SRI CHANDRASEKHARENDRA SARASWATHI VISWA MAHAVIDYALAYA
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ONLINE COURSE

DEPARTMENT OF MANAGEMENT STUDIES

Production Planning and Control

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UNIT-I:

PRODUCTION PLANNING AND CONTROL

What Is PPC?

- “The highest efficiency in production is obtained by manufacturing the required quality of product , of required quantity ,at the required time by the best and cheapest method” -

Hence, PPC is a tool to coordinate all manufacturing activities in a production system.

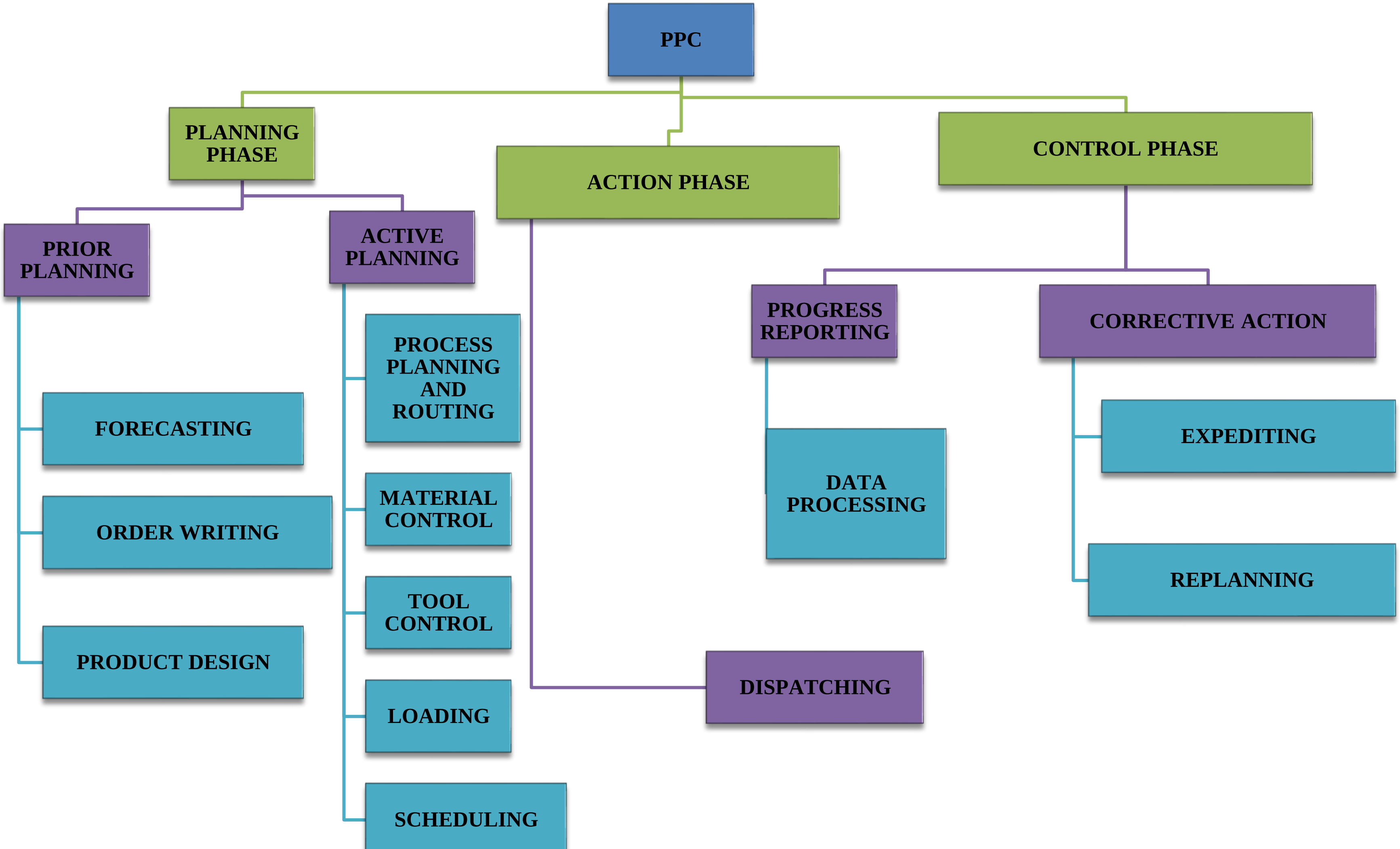
Objectives of PPC

- ✓ To deliver required goods in required quantities to the customer in the required delivery schedule to achieve maximum customer satisfaction and minimum cost
- ✓ To ensure maximum utilization of the available resources
- ✓ To ensure production of quality products
- ✓ To minimize the manufacturing time

Objectives of PPC-contd…

- To maintain optimum inventory levels
- To maintain flexibility in manufacturing operation
- To coordinate between labor and machines and various supporting documents
- To plan for plant capacities for future requirements
- To remove bottle neck at all stages of production and to solve problems related to production
- To ensure effective cost reduction and cost control

Functions of PPC



Planning Phase

Estimation of type, quality & quantity of future work

Giving authority to one or more person to undertake a particular job

Collection of information regarding speifications,BOM,drawings etc

Finding the most economical process of doing a work and deciding where and how work will be done

Involves determining the requirements and control of materials

Involves determining the requirements and control of tools used

Assignment of work to manpower, machinery etc

Determines when and in what sequence the work will be carried out. It fixes the starting as well as ending time for the job

- PRIOR PLANNING
  - FORECASTING
  - ORDER WRITING
- ACTIVE PLANNING
  - PROCESS PLANNING AND ROUTING
  - MATERIAL CONTROL
  - TOOL CONTROL
  - LOADING
  - SCHEDULING

