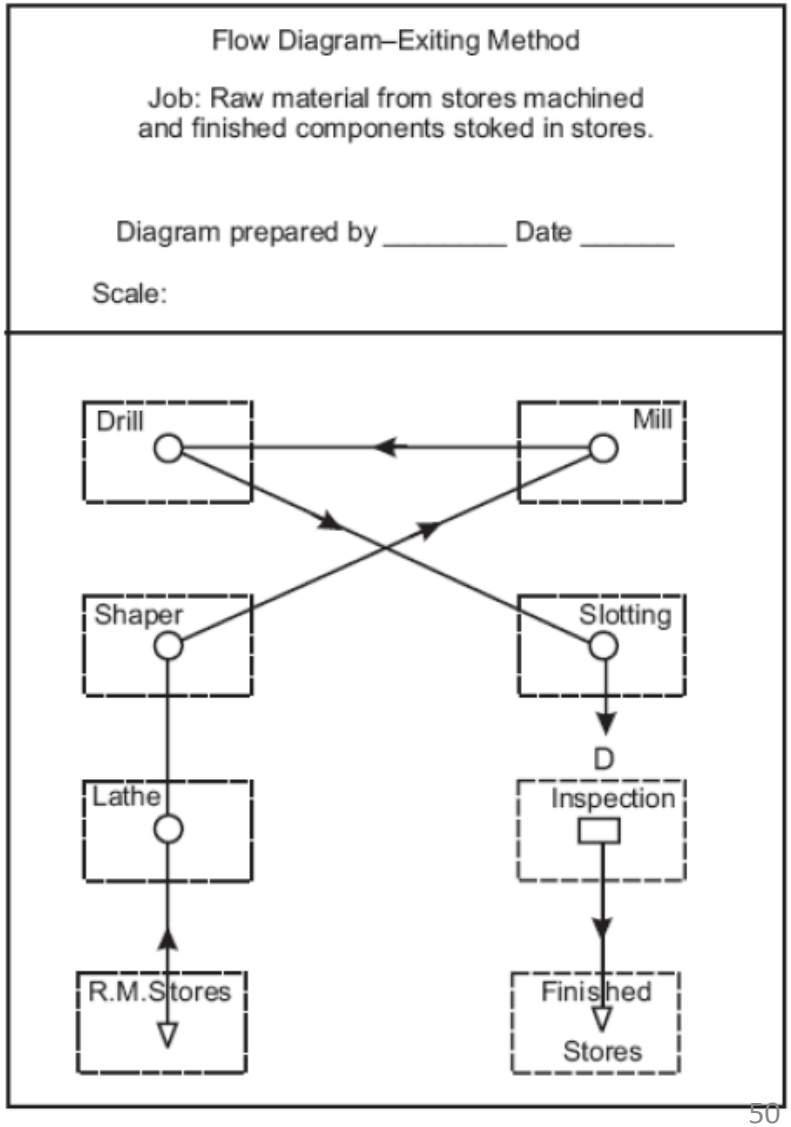
- Therbligs are 18 kinds of elemental motions used in the study of motion economy in the workplace.
- A workplace task is analyzed by recording each of the therblig units for a process, with the results used for optimization of manual labor by eliminating unneeded movements.



Flow Diagram

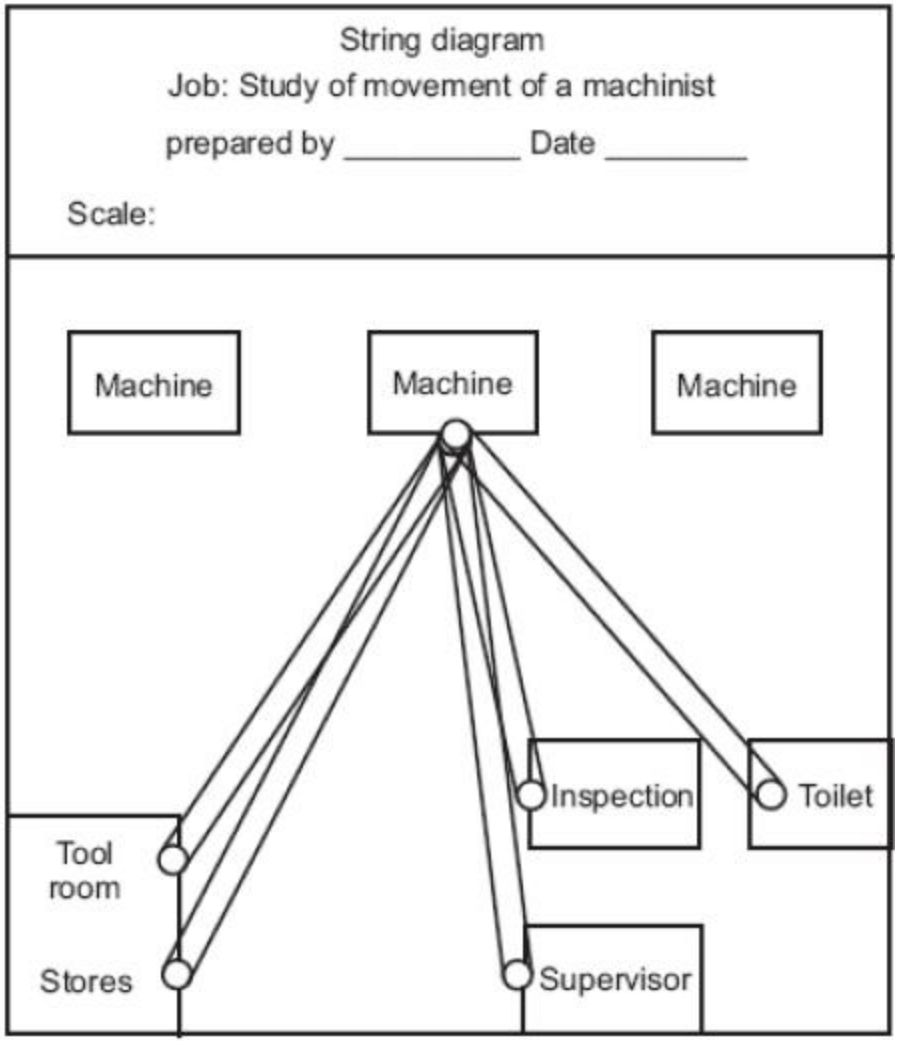
- In any production shop, repair shop or any other department, there are movements of men and material from one place to another. Process charts indicate the sequence of activities.
- They do not show the frequent movements of men and material.
- If these movement are minimized, a lot of savings can be achieved in cost and effort
- The flow diagram are used for the following purposes:

  1. To remove unwanted material movement.
  2. To remove back tracking.
  3. To avoid traffic congestion.
  4. To improve the plant layout.



String Diagram

- We make use of flow diagram for recording the movement of men or material when the movement is simple and the path is almost fixed.
- But when the paths are many and are repetitive, it may not be possible to record them in a flow diagram. Here a string diagram is used.
- String diagram is a scaled plan of the shop.
- Location of machines and various facilities are drawn to scale in a drawing sheet.



Applications – String diagram

1. It is used for recording the complex movements of material or men.
2. Back tracking, congestion, bottlenecks, under utilized paths are easily found out.
3. It is used to check whether the work station is correctly located.
4. Used to record irregular movements.
5. Used to find out the most economical route.

TRAVEL CHART (or, FROM-TO CHART)

- It is a tabular record of quantitative data about movement of workers/materials/equipment between any number of places over a given period of time. It is always in the form of a **SQUIRE**, having within it the squires.

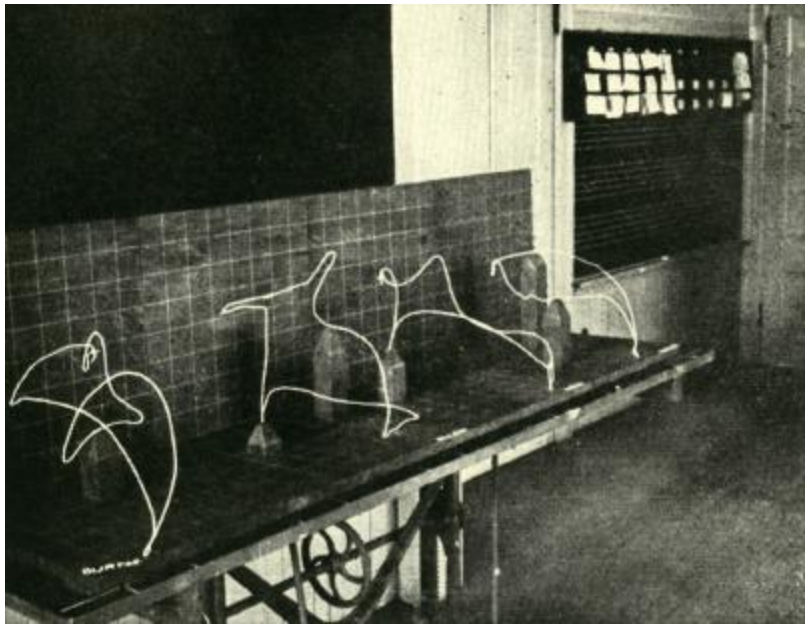
EACH SMALL SQUIRE REPRESENTS A STATION.

Along the TOP, squires from left to right represent the stations **FROM** where movement or travel occurs.

Along those DOWN THE LEFT HAND, the squires represent the stations **TO** which the movement is made.

Cycle Graph

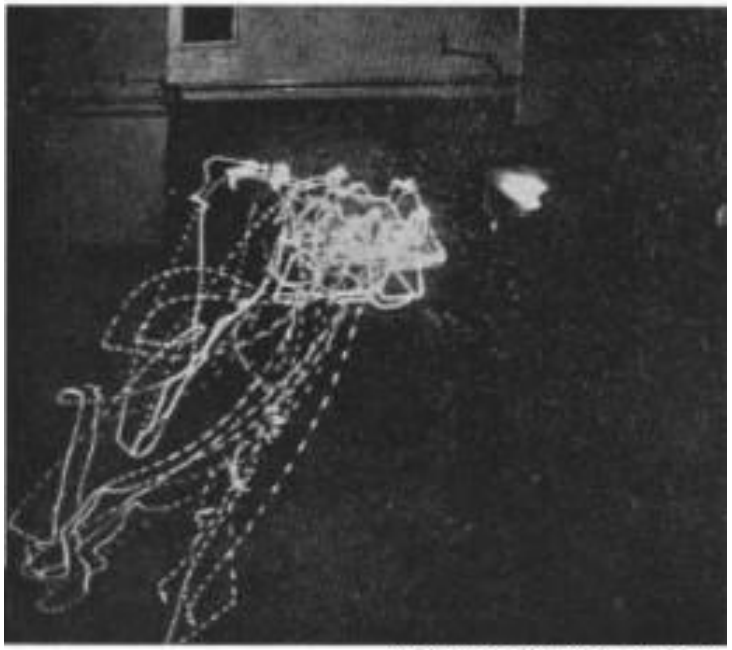
- To make a cycle graph , a small electric bulb is attached to the finger, hand, or any other part of the body whose motion is to be recorded.
- By using still photography, the path of light of bulb (in other words, that of the body member) as it moves through space for one complete cycle is photographed.
- The working area is kept relatively less illuminated while photograph is being taken.
- More than one camera may be used in different planes to get more details. After the film is developed, the resulting picture (cycle graph) shows a permanent record of the motion pattern employed in the form of a closed loop of white continuous line with the working area in the background.
- A cycle graph does not indicate the direction or speed of motion.
- It can be used for Improving the motion pattern, and Training purposes in that two cycle graphs may be shown with one indicating a better motion pattern than the other.



Chrono Cycle Graph

- The chrono cycle graph is similar to the cycle graph, but the power supply to the bulb is interrupted regularly by using an electric circuit.
- The bulb is thus made to flash. The procedure for taking photograph remains the same.
- The resulting picture (chrono cycle graph), instead of showing continuous line of motion pattern, shows short dashes of line spaced in proportion to the speed of the body member photographed.
- Wide spacing would represent fast moves while close spacing would represent slow moves.
- The jumbling of dots at one point would indicate fumbling or hesitation of the body member.
- A chrono cycle graph can thus be used to study the motion pattern as well as to compute velocity, acceleration and retardation experienced by the body member at different locations

Illustration No. 1.