Action Phase

It is the transition from planning to action phase. In this phase the worker is ordered to start the work

ACTION PHASE

DISPATCHING

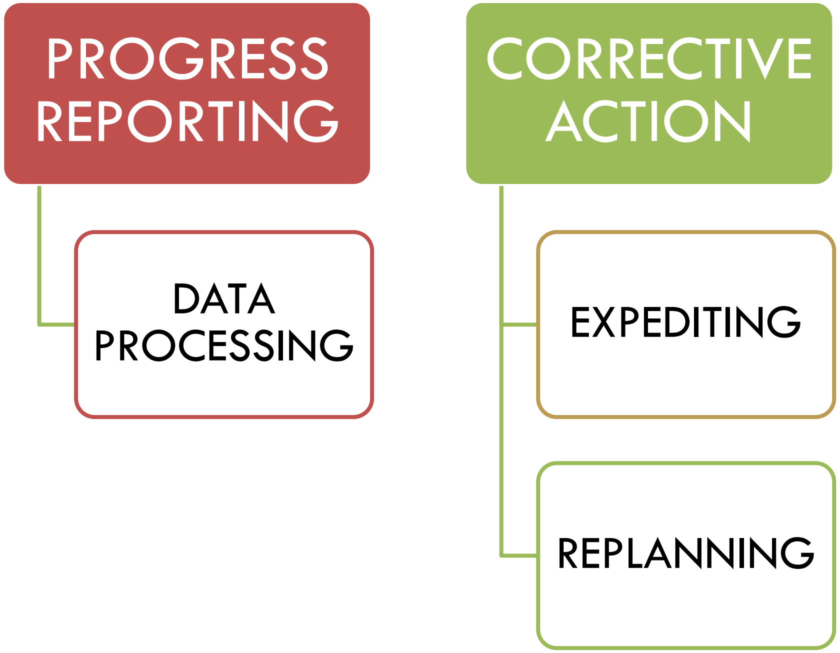
Control Phase

Data regarding the job process is collected

It is interpreted with the present level of performance

Taking action if the progress reporting indicates the deviation of the plan from the originally set targets

Re planning of the whole affair becomes essential, in case expediting fails to bring the deviated plan to its actual path



Stages/Steps in PPC

ROUTING
- Related to production planning

SEQUENCING
- Related to production planning

SCHEDULING
- Related to production control

DISPATCHING
- Related to production control

FOLLOW UP
- Related to production control

1) Routing

- Routing is the first step in production planning and control.
- Routing can be defined as the process of deciding the path (route) of work and the sequence of operations.
- In short, routing determines ‘What’, ‘How much’, ‘With which’, ‘How’ and ‘Where’ to produce.

2) Sequencing

- ✓ Defined as the order in which jobs pass through machines or work stations for processing
- ✓ The main aim is to find out such sequence out of the possible sequence that will complete the work in shortest time
- ✓ Sequencing problems becomes tedious as the number of jobs and machines increases

3) Scheduling

- ✓ Scheduling means setting of starting and finishing dates for each operation, assembly and the finished product.
- ✓ It also means to :
- ❖ Fix the amount of work to do.
- ❖ Arrange the different manufacturing operations in order of priority.
- ❖ Fix the starting and completing, date and time, for each operation

4) Dispatching

- It's the next step after scheduling
- Also means starting the actual production of a particular work which has been planned in routing schedule.
- It provides the necessary authority to start the work.
- It is based on route-sheets and schedule sheets.

Dispatching Includes The Following:

- ✓ Issue of materials, tools, fixtures, etc., which are necessary for actual production.
- ✓ Issue of orders, instructions, drawings, etc. for starting the work.
- ✓ Maintaining proper records of the starting and completing each job on time.
- ✓ Moving the work from one process to another as per the schedule.
- ✓ Starting the control procedure.
- ✓ Recording the idle time of machines.

5) Follow Up

- ✓ Follow-up or Expediting is the last step in production planning and control. It is a controlling device. It is concerned with evaluation of the results.
- ✓ Follow-up finds out and removes the defects, delays, limitations, bottlenecks, loopholes, etc. in the production process. It measures the actual performance and compares it to the expected performance. It maintains proper records of work, delays and bottlenecks. Such records are used in future to control production.

Role and Scope of Production Planning & Control

- The type and complexity of the Production Planning & Control techniques vary with the type and volume of production.
- Factories producing large volumes of standardized products need very simple production control techniques.
- On the other hand factories producing a variety of products and product mix need meticulous control with complex production control techniques.

Role and Scope of Production Planning & Control : contd..

- ✓ Production Planning & Control has to ensure that all the operations are done on all components without exception.
- ✓ PP&C must balance the extent of meticulous control against the costs.

Benefits of Production Planning & Control

- **Benefits to Consumers**
  - Increased productivity
  - Better quality standards
  - Prompt deliveries
  - Improved knowledge base and sharing

Benefits of Production Planning & Control

- Benefits to the Producer
  - Adequate wages
  - Job security
  - Improved working conditions
  - Increased satisfaction
  - Increased use of best practices
  - Reduced duplicative workflows
  - Improved decision making
  - More commonality in approaches and tools
  - Optimized resources
  - Improved project performance

Benefits of Production Planning & Control-contd…

- **Benefits to Investors**
  - Security
  - Adequate returns on investments
  - Fame and popularity
  - Capture of market share
- **Benefits to Suppliers**
  - Cooperation
  - Well balanced and assured purchases
  - Prompt payment

Benefits of Production Planning & Control-contd…

- ✓ **<u>Benefits to Community</u>**
  - Stability
  - Economic and social status
  - Employment
  - Price and satisfaction
- ✓ **<u>Benefits to the Nation</u>**
  - Prosperity
  - Taxes and revenue

Types of Production

1. **Intermittent Production:**

    a) Job (or) unit production

    b) batch (or) quality production

2. Continuous (or) mass production

Intermittent Production System

- ✓ Intermittent means something that starts (initiates) and stops (halts) at irregular (unfixed) intervals (time gaps).
- ✓ In the intermittent production system, goods are produced based on customer's orders. These goods are produced on a small scale. The flow of production is intermittent (irregular).

Intermittent Production System-contd…

- In other words, the flow of production is not continuous. In this system, large varieties of products are produced. These products are of different sizes. The design of these products goes on changing. It keeps changing according to the design and size of the product. Therefore, this system is very flexible.

Job Production/Unit Production

- This is the oldest method of production on a very small scale with this the individual requirement met. Each job order stand alone and is not likely to repeat.
- This type has lot of flexibility of operation and hence GPMs are required. Factory adopting this type of production is small in size. The layout of such factory is made flexible. So that maximum work can be easily carried out with slight adjustments.

Job Production/Unit Production-contd…

- **Application:**
- Used for things for which does not produce on a large scale, and things are highly artistic nature.

Job Production/Unit Production-contd…

- The Job-shop production system is followed when there is:

1. High variety of products and low volume.
2. Use of general purpose machines and facilities.
3. Highly skilled operators who can take up each job as a challenge because of uniqueness.
4. Large inventory of materials, tools, parts.
5. Detailed planning is essential for sequencing the requirements of each product, capacities for each work centre and order priority

Job Production/Unit Production-contd…

Advantages:

- Only method which can meet the individual requirement.
- There are no managerial problems because of very less no of workers.
- Man working in huge production get an opportunity to produce large type of product and can become expert I very short time.
- This requires very less money and easy starting.
- The risk of loss is less.
- Because of flexibility of factory due to the reduction of demand

Job Production/Unit Production-contd…

- **Disadvantage:**
- As the purchase of raw material is less, the cost of raw materials is more.
- For handling different types of jobs only skilled workers are needed. Thus labour cost increases.
- Higher cost due to frequent set up changes.
- Higher level of inventory at all levels and hence higher inventory cost.
- Production planning is complicated.
- Larger space requirements

Batch Production-contd…

Batch production is defined "as a form of manufacturing in which the job passes through the functional departments in lots or batches and each lot may have a different routing."

It is characterised by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales.

Batch Production-contd…

- Batch production is defined "as a form of manufacturing in which the job passes through the functional departments in lots or batches and each lot may have a different routing."
- It is characterised by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales.

Advantages

- 1. **Better utilisation** of plant and machinery.
- 2. Promotes **functional specialisation**.
- 3. **Cost** per unit is **lower** as compared to job shop production.
- 4. **Lower investment** in plant and machinery.
- 5. **Flexibility** to accommodate and process **number of products.**
- 6. **Job satisfaction** exists for operators.

Demerits of Batch Production

- Work-in-progress inventory is high
- Large storage space is required
- No standard sequence of operation can be used
- Machine set-ups and tooling arrangements have to be changed frequently
- Idle time between one operation and other

Flow or Continuous System

- According to Buffa, "Continuous flow production situations are those where the facilities are standardized as to routings and flow since inputs are standardized. Therefore a standard set of processes and sequence of processes can be adopted."
- Manufacturing of large quantities of a single or at most a very few varieties of products with a standard set of processes and sequences

Characteristics of Flow System

- Volume of output is generally large and goods are produced in anticipation of demand
- Product design and operations sequence are standardized
- Special purpose automatic machines are used to perform standardized operations
- Machine capacities are balanced
- Fixed path materials handling equipment is used
- Product layout designed according to a separate line for each product is considered

Merits of Flow System

- Work-in-progress inventory is minimum
- Quality of output is kept uniform
- Any delay at any stage is automatically detected
- Handling of materials is reduced
- Control over materials, cost and output is simplified
- Work can be done by semi-skilled workers

Demerits of Flow System

- Very rigid
- If there is a fault in one operation, the entire process is disturbed
- Necessary to avoid piling up of work or any blockage in the line
- Investments in machines are fairly high

Forecasting

- Forecast: A statement about the future.
- Forecasting: Estimating the future demand for products/services and the resources necessary to produce these outputs.
- Forecasting defined: Forecasting is the first step in planning. It is defined as estimating the future demand for products and services and the resources necessary to produce these outputs.
- Estimates of the future demand for products or services are the starting point for the entire sales forecasts

Demand Forecasting

- **Demand forecasting** is a process that takes historical sales data and uses it to make estimations (or **forecasts**) about customer **demand** in the future. For enterprises, **demand forecasting** allows for estimating how many goods or services will sell and how much inventory needs to be ordered

Need for Demand Forecasting

Need For Short Term Forecasting:

- Appropriate Production Scheduling-(over-production ,problem of short supply)
- Helping the firm in reducing Costs
- Work Force Scheduling-(overtime, lay-offs or hiring)
- Determining Appropriate Price Policy.

Need for Long term Forecasting

- Planning of a new Unit or Expansion of an Existing Unit
- Production Planning
- Planning Long-term
- Financial Requirements.
- Planning Man-power Requirements.
- Implementation of Project
- Effective Control.

Types of Forecast

- Technological Forecasts: Concerned with rates of technological progress. It will provide changes will provide many companies with new products and materials to offer for sale.