(Gilbreth Fatigue Study.)

Typical chronocyclegraph of the motion of a bricklayer, laying three bricks by the old method.

Principles of Motion Economy

- The **principles of motion economy** form a set of rules and suggestions to improve the manual work in manufacturing and reduce fatigue and unnecessary movements by the worker, which can lead to the reduction in the work related trauma.

- The principles of motion economy can be classified into three groups:
  - Principles related to the use of *human body*,
  - Principles related to the arrangement of the *work place*,
  - Principles related to the *design of tools and equipment*.

Use of Human Body

- The two hands should begin motions at the same time.
- The two hands should not be idle at the same time except during rest periods.
- Motions of the arms should be made in opposite and symmetrical directions and should be made simultaneously
- Hand motions should be confined to the lowest classification with which it is possible to perform the work satisfactorily:
  - Finger motions
  - Wrist motions
  - Forearm motions
  - Upper arm motions
  - Shoulder motions
- Momentum should be employed to assist the worker whenever possible, and it should be reduced to a minimum if it must be overcome by muscular effort.
- Smooth continuous motions of the hands are preferable to zigzag motions or straight-line motions involving sudden and sharp changes in direction.

Arrangement of the Work Place

- There should be a definite and fixed place for all tools and materials.
- Tools, materials, and controls should be located close in and directly in front of the operator.
- Drop delivers should be used whenever possible.
- Materials and tools should be located to permit the best sequence of motions.
- Arrange the height of the workplace and chair for alternate sitting and standing, when possible.
- Provide a chair of the type and height to permit good posture.

Design of Tools and Equipment

- Combine tools whenever possible.
- Preposition tools and materials.
- Where each finger performs some specific movement, the load should be distributed in accordance with the inherent capacities of the fingers.
- For light assembly, a screwdriver handle should be smaller at the bottom.
- Momentum should be used to help the worker in doing their task not to increase their task.

MICROMOTION STUDY

- It is a technique for recording and timing an activity.
- It consists of taking motion pictures of the operation with a clock in the picture (or with a video camera running at a known speed.
- The film is a permanent record of the method and the time and is always ready to be examined when needed.

Purposes of Micromotion Study

1. To assist in finding the preferred method of doing the work.
2. To assist in training the workers to understand the meaning of motion study and to enable them to apply motion economy principles in a professional way.

Micromotion study as an Aid in Improving Methods

The procedure of making a micromotion study consists of:

1. Filming the operation to be studied.
2. Analysing the film.
3. Charting the results of the analysis.
4. Developing the improved method.

Micromotion study

- The speed of the camera used ranges from 960 to 1000 frames per minute. But faster cameras may be used to study very fast hand motions or complex operations.
- The pictures should be enlarged many times to facilitate the analysis of the motions.
- Micromotion study should be used when it is economical to do so (short cycle highly repetitive operations, large volume production, or operation performed by a large number of workers).

Memomotion Study

- In memomotion study, the camera speed is at 60 or 100 frames per minute.
- In addition to its use in industrial operations, it is used to study many other operations such as check-in operations as airline counters, the manner in which customers select items in the store, traffic flow on highways, and in banks.
- It costs less than micromotion study (only costs 6% of the cost of a micromotion study

CRITICAL EXAMINATION

- Means by which each activity is subjected to a systematic and progressive series of questions.
- Grouping of activities: Five sets of activities can be grouped in two categories
- Those in which something actually happens to the work-piece (it is moved, worked upon or examined)
- Those in which it is not being touched (in storage or in delay)
- Objective is to maximize proportion of "do" activities.
- All other activities, however necessary, are considered "non-productive."

DEVELOPMENT

- The shortcomings of the present process are brought out by the systematic questioning process that is combined with a knowledge relevant to the process being examined.
- Industrial may have the knowledge required or may not have the adequate knowledge.
- They need to have a knowledge library to support their effort as well as access to the experts during the study period.
- Alternatives to the current activities which have the shortcomings are to be generated during this stage.

IMPLEMENTATION

- Industrial engineers of methods study persons have to train the operators and their supervisors in the new method and participate in installing the method.
- Industrial engineers have to conduct a periodic review of methods to observe modifications brought into the installed methods by operators and supervisors and if they are beneficial, they have to be made part of standard operating procedure (SOP).

Work measurement

- **Work measurement** is the application of techniques designed to establish the time for an average worker to carry out a specified manufacturing task at a defined level of performance.
- It is concerned with the length of time it takes to complete a work task assigned to a specific job.

Time study

- Time study is a direct and continuous observation of a task, using a timekeeping device (e.g., decimal minute stopwatch, computer-assisted electronic stopwatch, and videotape camera) to record the time taken to accomplish a task and it is often used when
  - there are repetitive work cycles of short to long duration,
  - wide variety of dissimilar work is performed, or
  - process control elements constitute a part of the cycle.

Work sampling

There are several recommended steps when starting to prepare a work sampling study:

- Define the manufacturing tasks for which the standard time is to be determined.
- Define the task elements. These are the defined broken-down steps of the task that will be observed during the study. Since a worker is going to be observed, additional categories will likely be included as well, such as "idle", "waiting for work", and "absent".
- Design the study. This includes designing the forms that will be used to record the observations, determining how many observations will be required, deciding on the number of days or shifts to be included in the study, scheduling the observations, and finally determining the number of observers needed.
- Identify the observers who will do the sampling.
- Start the study. All those who are affected by the study should be informed about it.
- Make random visits to the plant and collect the observations.
- After completing the study, analyze and present the results. This is done by preparing a report that summarizes and analyzes all data and making recommendations when required.

PREDETERMINED MOTION TIME SYSTEM

- A **predetermined motion time system (PMTS)** is frequently used to set labor rates in industry by quantifying the amount of time required to perform specific tasks.
- The first such system is known as Methods-time measurement, released in 1948 and today existing in several variations, commonly known as MTM-1, MTM-2, MTM-UAS, MTM-MEK and MTM-B.
- Obsolete MTM standards include MTM-3 and MMMM (4M). The MTM-2 standard has also largely been phased out by the organization, but is still used in some commercial applications.

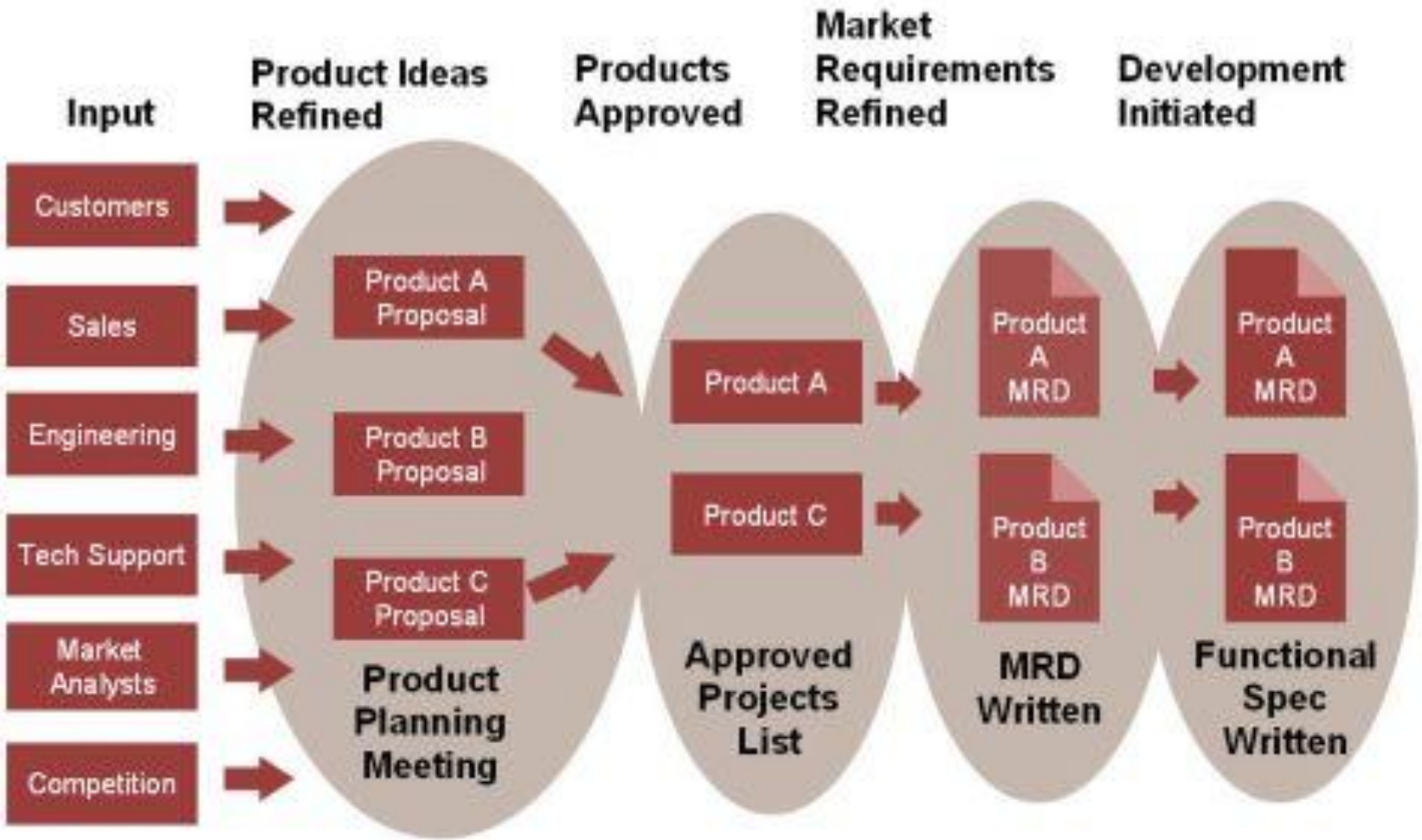
Unit-3

PRODUCTION PLANNING AND PROCESS PLANNING

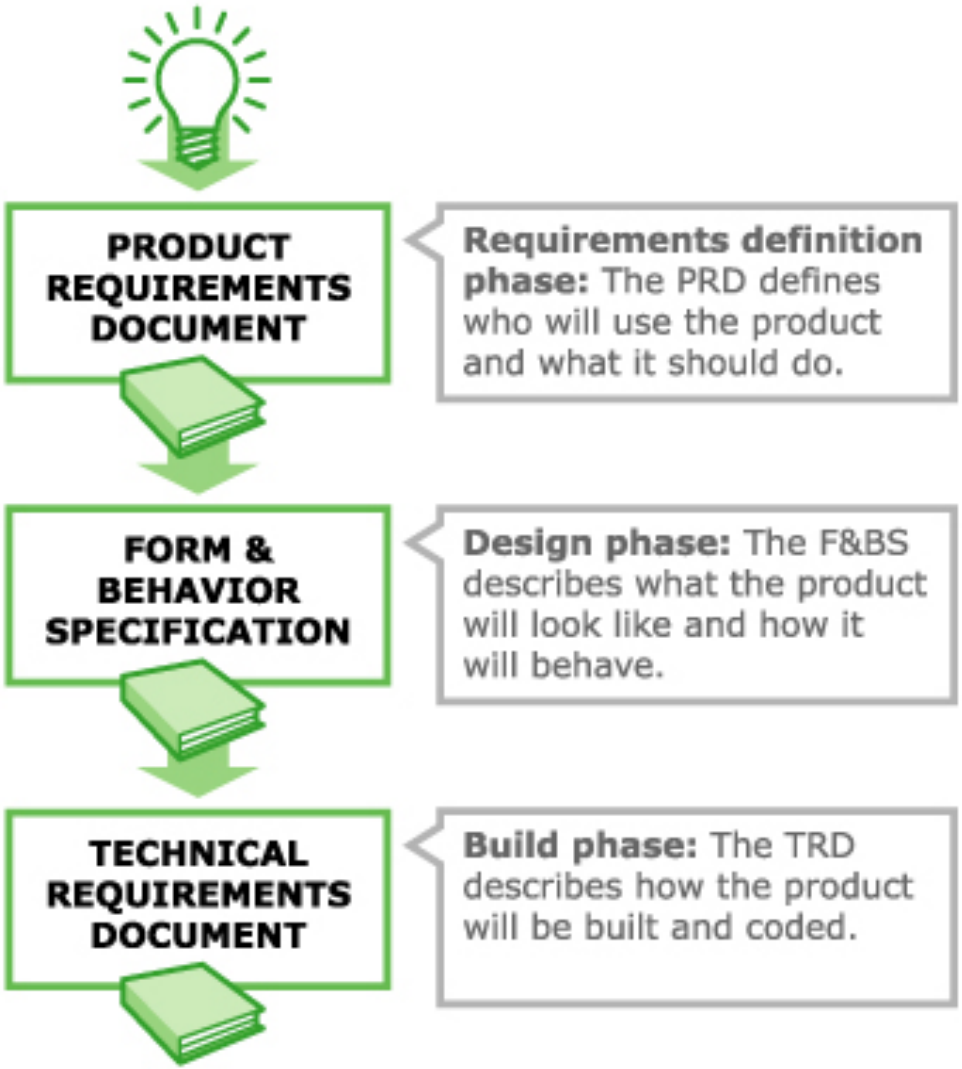
PRODUCT PLANNING

- **Product Planning** is the ongoing process of identifying and articulating market requirements that define a product's feature set.
- Product planning serves as the basis for decisions about price, distribution and promotion.