Types of Forecast-contd…

- Economic forecasts: Statements of expected future business conditions published by governmental agencies.
- Demand Forecasts: Projections of demand for a company's products or services throughout some future period, it provides the basis for the company's planning and control decisions.

Importance of Forecast

- These forecast drive a company's production capacity and scheduling systems and serve as inputs to financial, marketing and human resource (manpower) planning.

Forecasting Time Horizons

- **Short -range forecast:** This forecast has a time span of upto one year, but is generally less than three months.
- It can be even for monthly or weekly forecasts.
- It is used for planning purchasing, job-scheduling, workforce levels, job assignments and production levels.

Forecasting Time Horizons-contd...

- **Medium-range forecast** (or intermediate range):
- A Medium range or intermediate range forecast generally spans from 3 months to 3 years.
- It is used in sales planning, production planning and budgeting (quarterly/yearly), cash budgeting and analyzing various operating plans.

Forecasting Time Horizons-contd...

- **Long-range forecast**:
- Generally 3 years or more in time span, long range forecasts are used in new product planning and development, capital expenditure planning and planning for facility location or expansion and research and development.

Elements/Requirements of A Good Forecast

- The forecast should be timely. This means that the forecasting horizon must have the time necessary to implement possible changes in production capacity, financial needs etc.
- The forecast should be accurate and the degree of accuracy should be known.
- The forecast should be reliable.

Elements/Requirements of a Good Forecast-contd…

- The forecast should be expressed in meaningful units such as rupees, units of products, machines and skills needed.
- Techniques should be simple.
- The forecast should be in the written form to permit an objective basis for evaluating the forecast once the actual results are known.

Steps In Demand Forecasting

- Understand the objective of forecasting
- Integrate demand planning and forecasting throughout the supply chain
- Understand and identify customer segments.
- Identify Major factors that influence the demand forecast.
- Determine the appropriate forecasting technique.
- Establish performance and Error Measures for forecast

Steps In Forecasting Process

- Determine the purpose (objectives) of the forecast: details required in the forecast, the amount of resources (manpower, computer time, rupees etc.)
- Select the items for which forecasts are needed: Determine whether the forecast needed for a single product or for a group of products (Product -line).
- Determine the time horizon for the forecast: Short-term, medium term, long term./ monthly, quarterly, or Yearly.

Steps In Forecasting Process-contd...

- Select the forecasting model (method or technique): Quantitative- Moving Averages, exponential Smoothing and regression analysis. Qualitative techniques such as judgmental or market research method.
- Gather and analyze the data needed for the forecast:

Steps In Forecasting Process-contd...

- Prepare the forecast: Using the Selected method.
- Monitor the forecast: Monitor the forecast to determine whether it is performed satisfactorily. If not, review the method, assumptions, validity of data and modify the forecast if needed and prepare a revised forecast.

Forecasting Approaches

- Qualitative: It consists mainly of subjective inputs, often of non-numerical description.
- Quantitative: It involves either projection of historical data or the development of association models which attempt to use causal variables.

Methods of Qualitative Forecasting

- Consumers Survey Method
- Sales Force Opinion Method
- Delphi Technique
- Past Analogy
- Executive Opinion- Nominal Group Technique- problem solving& decision making method.

Methods of Quantitative Forecasting-contd…

1) Trend Projection Method
2) Barometric Method
3) Regression Method
4) Econometric Method

Trend Projection Method

- The **Trend Projection Method** is the most classical **method** of business **forecasting**, which is concerned with the movement of variables through time. This **method** requires a long time-series data. Under this **method**, it is assumed that future sales will assume the same **trend** as followed by the past sales records.

Trend Projection Method-contd…

- The trend can be estimated by using any one of the following methods:

a) Graphical Method

b) Least Square Method

c) Time Series Data

d) Moving Average Method

e) Exponential Smoothing

Graphical Method

- A trend line can be fitted through a series graphically. The direction of curve shows the trend.
- The main drawback of this method is that it may show the trend but not measure it.

Least Square Method

- Least Square is the method for finding the best fit of a set of data points. It minimizes the **sum** of the residuals of points from the plotted curve. It gives the trend line of best fit to a time series data. This method is most widely used in time series analysis.

TIME SERIES

- Time series forecasting methods are based on analysis of historical data (time series; a set of observations measured at successive times or over successive periods.)
- They make the assumption that past patterns in data can be used to forecast future data points.

Moving- Average Method

- Moving Average method is a simple device of reducing fluctuations and obtaining trend values with a fair degree of accuracy.
- In this method, the average value of a number of years (months, weeks or days) is taken as the trend value for thee middle point of the period of moving average.
- The process of averaging smoothes the curve and reduces the fluctuations.

Exponential Smoothing

- **Exponential smoothing** is a way to **smooth** out data for presentations or to make forecasts. It's usually **used for** finance and economics. If you have a time series with a clear pattern, you could **use** moving averages — but if you don't have a clear pattern you can **use exponential smoothing** to forecast.

Exponential Smoothing-contd…

- They are readily available in standard computer software packages.
- They require relatively little data storage and computation.

Problem:1
(Simple Average)

- A XYZ television supplier found a demand of 200 sets in July, 225 sets in August & 245 sets in September. Find the demand forecast for the month of October using simple average method.

Solution for Problem:1

- The average demand for the month of October is

$$
\begin{aligned}
SA &= \left(\frac{D1 + D2 + D3}{3}\right) \\
&= \left(\frac{200 + 225 + 245}{3}\right) \\
&= 223.33 \\
&\approx 224 \text{ units}
\end{aligned}
$$

Problem:2
(Simple Moving Average)

A XYZ refrigerator supplier has experienced the following demand for refrigerator during past five months.