Product Planning Cycle

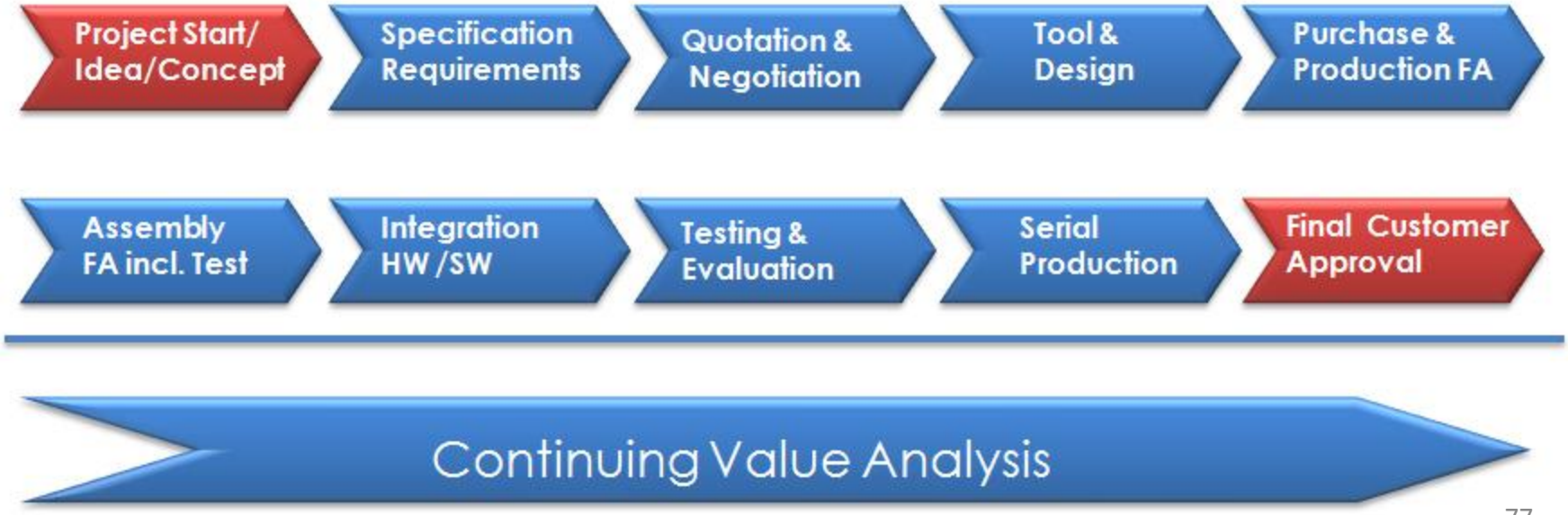


EXTENDING ORIGINAL PRODUCT INFORMATION



VALUE ANALYSIS

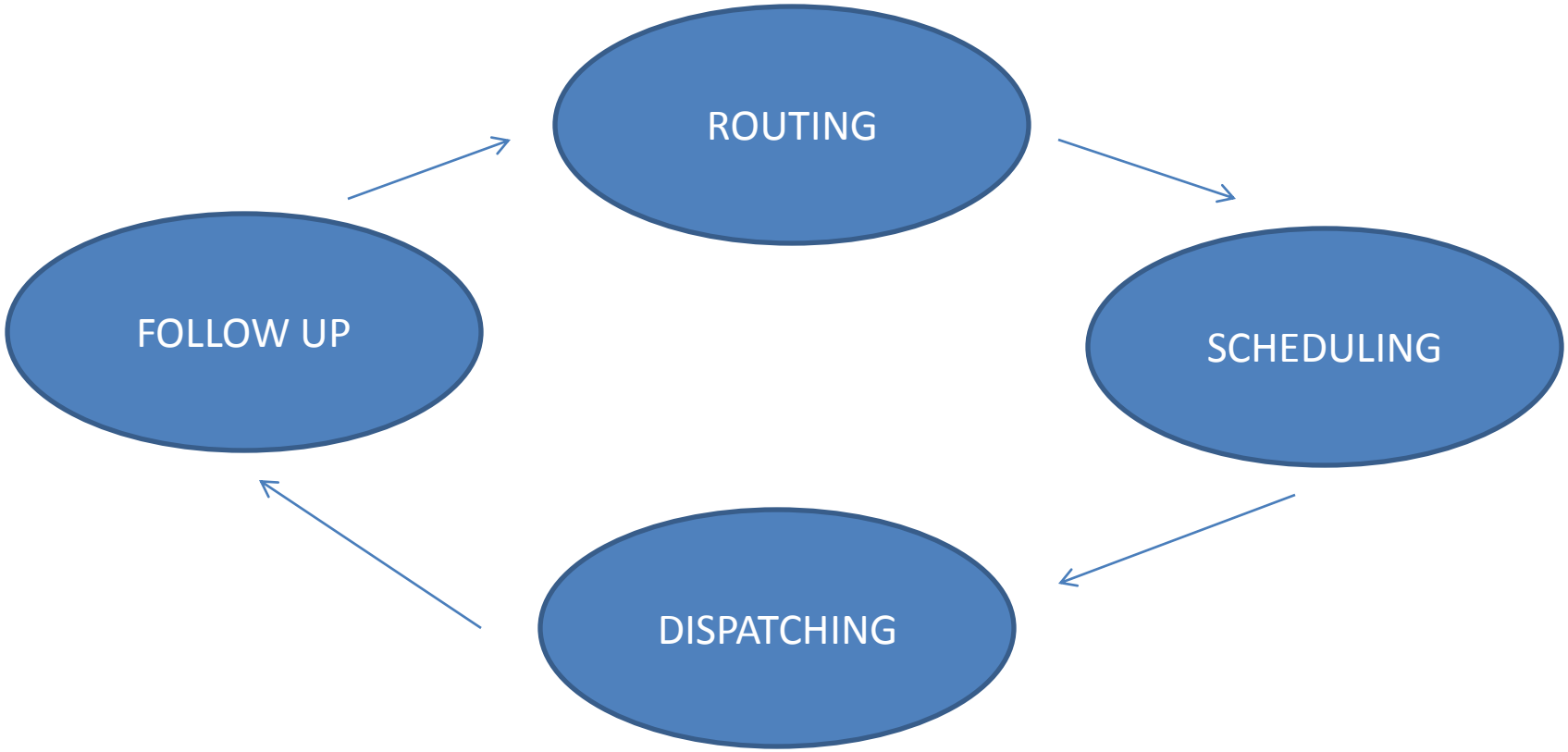
- Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost



LACK OF PRODUCT PLANNING

- Unsatisfied customer
- Durability deteriaration
- Lack of quality
- Loss of brand name., Etc

PROCESS PLANNING

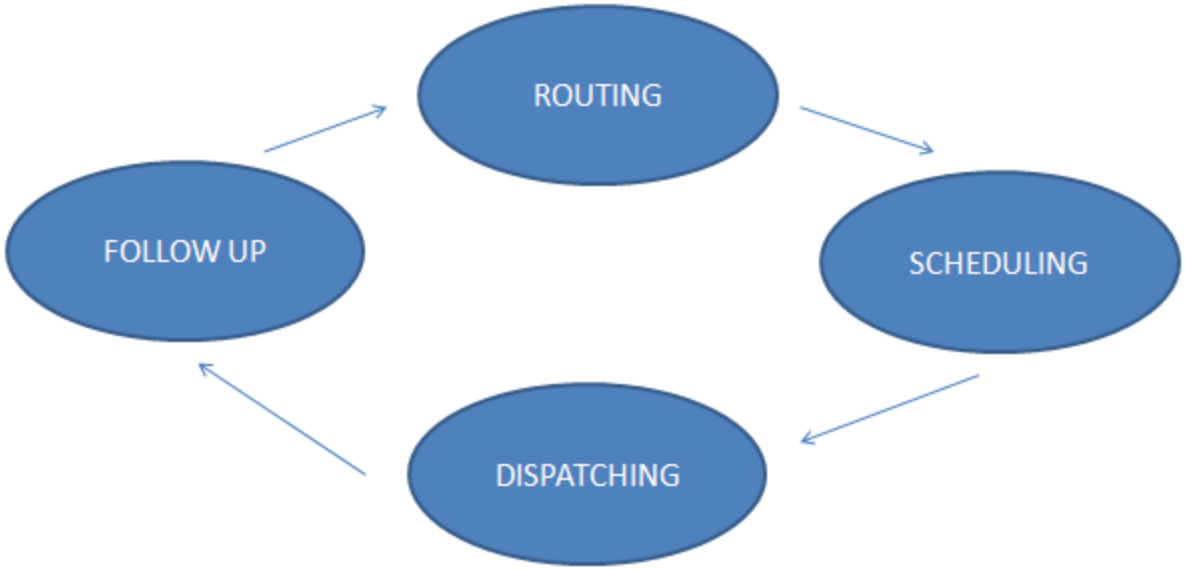


PROCESS PLANNING – INPUT INFO.

- PRODUCT
- PROCESS
- CAPACITY
- ORDERS
- DUE DATES
- RESOURCES
- ETC.,

STEPS IN PROCESS PLANNING

- **Analyzing environment**
- **Establishing objectives or goals**
- **Seeking necessary Information**



QUANTITY DETERMINATION – BATCH PRODUCTION

- **Economic batch quantity** (EBQ), also called "optimal batch quantity" or economic production quantity, is a measure used to determine the quantity of units that can be produced at minimum average costs in a given batch or production run.
- Economic Production Quantity model (also known as the EPQ model) is an extension of the Economic Order Quantity model. The Economic Batch Quantity model, or production lot-size model, is similar to the EOQ model in that an optimum is to be calculated for the batch quantity to be produced.

EBQ

In working with this EBQ model, principal assumptions are:

- The demand (D) is known and constant within a certain period of time
- The unit cost of the inventory item (U) is constant
- The annual holding-cost per unit (Ch) is constant
- The setup-cost per batch (C) is constant
- The production time (tp) is known and constant
- there is one kind of product
- There is no interaction with other products
- The aspect of time does not play a role, just the setup time does
- The setup cost is constant and does not act upon the batch quantity.