Month	Demand
February	20
March	30
April	40
May	60
June	45

Find out the demand forecast for the month of July using five-period moving average & three-period moving average using simple moving average method.

Solution for Problem:2

$$MA_n = \frac{\sum_{i=1}^{n} Di}{n}$$

For five period average (i.e. n = 5)

$$MA_5 = \frac{20 + 30 + 40 + 60 + 45}{5}$$

$$= 29 \text{ units}$$

For three period average (i.e. n = 3)

$$MA_3 = \frac{40 + 60 + 45}{3}$$

$$= 48.33$$

$$\approx 49 \text{ units}$$

Problem:3
(Exponential Smoothing)

- One of the two wheeler manufacturing company experienced irregular but usually increasing demand for three products. The demand was found to be 420 bikes for June and 440 bikes for July. They use a forecasting method which takes average of past year to forecast future demand. Using the simple average method demand forecast for June is found as 320 bikes (Use a smoothing coefficient 0.7 to weight the recent demand most heavily) and find the demand forecast for August

Solution for Problem:3

$$F_t = \alpha D_{t-1} + (1-\alpha)F_{t-1}$$

where α = Smoothig Coefficient

D_{t-1} = Actual Demand for Recent Period

F_{t-1} = Demand Forecast for Recent Period

F_t = Forecast of Next Period Demand

for July :

$= 0.7(420) + (1-0.7)320$

$= 294 + 96$

$= 390$ units

for August :

$= 0.7(440) + (1-0.7)\,390$

$= 308 + 117$

$= 425$ units

UNIT-II:

PRODUCTION PLANNING AND CONTROL-WORK STUDY

Introduction

- With increasing complexities of the technological world, need to simplify the work system has been increasing day by day.
- Work study is an area of knowledge that addresses the problem of work simplification with the basic objectives of:
- PRODUCTIVITY ENHANCEMENT &
- HUMAN COMFORT & SAFETY

Definition

- It is the systematic study of work systems with the purposes of

1. Developing the preferred system and Method (with lowest cost)
2. Standardizing this system and method
3. Determining standard time for the task
4. Assisting in training the worker in the preferred Method

Explanation

- Above stated definition has FOUR parts. However, the TWO most important for WORK STUDY are:

1. MOTION STUDY (or Work Methods Design) &
2. TIME STUDY (or Work Measurement)

ILO_DEFINITION

- It is the systematic examination of carrying on activities so as to improve the effective use of resources and to set standards of performance for the activities being carried out.

Productivity

- MATHEMATICALLY:

  PRODUCTIVITY = [OUTPUT / INPUT]

- **PRODUCTIVITY** measures the extent to which a certain **OUTPUT** can be extracted from a given **input.** It may be noted that **PRODUCTION** (which is number of products) is different from **PRODUCTIVITY**.

Work Study

- WORK STUDY is a tool of productivity enhancement.
- It Simplifies a Job to Reduce Unnecessary Or Excess Work, wasteful Use Of Resources and Sets Up Standard Time For Performing That Job.

Techniques of Work Study

- These are:
  1. **METHOD STUDY** is the systematic recording and critical examination of ways of doing things in order to make improvements. THUS it simplifies the job and develops more economical method of doing it.
  2. **WORK MEASUREMENT** is the application of techniques designed to establish the time for a qualified worker to carry out a task at a defined rate of working. Thus it determines how long it should take to carry out the work.

Basic Procedure of WS Comprise of Following Steps:

1. **SELECT** the job/task/process to be studied.
2. **Record** all the relevant data/facts about the selected job.
3. **Examine** the recorded facts critically by challenging its purpose, place, sequence, person, and method.
4. **Develop** new methods, as alternative methods, of doing the selected job.
5. **Evaluate** results of different alternative solutions.
6. **Define** the new method and present it to the concerned people.
7. **Instal** the new method and provide training to the concerned staff .
8. **Maintain** the new standard practice and establish control procedures.

JOB/TASK/PROCESS SELECTION

- It involves following considerations:

1. Economic Considerations
2. Technological Considerations &
3. Human Considerations

JOB/TASK/PROCESS SELECTION-contd…

1. ***Economic Considerations:*** Cost effectiveness i.e. to check whether or not the WS application would pay. For this, key-profit giving/ costliest operations with largest waste/scrap should be attacked first. Next bottleneck operations, repetitive operations, repeated material handling operations should be studied. For locating most important operations, PARETO ANALYSIS could be used.

JOB/TASK/PROCESS SELECTION-contd…

2. ***Technical/Technological Considerations:*** ***T***he analysis involves application of WS for the selection of the operations/processes where new technology.

   Example: Automation/robotisation should be introduced.

JOB/TASK/PROCESS SELECTION-contd…

3. ***Human Considerations:*** Analysis involves location of those operations which present the sources of dissatisfaction and/or annoyance to the workers due to fatigue or monotony or unsafe environment or a work which is clumsy in nature.