Variables

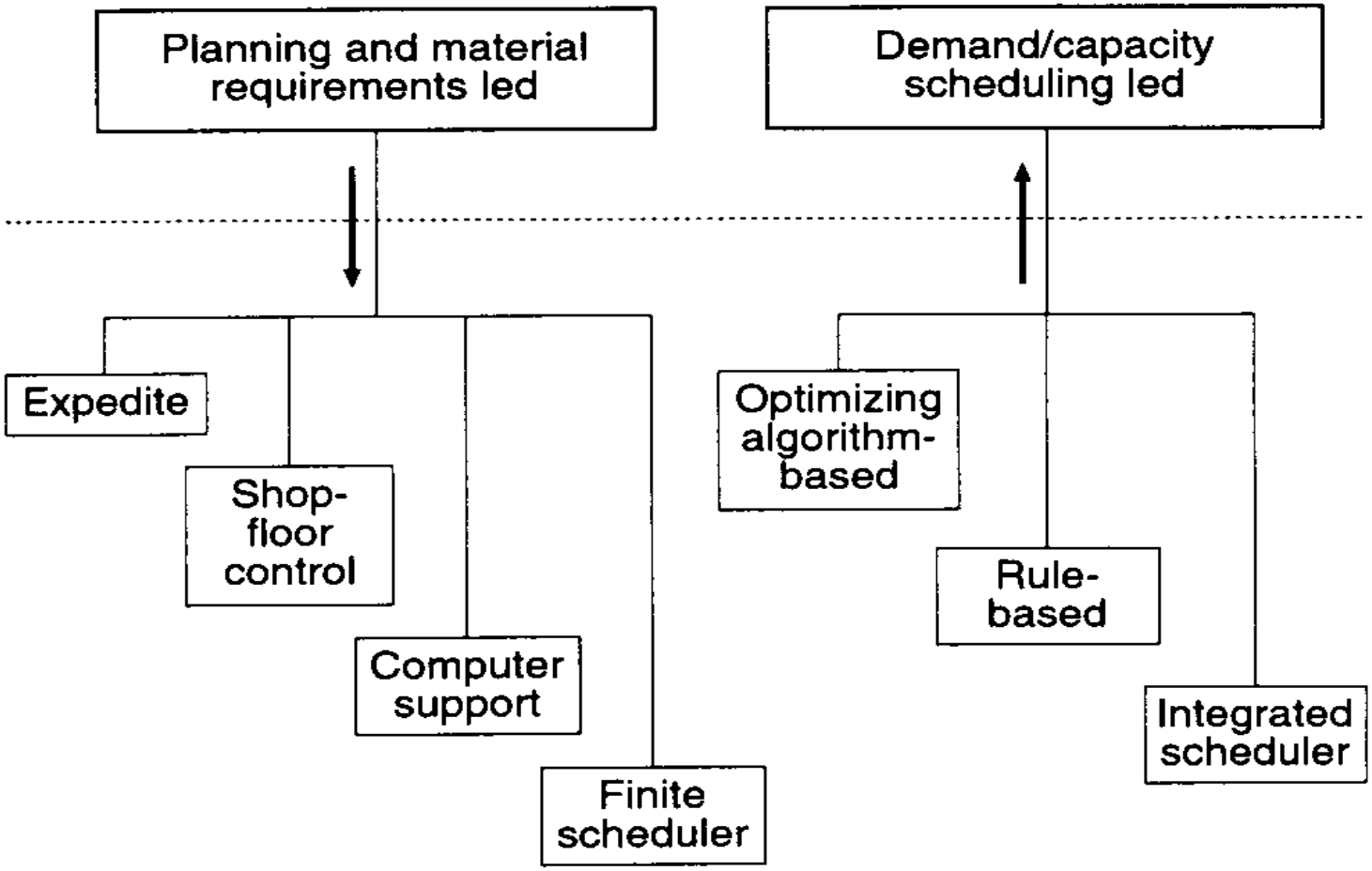
- K = setup cost
- D = demand rate
- F = holding cost
- T = cycle length
- P = production rate

Formula: Sqrt(2x annual demandx setup costs)/(inventory carrying cost per unit)

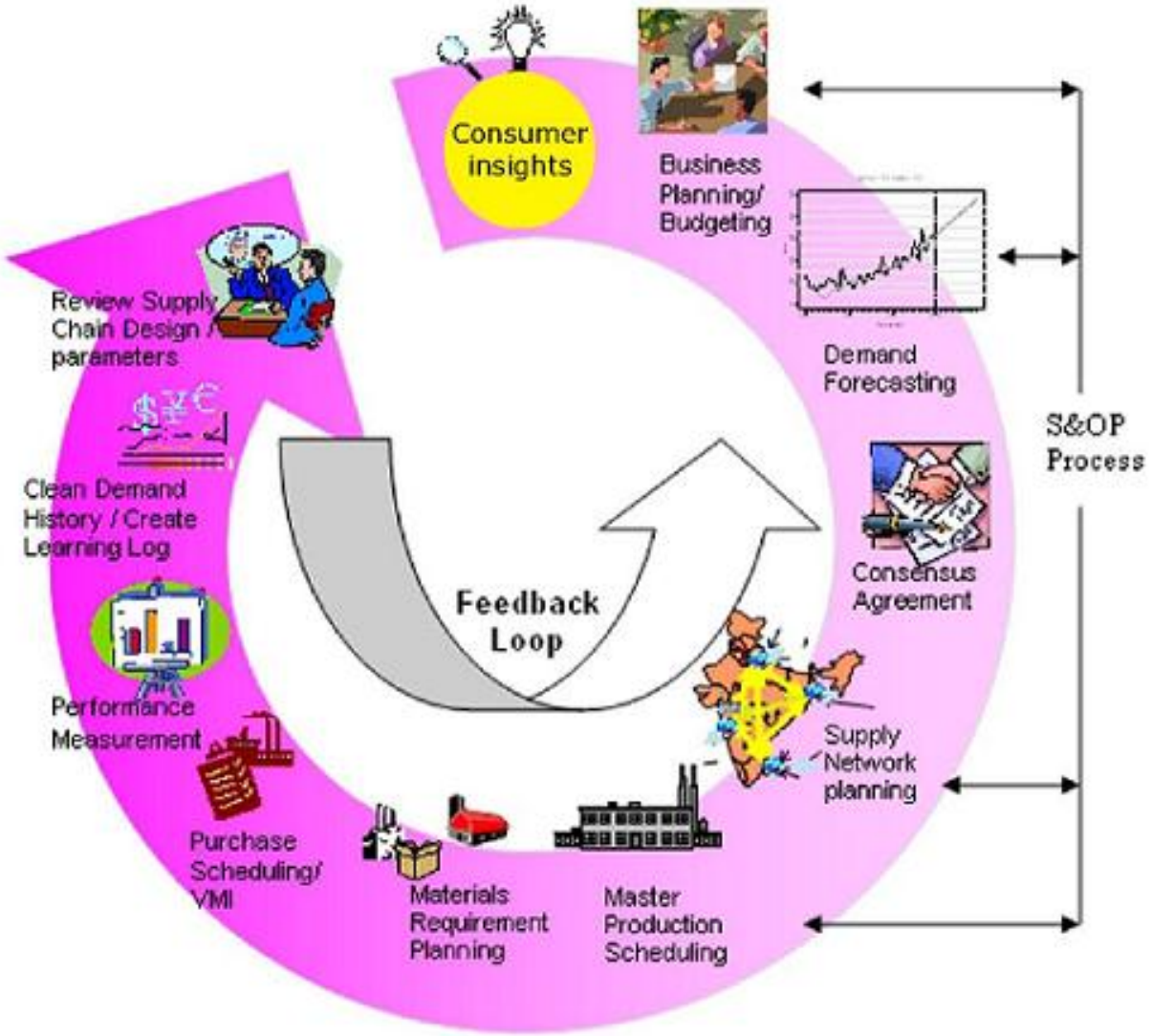
Unit-4

PRODUCTION SCHEDULING

PRODUCTION CONTROL



LOADING AND SCHEDULING



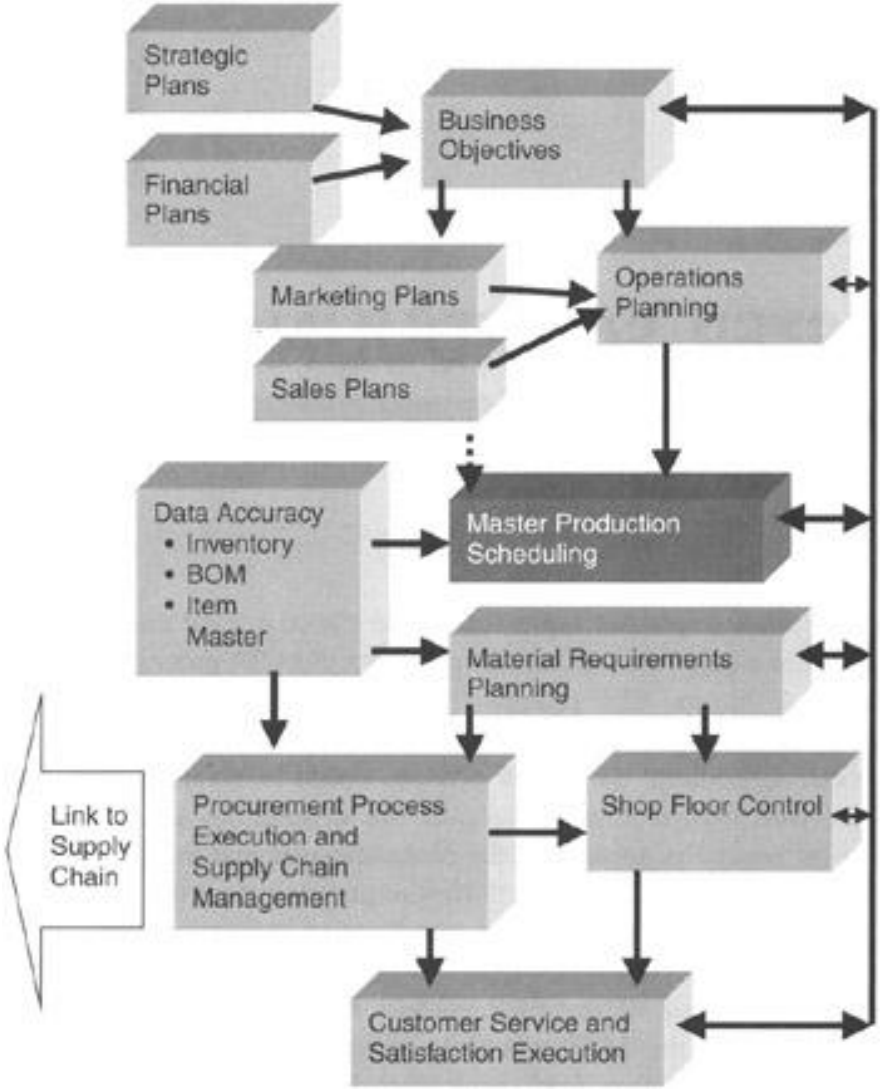
LOADING

- Once the route has been established, the work required can be loaded against the selected machine or workstation.
- The total time required to perform the operation is computed by multiplying the unit operation times given on the standard process sheet by the number of parts to be processed.
- This total time is then added to the work already planned for the workstation.
- This is the function of loading, and it results in a tabulated list or chart showing the planned utilization of the machines or workstations in the plant

SCHEDULING

- Scheduling is the last of the planning functions.
- It determines when an operation is to be performed, or when work is to be completed; the difference lies in the detail of the scheduling procedure.
- In a centralized control situation - where all process planning, loading, and scheduling for the plant are done in a central office- the details of the schedule may specify the starting and finishing time for an operation.
- On the other hand, the central schedule may simply give a completion time for the work in a given department.

MASTER SCHEDULING

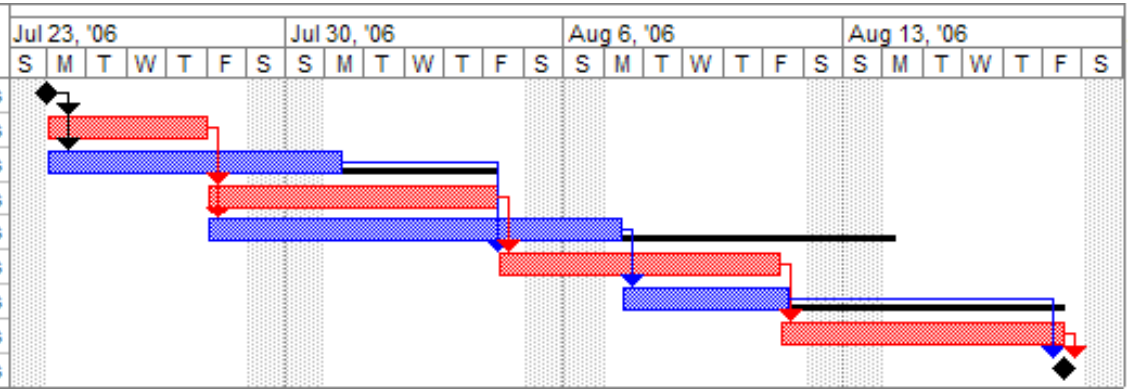


SCHEDULING -BENEFITS

- Inventory reduction,
- Process change-over reduction
- leveling
- Reduced scheduling effort
- Increased production efficiency
- Labor load leveling
- Accurate delivery date quotes
- Real time information

GANTT CHART

ID	Task Name	Predecessors	Duration
1	Start		0 days
2	a	1	4 days
3	b	1	5.33 days
4	c	2	5.17 days
5	d	2	6.33 days
6	e	3,4	5.17 days
7	f	5	4.5 days
8	g	6	5.17 days
9	Finish	7,8	0 days



•A **Gantt chart** is a type of bar chart, developed by Henry Gantt, that illustrates a project schedule.

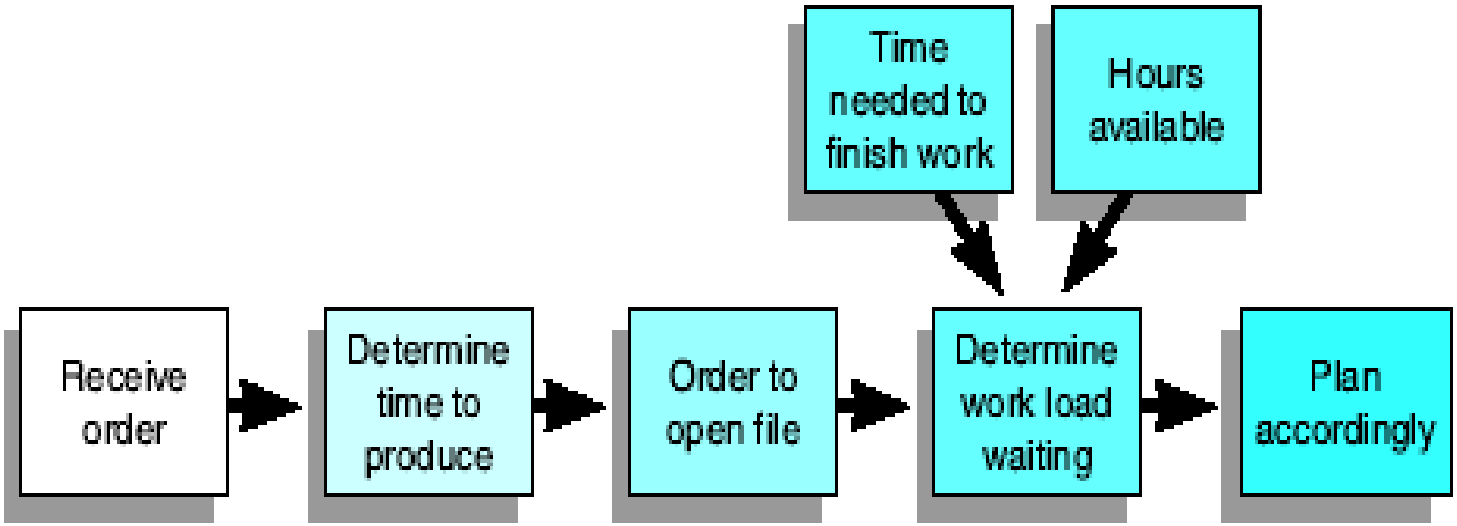
• Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project. Terminal elements and summary elements comprise the work breakdown structure of the project.

•Some Gantt charts also show the dependency (i.e., precedence network) relationships between activities.

Production Control

- Perpetual loading
  - Tabulation of the time necessary to finish unfulfilled orders and determine how long it will take to finish this work.

Perpetual loading



LINE OF BALANCE

- Find a feasible defined replacement for all undefined (‘ANY’) ergonomic constraints on workstations, i.e. one compatible with the ergonomic constraints and precedence constraints defined on operations, as well as zoning constraints and possible drifting operations
- Solve the within-workstation scheduling problem on all workstations, for all products being assembled on the line
- Assign the operations to workstations to achieve the best average balance, while keeping the peak times at a manageable level.

Linear Scheduling Method

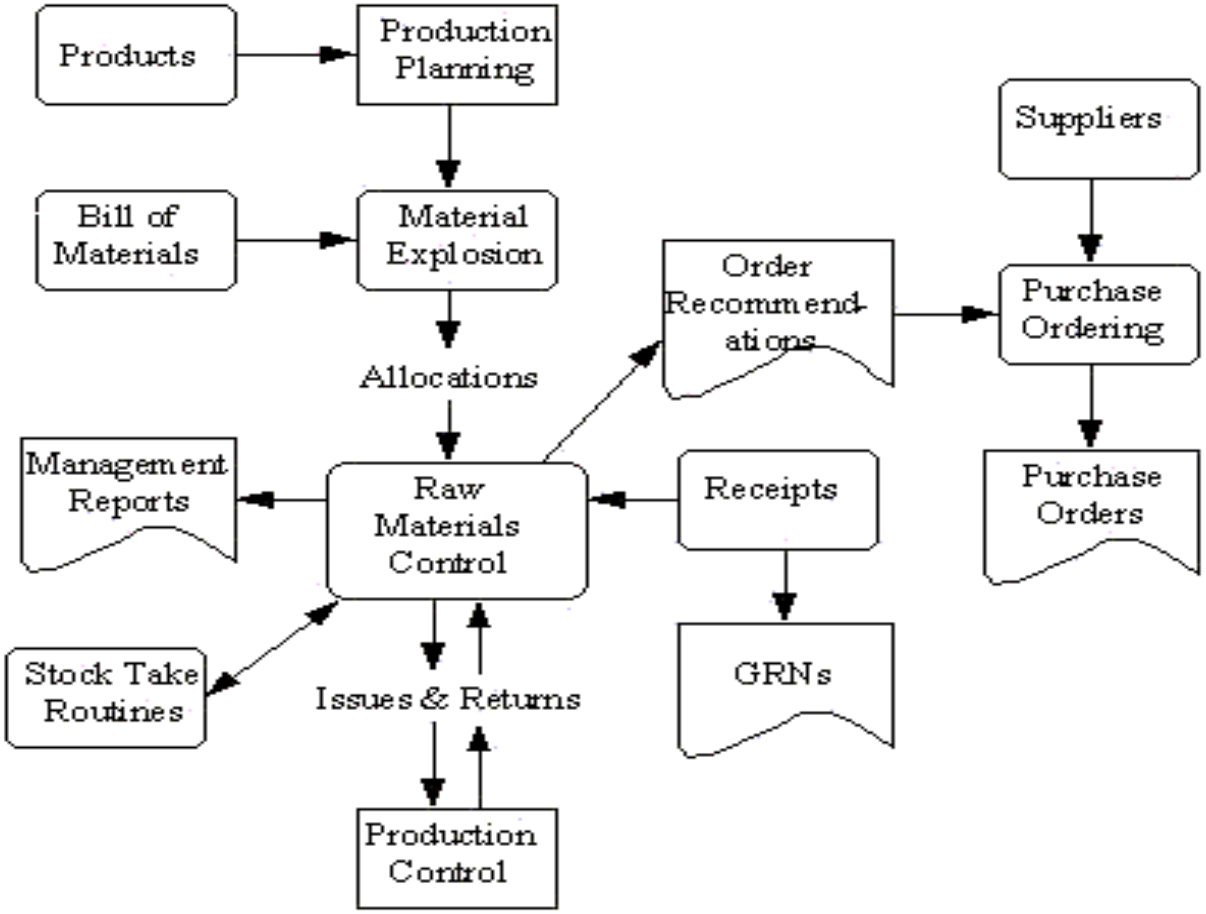
- **Linear Scheduling Method** (LSM) is a graphical scheduling method focusing on continuous resource utilization in repetitive activities. It is believed that it originally adopted the idea of Line-Of-Balance method.
- The main advantages of LSM over Critical Path Method (CPM) is its underlying idea of keeping resources continuously at work. In other words, it schedules activities in such a way that:

1. resource utilization is maximized;
2. interruption in on-going process is minimized, including hiring-and-firing; and
3. the effect of the learning curve phenomenon is minimized

BATCH PRODUCTION SCHEDULING

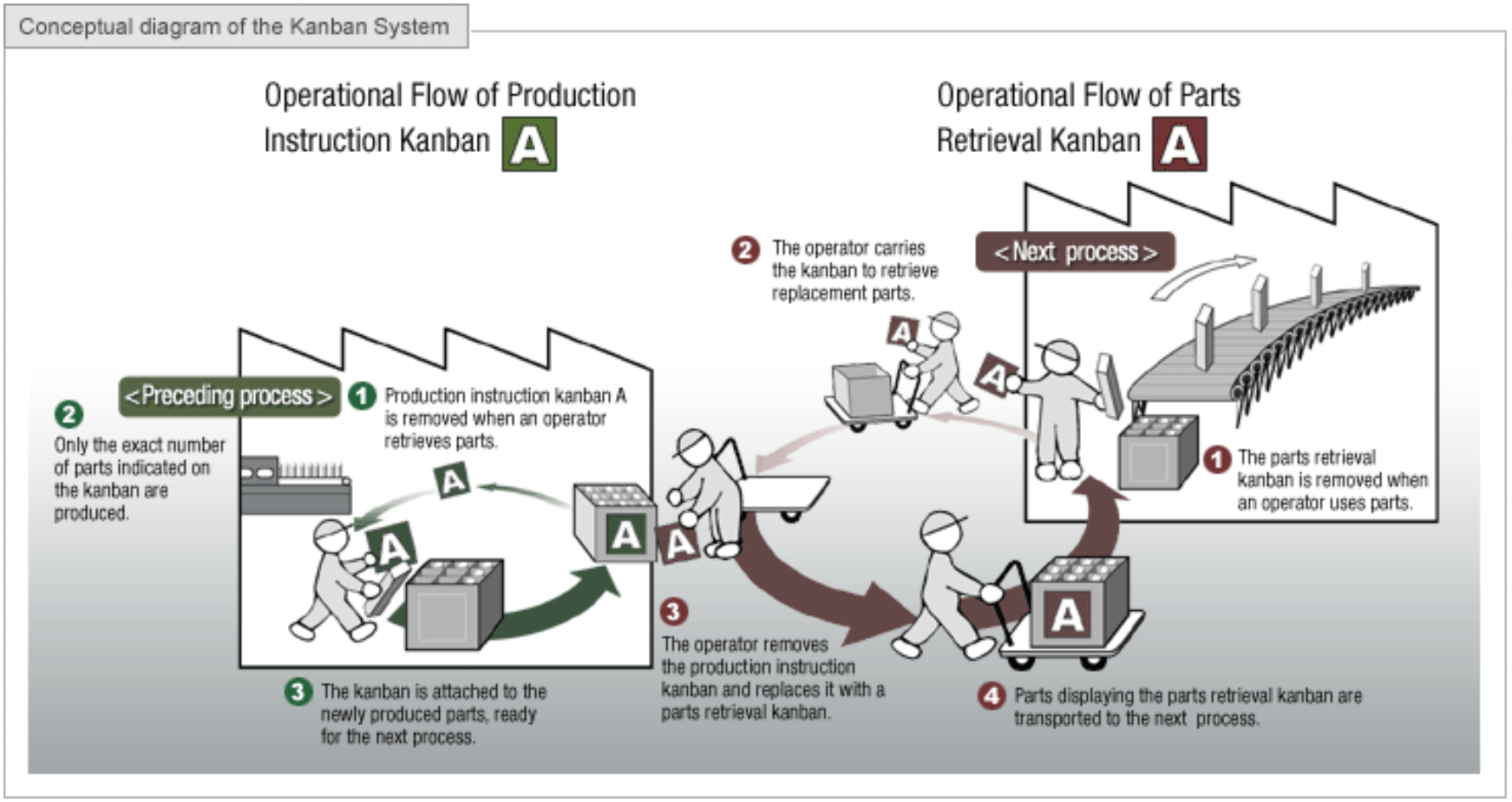
- Batch production scheduling is the practice of planning and scheduling of batch manufacturing processes.
- Although, scheduling may apply to traditionally continuous processes, such as refining, it is especially important for batch processes such as those for pharmaceutical active ingredients, biotechnology processes and many specialty chemical processes.
- Batch production scheduling shares some concepts and techniques with finite capacity scheduling which has been applied to many manufacturing problems.
- The specific issues of scheduling batch manufacturing processes have generated considerable industrial and academic interest

MRP



MATERIAL REQUIREMENTS PLANNING

KANBAN


Conceptual diagram of the Kanban System
Operational Flow of Production
Instruction Kanban A
Operational Flow of Parts
Retrieval Kanban A
<Preceding process>
<Next process>
2 Only the exact number of parts indicated on the kanban are produced.
1 Production instruction kanban A is removed when an operator retrieves parts.
2 The operator carries the kanban to retrieve replacement parts.
1 The parts retrieval kanban is removed when an operator uses parts.
3 The kanban is attached to the newly produced parts, ready for the next process.
3 The operator removes the production instruction kanban and replaces it with a parts retrieval kanban.
4 Parts displaying the parts retrieval kanban are transported to the next process.