Recording The Facts

- Related to the existing process/job ALL THE FACTS should be recorded accurately.
- **TOOLS OF FACT-RECORDING** are:

A. _**CHARTS,** which may be of two types:

i. ***Based on Sequence:***

a) Outline Process Chart

b) Flow Process Chart

c) Two-Handed Chart (or Operation Chart / Left Hand & Right Hand chart)

Recording The Facts-contd…

ii. ***Based on TIME scale:***

a) Multiple Activity Chart

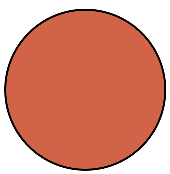
b) SIMO (SImultaneous MOtion) Chart

B. ***DIAGRAMS:*** which may be of the following types: Flow diagram, String Diagram, Travel Chart, Cyclegraph, & Chronocyclegraph,

Process Chart Symbols

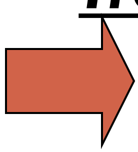
- ASME has recommended FIVE standard symbols to be used on Process Charts, given below:

1. ***OPERATION:*** Main steps of the task /job involving modification/change.

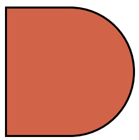


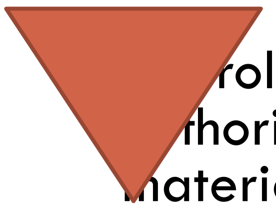
2. ***INSPECTION:*** Checking quality/quantity.

3. ***Transportation:*** For movement of persons/materials



Process Chart Symbols-contd…

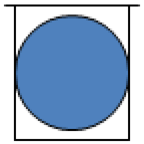
4.  ***Delay (Temporary):*** For waiting time of operators or materials.

5.  ***Storage (Permanent Delay):*** For

rolled storage involving
thorized issue/receipt of
aterial, etc.

Note: For two parallel events, both are shown in one joint or combined symbol:

Example: Operation & Inscription jointly are shown by symbol indicated in the figure.



Flow Process Chart

- It uses ALL THE FIVE SYMBOLS and provides the total sum details of the process/job under study.
- A Flow Process chart may be of the following types:

1. **Man-type** in which every symbol is related to his/her activity only.
2. **Material Type** in which every symbol is related to the material of the job or a document (e.g. in offices) or a machine/equipment.

- Data / information in a flow process chart are recorded in specifically designed FORM, as given in the TEXT BOOK/CLASS ROOM.

Critical Examination

- The facts recorded in the flow process chart are now examined critically.
- By applying the Questioning Technique, which involves the following sequence:

Critical Examination-contd…

- **PURPOSE** for which the activity is done
- **PLACE** at which the activity is done
- **SEQUENCE** in which the activity is done
- **PERSON** by whom which the activity is done
- MEANS by which the activity is done with the objective of Eliminating/ Combining/ Rearranging/Simplifying
- The activities involved in the process.

Questioning Technique involves

1. PRIMARY QUESTIONS and
2. SECONDARY QUESTIONS explained below:

Primary Questions

According to the QUESTIONING TECHNIQUE the PRIMARY QUESTIONS are as follows:

- **Purpose-based:** WHAT is actually done?
  WHY is the activity necessary, at all?
- **Place-based:** WHERE is it being done?
  WHY at this place?
- **Sequence-based:** WHEN is it done?
  WHY at that time?
- **Person-based:** WHO is doing it ?
  WHY by this person?
- **Means-based:** HOW is it being done?
  WHY in that particular way?

ELIMINATE

COMBINE or REARRANGE

SIMPLIFY

Secondary Questions

- **Corresponding to each answer obtained through the PRIMARY QUESTIONS further questions are raised to explore about the**

  ALTERNATIVES

  i. e. alternate purpose, place, sequence, person & means.

This methodology makes use of the SECONDARY QUESTIONS given as follows:

Secondary Questions-contd…

- **What else** might be done?
- **Where else** might it be done?
- **When else** might it be done?
- **Who else** might do it? &
- **How else** might it be done?

- ✓ By answering the primary & secondary questions we use the systematic critical examination in order to evolve a better method of doing the work.

Recording Movement of Workers/Materials

- Tools used for this purpose are:
- String Diagram
- Flow Diagram
- Travel Chart

String Diagram

- It is a scale plan or model on which a thread or string is used to trace and measure the path of Workers/ Materials during a specified sequence of events.
- Length of the thread/string measures the distance moved.

Floor Diagram

- It is a FLOOR-PLAN showing the path of travel of the operator or the material, through the plant.
- It also indicates the direction of travel by means of arrows, drawn on the diagram.

Travel Chart

- A travel chart is a tabular record for representing the quantitative data regarding the movement of workers, materials or equipments between different stations during a given period of time. Though string diagram is a very effective technique of recording for critical examination of the movement of man and material but string diagrams take very long time to construct.