DISPATCHING

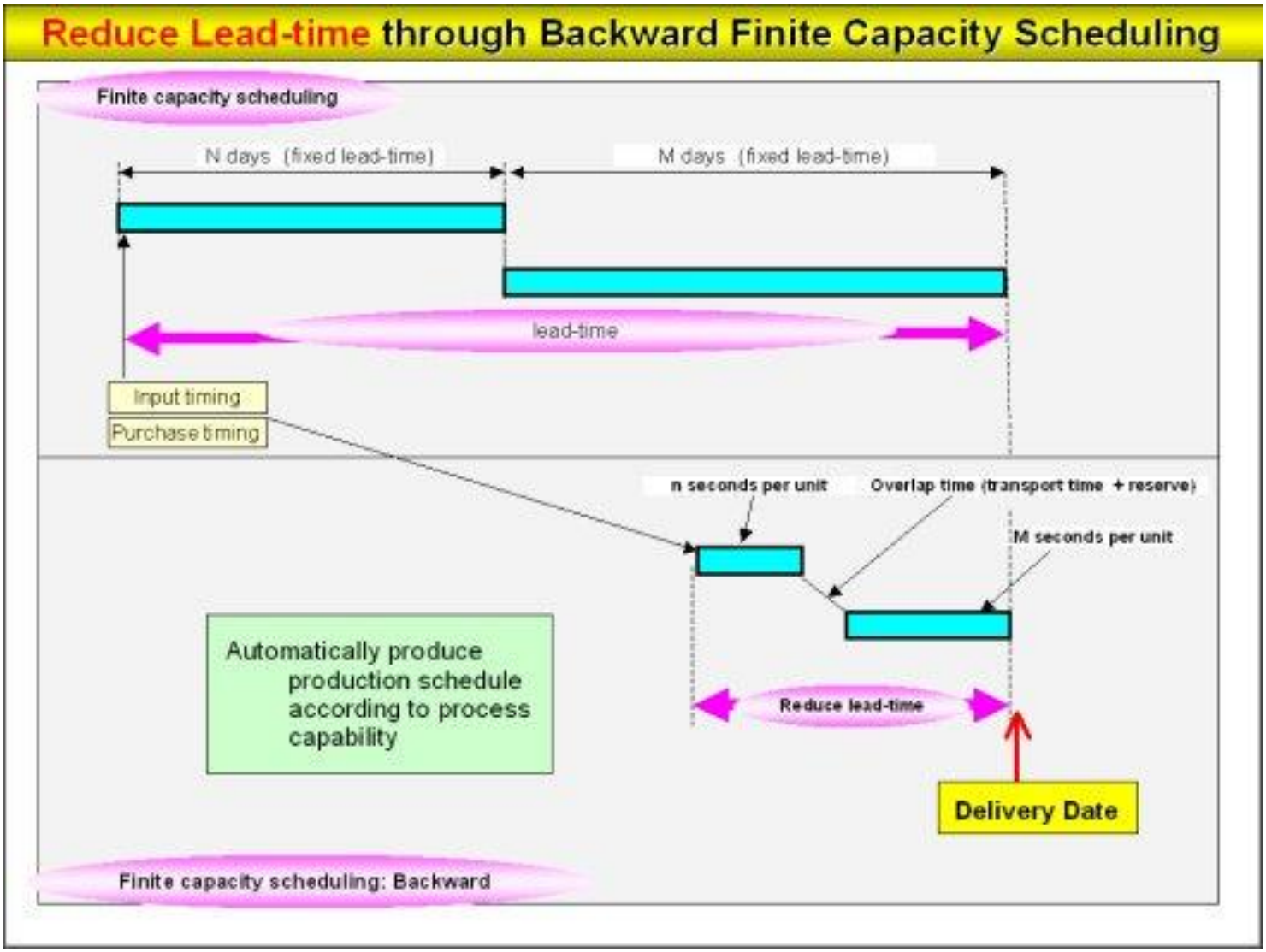
DISPATCHING

- Authorizing the start of an operation on the shop floor is the function of dispatching.
- This function may be centralized or decentralized.
- The departmental dispatcher would authorize the start of each of the machine operations – the dispatch actions are based on the foreman's routing and scheduling of the work through his department. This is decentralized dispatching.

PROGRESS REPORTING AND EXPEDITING

- The manufacturing activity of a plant is said to be “in control” when the actual performance is within the objectives of the planned performance.
- When jobs are started and completed on schedule, there should be very little, if any, concern about the meeting of commitments.
- Optimum operation of the plant, however, is attained only if the original plan has been carefully prepared to utilize the manufacturing facilities fully and effectively.

Mfg. lead time



Mfg. lead time

Inventory control

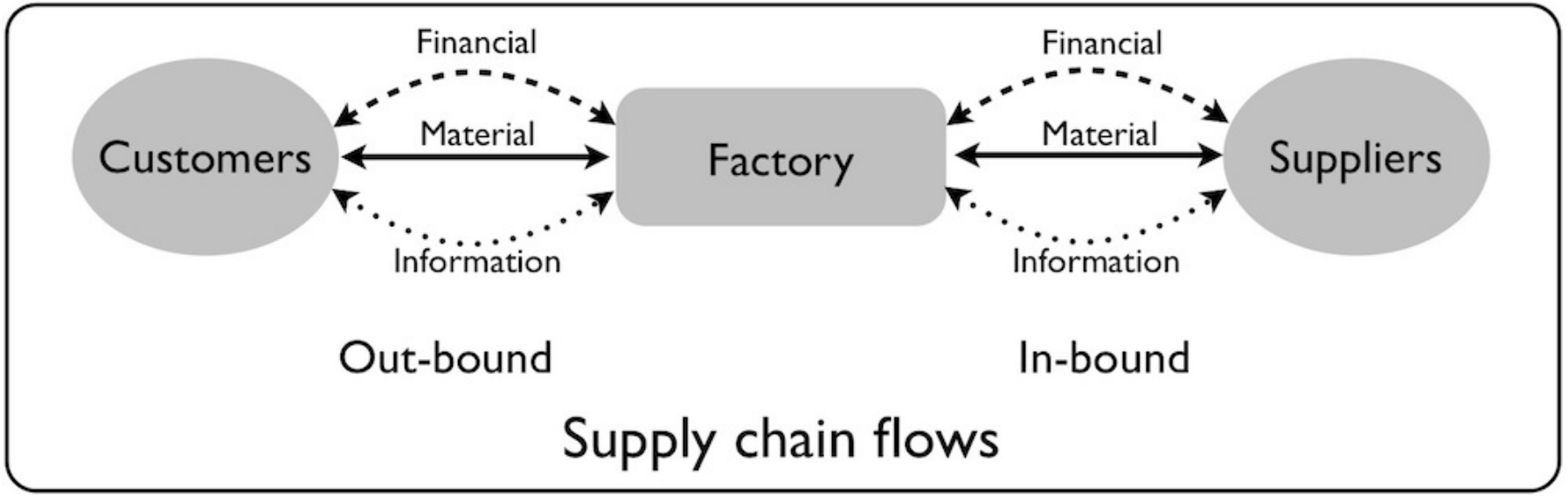
- **Inventory Control** is the supervision of supply, storage and accessibility of items in order to ensure an adequate supply without excessive oversupply.
- It can also be referred as internal control - an accounting procedure or system designed to promote efficiency or assure the implementation of a policy or safeguard assets or avoid fraud and error etc.
- **Inventory control** may refer to:
  - In economics, the inventory control problem, which aims to reduce overhead cost without hurting sales
  - In the field of loss prevention, systems designed to introduce technical barriers to shoplifting
  - It answers the 3 basic questions of any supply chain:

1. When?
2. Where?
3. How much?

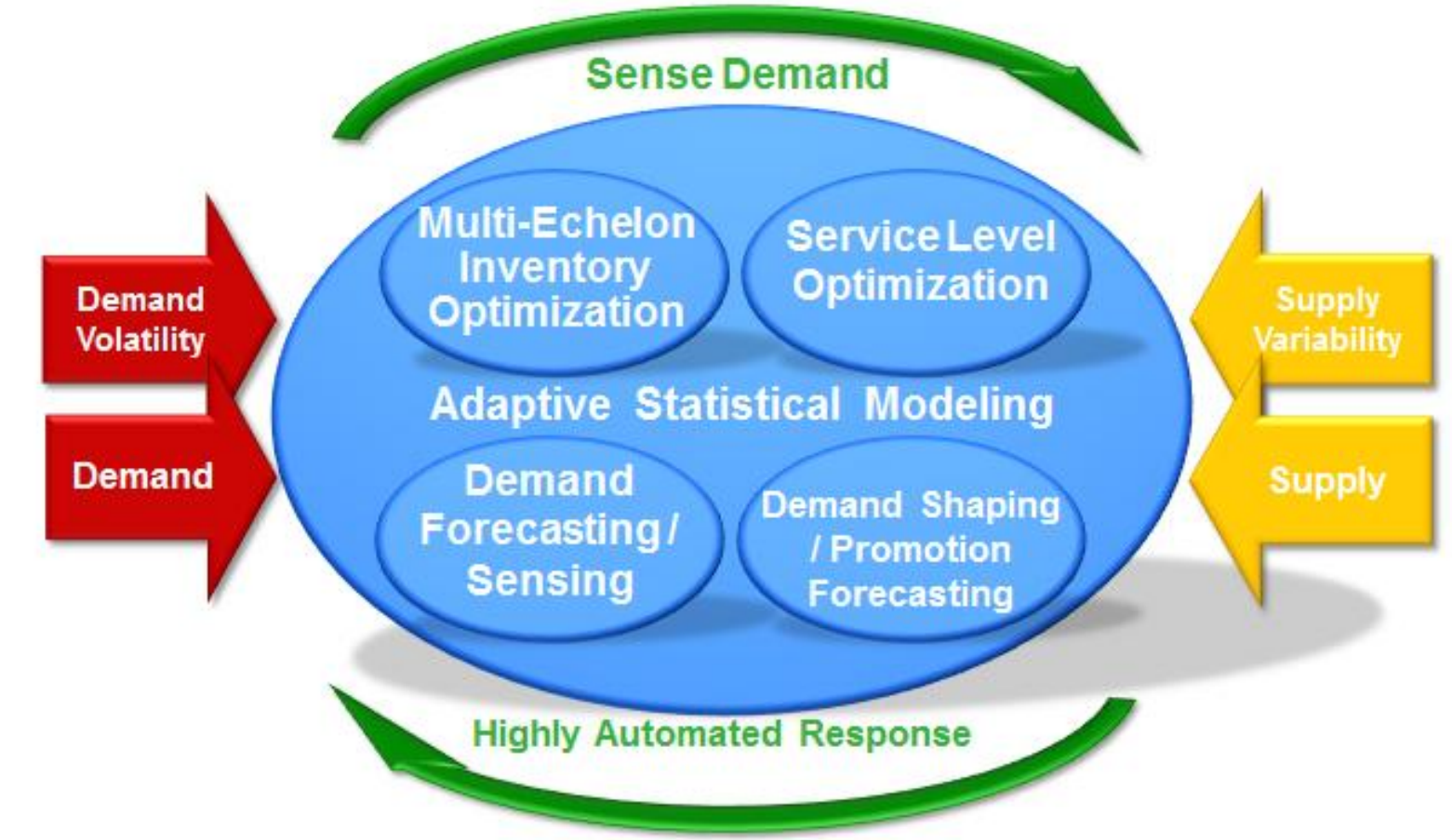
Purpose of holding stock

- Safety stock is the amount of inventory a business carries over and above their calculations for actual need. ie, a packaging company maintains enough plastic to manufacture packaging ordered by customers in the amount needed until their next shipment of plastic arrives.
- But, because orders vary and shipping times vary, the company decides to keep 5% more on hand than likely to be needed. This extra 5% is safety stock.

Effect of demand of inventories

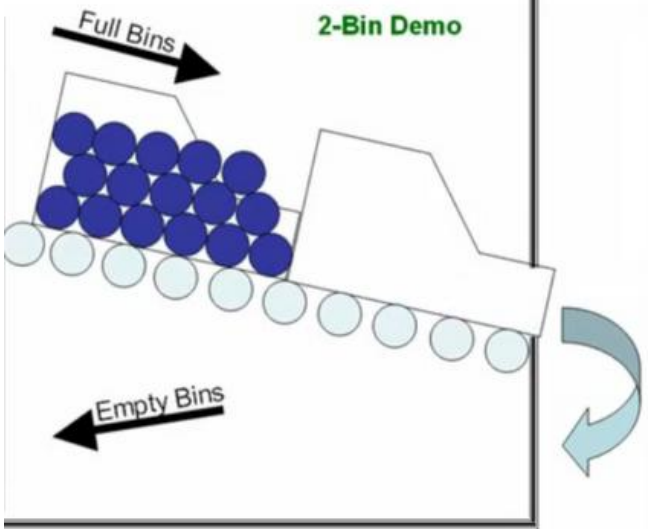


Robust method for reducing demand inventory variation

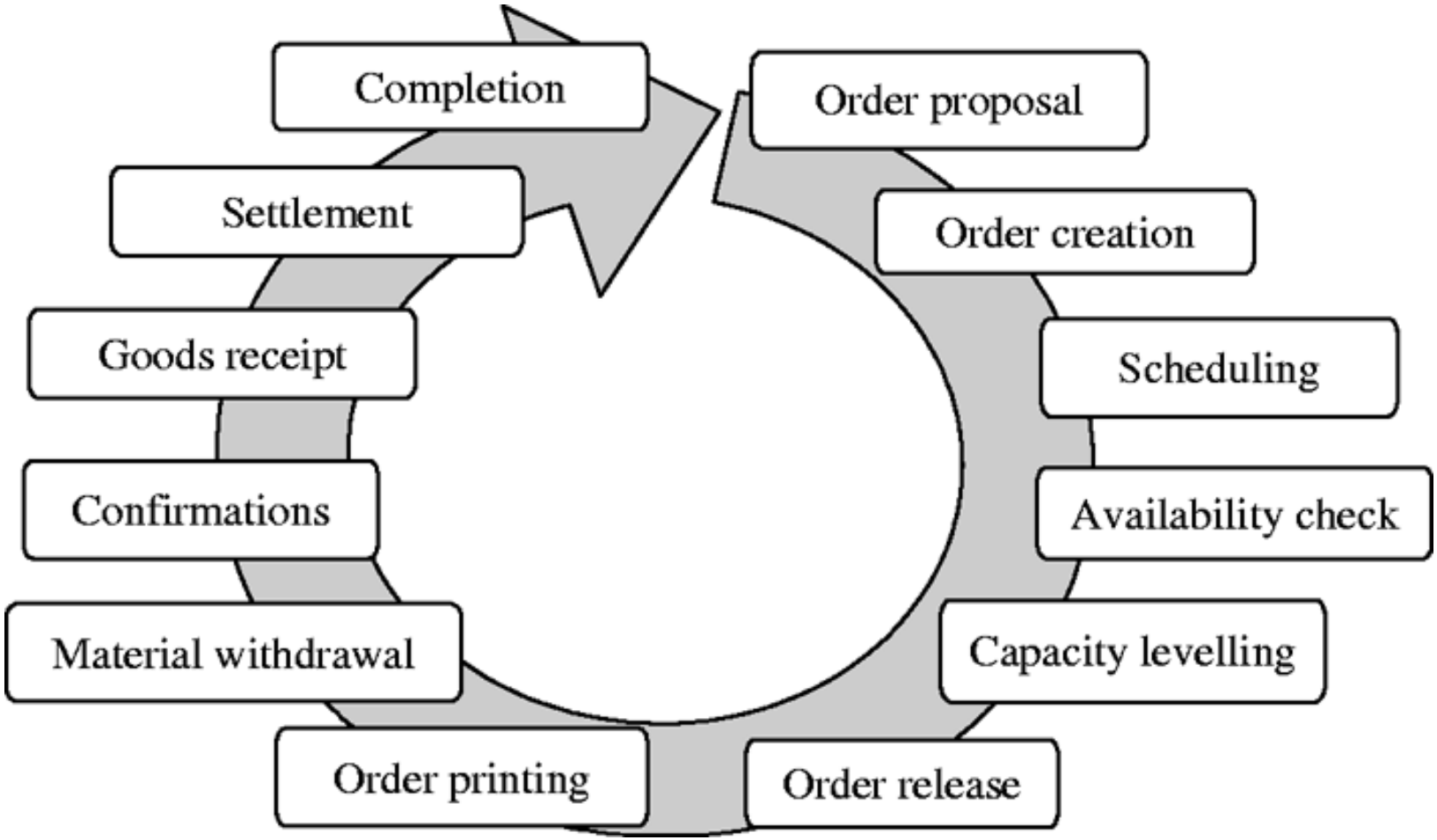


Two bin system

- Two bin system is used for the material control.
- It is that technique of material control in which we have two bins, one is used for in use minimum stock and second bin is used for reserve stock or to keep the remaining quantity of material.
- This system of inventory control is also called in USA kanban.
- First bin is utilized for issuing the material for production and then, second bin is used. Its record is done on bin cards and store ledger card.

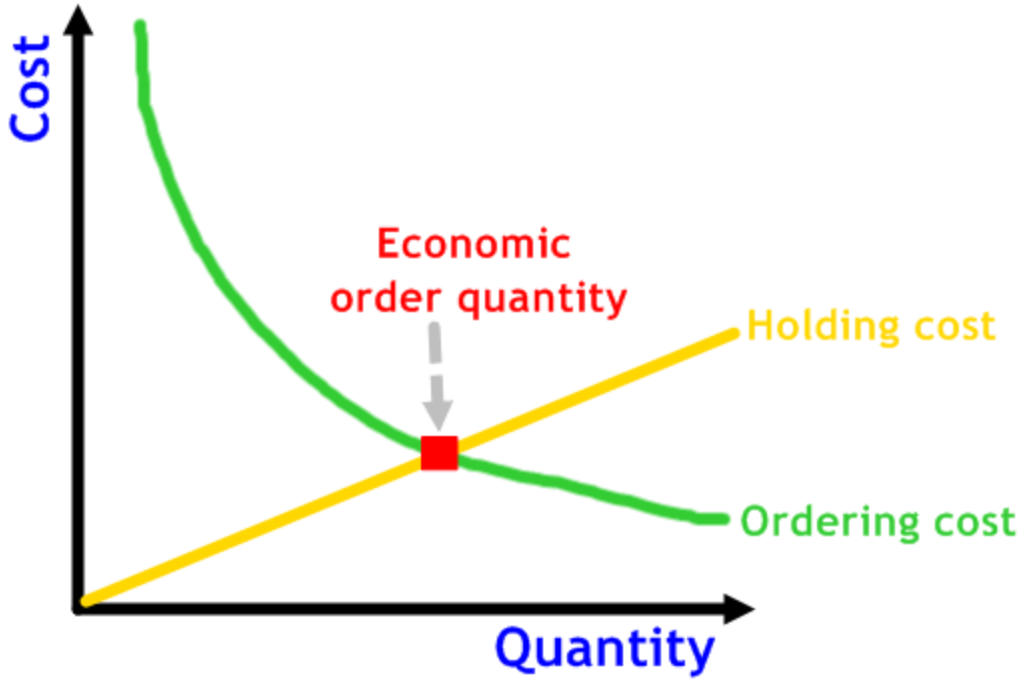


Order cycle

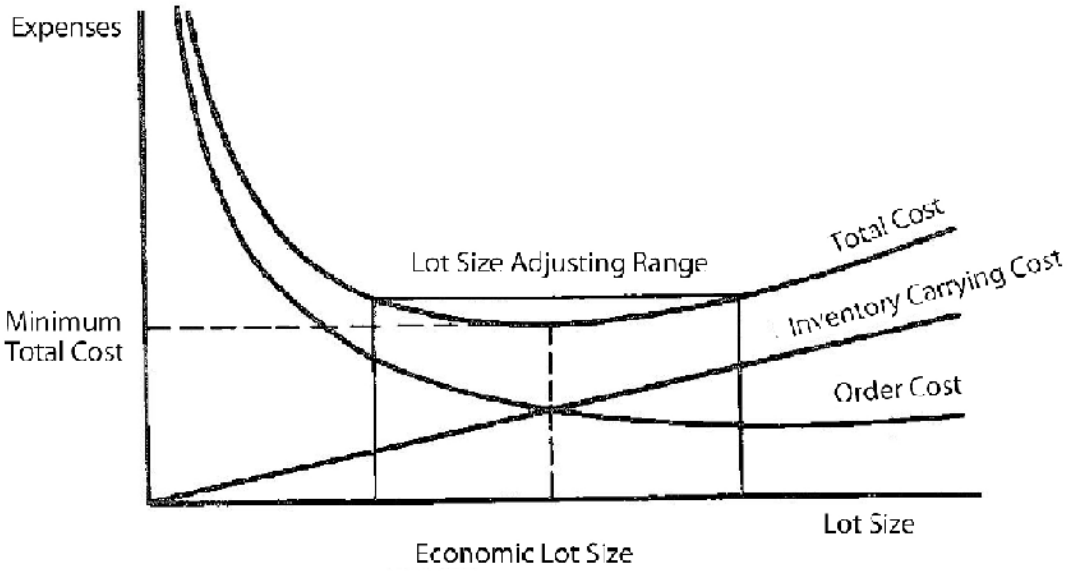

Completion
Order proposal
Settlement
Order creation
Goods receipt
Scheduling
Confirmations
Availability check
Material withdrawal
Capacity levelling
Order printing
Order release

EOQ

- **<u>Economic order quantity</u>** (**EOQ**) is the classical inventory model for stock held on cycle with assumptions of **known demand and production lead time**. The objective is to select an order quantity that minimizes the marginal annual costs for **holding inventory** and **placing orders**.



Economic Lot Size



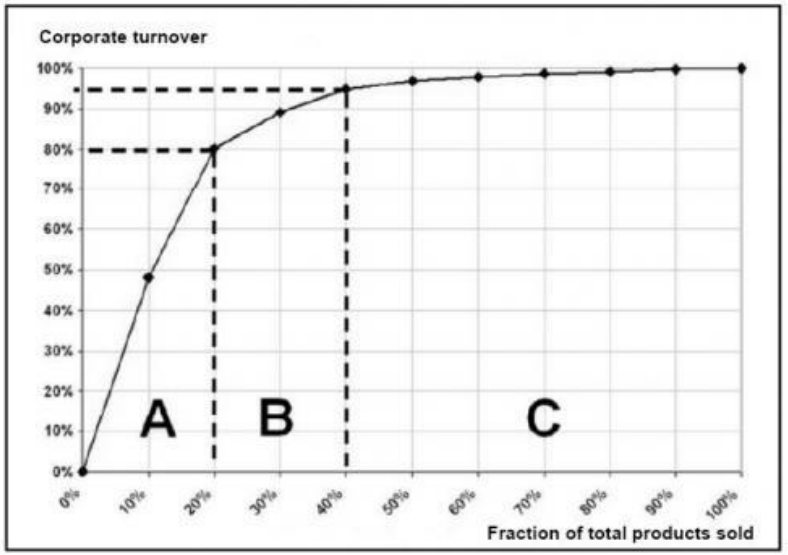
$$\text{Economic Lot Size} = \sqrt{\frac{2 \times \text{Forecast Annual Usage} \times \text{Order Cost per (Note 1)}}{\text{Annual Inventory Carrying Cost Rate (Note 2)} \times \text{Unit Cost}}}$$

(Note 1)
As for manufactured items, it means e.g. each cost of preparation/setup, and the loss of materials.