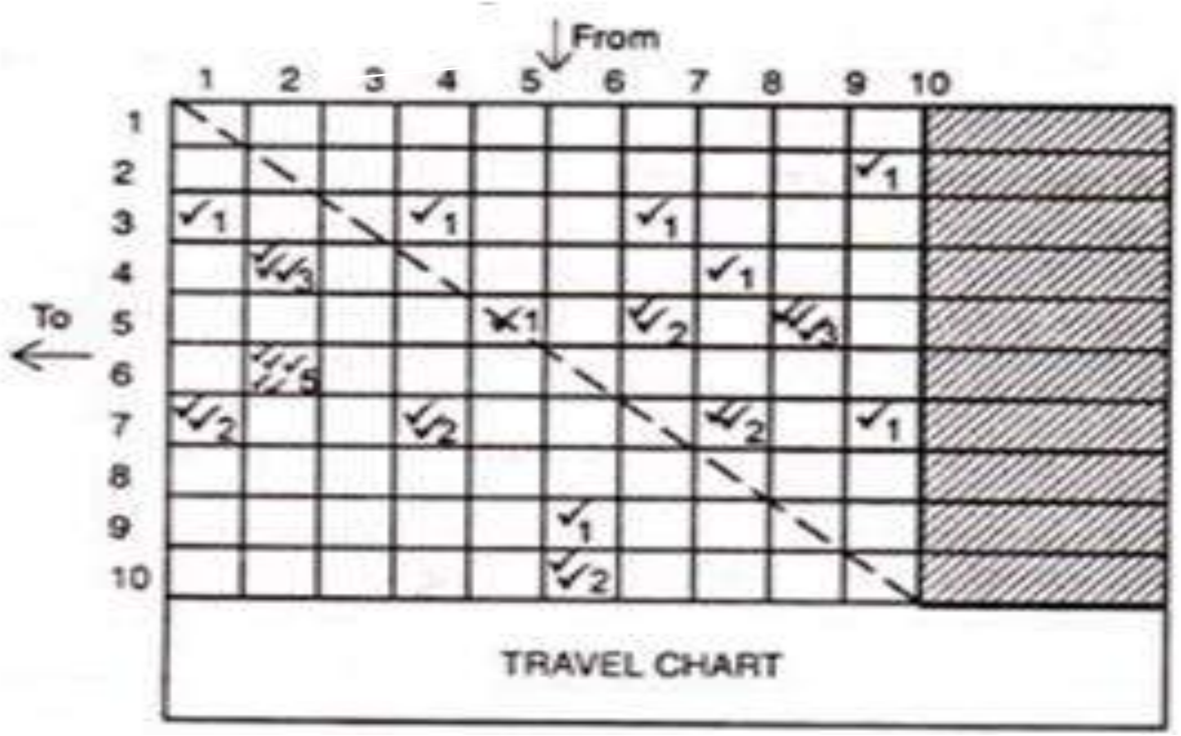
Travel Chart-contd…

- Travel chart consist of a square, which itself consists of a number of squares. Now, each small sequence represents a work station. A diagonal line is drawn from top left to bottom right. Say, a workplace or a workshop consists of 10 workstations and the movement of the worker is to be noted down

Travel Chart-contd…

- A big square in drawn and it is divided into 10×10 small squares. Each square represents a work station. Now, the movement of the worker from any station to other stations in shown in the travel chart.

Travel chart Diagram



Principles of Motion Economy

- These principles can be helpful in work design, in reducing the human fatigue and in improving the work efficiency.

Principles of Motion Economy As Related To The Use of Human Body

1. The two hands should **begin and complete** their movements **at the same time.**
2. The two hands should **not be idle at the same time.**
3. Motions of the arms should be **symmetrical and in opposite direction** and should be made simultaneously.
4. Hand and body motions should be made at the **lowest classification** at which it is possible to do the work satisfactorily.

Principles of Motion Economy As Related To The Use of Human Body-contd…

5. **Momentum** should be employed to help the worker ,but should be reduced to a minimum whenever it is to overcome by muscular effort.
6. Continuous **curved motions are to be preferred to straight line motion** involving sudden and sharp changes in direction.
7. **Ballistic (free-swinging) motions are faster,** easier, and more accurate than restricted or controlled motions.

Principles of Motion Economy As Related To The Use of Human Body-contd…

8. **Rhythm** is essential to the smooth and automatic performance of a repetitive operation. The work should be arranged to permit an easy and natural rhythm whenever it is possible.
9. Work should be **arranged so that eye-movements are confined to a comfortable area,** without the need for frequent changes of the focus.

Fundamental Hand Motions

- Gilbreth observed that most work done by two hands consists of a few fundamental motions.
- He called EACH ONE of them as THERBLIG.

Fundamental Hand Motions-contd…

- Today we have 17 Therbligs as follows:

i. Search, select, grasp, transport empty, transport loaded, hold, release load, position, preposition, inspect, assemble, disassemble, use, unavoidable delay ,avoidable delay, plan, &rest for overcoming fatigue.

- THESE ARE USED IN MICROMOTION STUDIES (FACTS RECORDED ON FILMS)

Micro Motion Studies

- Operations with very short cycles & repetitive cycles need greater details to analyze it for saving motions and effort(i.e. planning for lesser fatigue). This goal can be achieved through Micro-motion Studies.
- MICRO means ‘small. Thus here we study the motions in terms of THERBLIGS.
- Such a study involves the use of FILM and VIDEO when operator performs the job.
- Later on the film/video can be run slowly THROUGH A PROJECTOR and ‘Frame by frame’ analysis of the work can be carried out.
- Film provides greater flexibility of filming and playback speeds WHEREAS video is easier in use.

Micro Motion Studies-contd…

- ✓ Advantages of micro motion studies over direct observation.
- Greater details are made available
- More accurate
- Easier in data collection
- Better for record keeping
- Help in work study personnel's development

Work Design

- Work design is a systematic investigation of desired and present work system to get the ideal work systems and methods
- **Objectives:**
- Increased productivity & higher effectiveness

Method Study

- 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.

Work Measurements

- The application of techniques designed to establish the time for a qualified worker to carry out the specified job at a defined level of performance.

Work Study

- Aims at
  - To analyse the work / job to achieve work simplification and their by raising the productivity
  - To have optimum use of human and other resources
  - To set the time standards for setting incentives schemes

Method Study-Procedure-SREDIM

- Select the Work / Procedure to be studied
- Record all the relevant information with the help of various recording devices
- Examine the collected facts critically
- Develop an improved method which is economical and practical after giving careful consideration to all the alternative
- Install the new method by issuing proper instructions.
- Maintain the new standards of methods through periodic verification / checking

Work Study Is Considered as a Tool of Raising Productivity Through:

- Resource utilisation
- Capital Investment
- Better Management

Selecting The Work To Be Studied (Factors Taken In To Account) :

- Economic Considerations
- Technical Consideration
- Design and development
- Manufacturing planning
- Human Consideration
- Energy and pollution Control

Work Measurement Procedure:

- Select the work to be studied
- Record all the relevant data pertaining to the circumstances in which work is being done
- Measure each element in terms of time over sufficient number of cycles of activity
- Examine the recorded data and time elements critically
- Compile a time for operation which will provide a realistic standard of performance
- Define the series of activities and the method of operations.