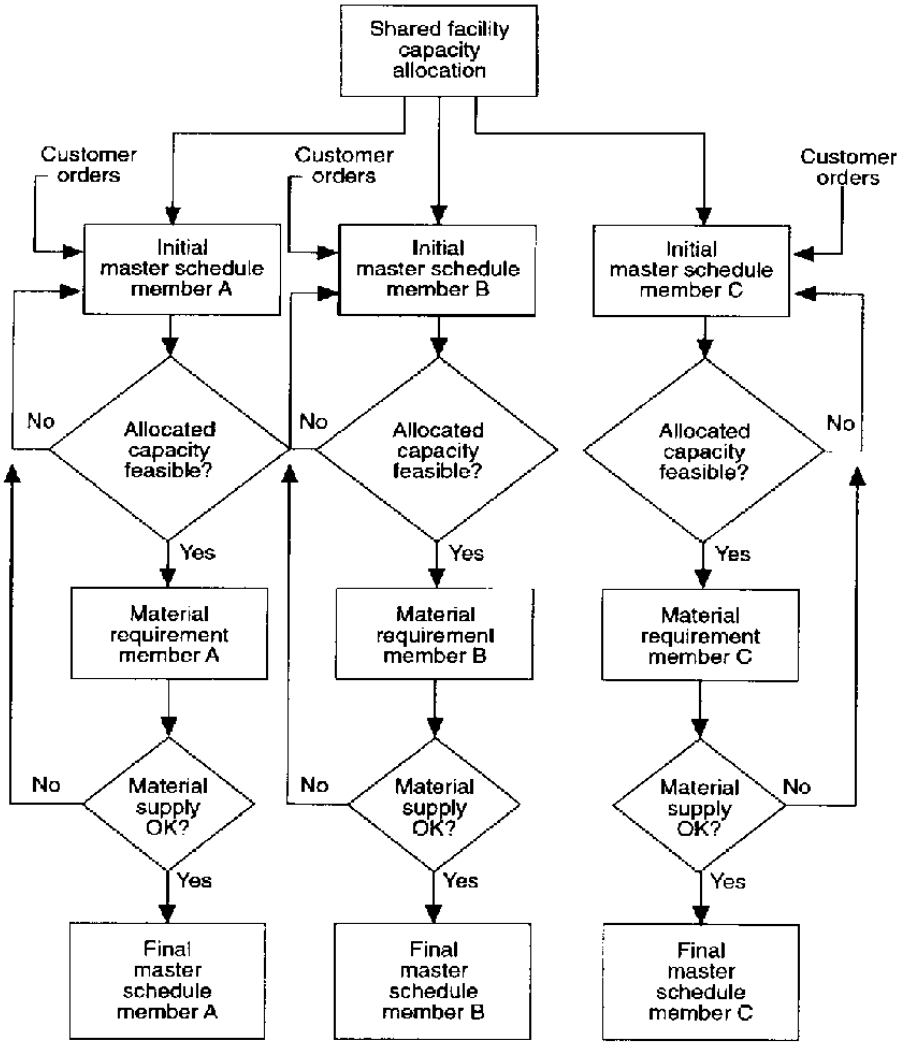
(Note 2)
It usually 20 to 30 %: 13 to 20 % for interest, 5 to 8 % for obsolescence, 1 to 3 % for storage cost, and others.

ABC analysis

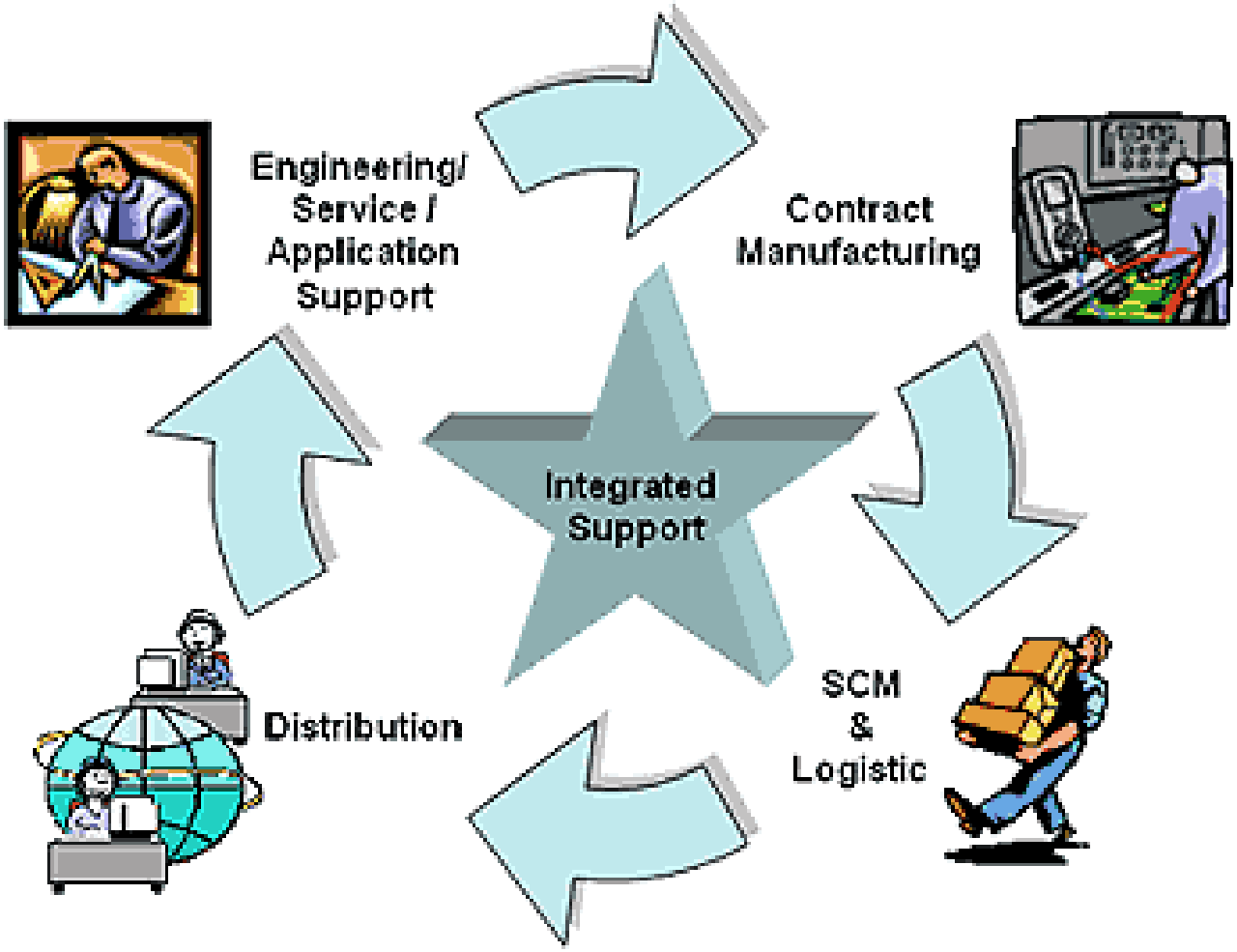
- The **ABC analysis** is a business term used to define an inventory categorization technique often used in materials management. It is also known as *Selective Inventory Control*. Policies based on ABC analysis:
- A ITEMS: very tight control and accurate records
- B ITEMS: LESS TIGHTLY CONTROLLED and good records
- C ITEMS: simplest controls possible and minimal records



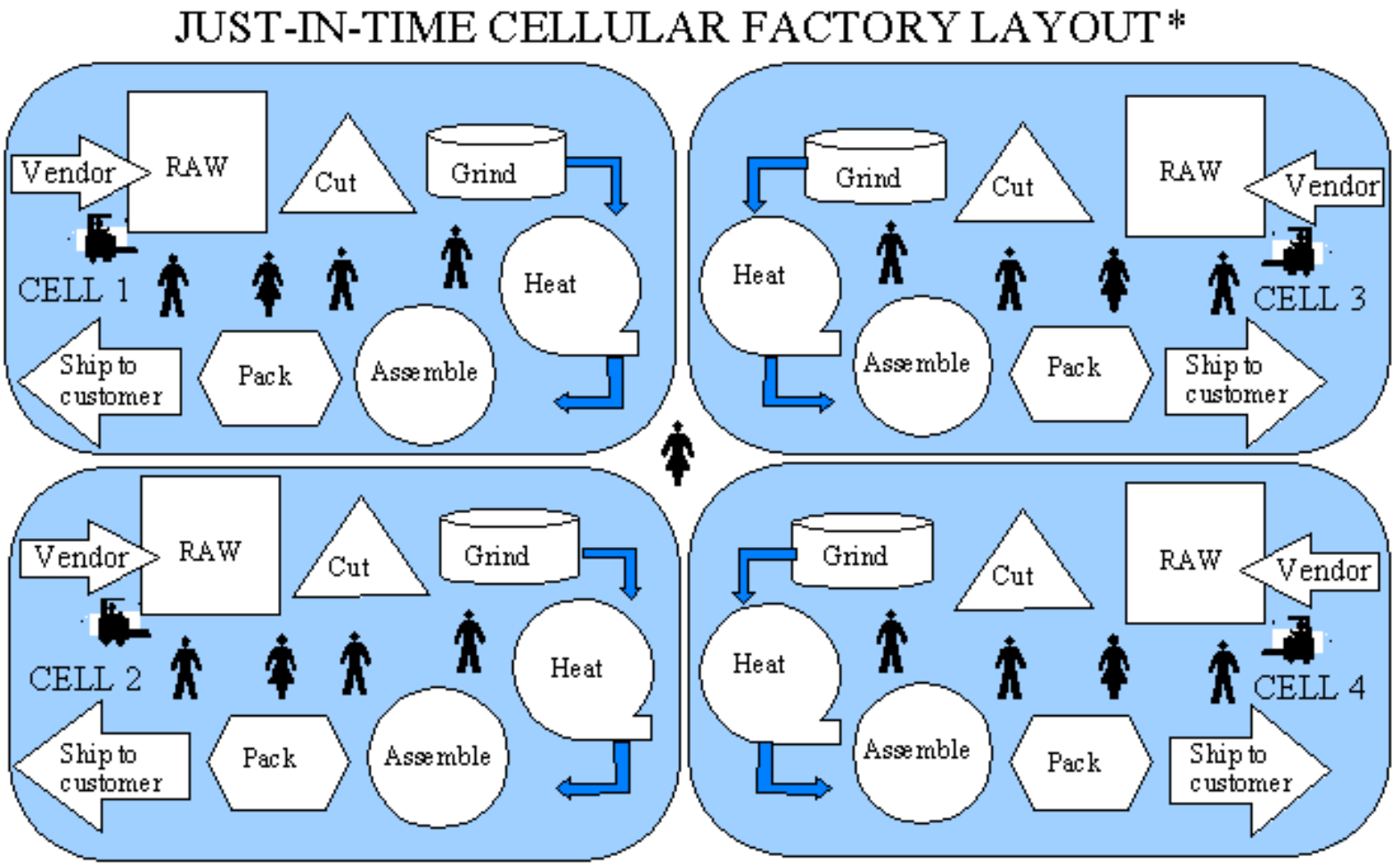
Computer integrated production planning



JIT manufacturing



JIT manufacturing



*Factory reorganized into four cells with various machines arranged in sequential order. Fewer workers, supervisors and forklift trucks. Much less work in process and no finished goods inventory.

ERP-Enterprise resource planning

MRP-II

- **Manufacturing resource planning** (**MRP II**) is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning, and has a simulation capability to answer "what-if" questions and extension of closed-loop MRP.