Method Study

- Selection of the job involves
  - Economic consideration
  - Technical consideration
  - Human consideration

Critical Examination

- Facts should be examined as they are and not as they should be
- Each step, how insignificant it may be, should be analysed in a logical sequence.
- Hasty judgements must be avoided.
- Opinion regarding alternatives to the existing method should not be formed unless all aspects of the existing method have been exposed to critical examination.

List of Questions For Critical Examination

Governing consideration	Basic question (Facts)	The Necessiity (Why)	Alternatives	The best
Purpose	What is being done?	Why is it done?	What else could be done?	What should be done?
Place	Where is it done?	Why there?	Where else?	When should it be done?
Sequence	When is it done?	Why then?	When else?	When should it be done?
Person	Who does it?	Why that person?	Who else?	Who should do it?
Means	How is it done?	Why that way?	How else?	How should it done?

Development And Selection

- Evaluation
- Investigation
- Selection

Evaluation

- Fault finding and fault identification
- Combination of ideas
- Estimation of cost of testing and implementation

Investigation

- **Test each idea for its technical feasibility**
- Design
- Changes in Design
- Tool Design
- Tool room
- Stores to provide
- Purchase to provide
- Production to assist methods
- Quality control to provide information
- Time Study
- Costing to provide information

Predict Performance of Each Feasible Idea

- Material Cost
- Manufacturing cost
- Tool Cost
- Jigs and fixtures cost
- Test each feasible alternative for its economic feasibility
- SELECTION

Installation of The Proposed Method

- Two Phases

1. Recommendation Phase
2. Implementation Phase

- Project Prepartation
- Project Presentation
- Implementation Plan

Work Measurement

- Work measurement is concerned with the determination of the amount of time required to perform a unit of work.

Work Measurement Procedure

- Select the work to studied, after having made a preliminary survey
- Record all the relevant data peprtaining to the circumstances in which the work is being done, the methods and the elements of activity in them.
- Measure each element in terms of time over a sufficient number of cycles of activity to ensure that a representative picture has been obtained.

Work Measurement Procedure-contd…

- **Examine** the recorded data and time elements critically to ensure that unproductive or random elements are separated from productive elements also examine the recorded times of each element.
- **Compile** a time for the operation which will provide a realistic standard of performance.
- **Define** precisely the series of actives and method of operation for which the time has been allowed and issue the standard time for the activities and methods specified

Techniques of Work Measurement

- Time Study
- Work sampling
- Pre-determined motion-time system(PMTS)
- Analytical estimating
- Synthesis from standard data
- MOST

Time Study

- Time study is a technique for determining as accurately as possible from a limited number of observations, the time necessary to carry out a given activity at a defined standard of performance.

Time Study Procedure

- Select the task to be timed
- Standardize the method of working
- Select the operator to be studied
- Record necessary details of the job and conditions of work
- Break the task into elements
- Measure the duration of each element and assess the pace of working
- Establish representative time of elements
- Extend observed time into normal time
- Assess relaxation and other allowances
- Calculate standard time of the job

Steps In Time Study

- Select the job to be timed
- Standardise the method
- select the operator
- record details
- Break the task into elements
- Measure the duration of each element and assess the pace of performance
- Determine representative time of each element
- Extend observed time into normal time

Formula

- NORMAL TIME =

$$\frac{\text{Observed Time x performance rating (\%)}}{100}$$

Work Sampling

- Work sampling is a sampling technique wherein a large number of observation are conducted at random intervals of time and the state of each member of the group-working is studied. The observation of non-working are further amplified and the cause of delay is recorded.

Uses of Work Sampling

- Cost reduction and cost control
- Assessment of allowances for output standards
- Fixation of output standards
- Testing the accuracy of the output standards

Procedure Work Sampling

- Decide on the objective of the study
- Explain to the concerned persons
- Fix up work and delay elements
- Decide on the duration of the study
- Determine the desired accuracy of the final results & confidence level.
- Make a preliminary estimate of % occurrence of the activity delay to be measured
- Design the study (No of observations, Total no of rounds, and their times etc.)

Synthesis Method

- In synthesis method, the full job is first divided into elements (parts). Then the time taken to do each element of the job is found out and synthesized (totaled). This gives the total time taken for doing the full job.
- In this technique, the time taken to do each element of the job is found out from previous time studies. So, this technique gives importance to past-time studies of similar jobs. It also uses standard data.

Synthesis Method-contd…

- Standard-data is the normal time taken for doing routine jobs. Standard data is easily available for routine-jobs like fitting screws, drilling holes, etc. So there is no need of calculating these times repeatedly.
- Most companies use Standard-data. They do not waste time doing studies for all elements of the job. This is because standard time is already available for most elements of a job.

Synthesis Method-contd…

- For example, a job of publishing a book contains four elements viz; typing, editing, printing and binding. The time taken for doing each element is first found out.
- Suppose, typing takes 40 days, editing takes 30 days; printing takes 20 days and binding takes 10 days. Then the time taken to do all the elements are totaled. That is, it takes 40 + 30 + 20 + 10 = 100 days to publish a book. This information is taken from previous time studies of other printing jobs or from the standard data.

The Advantages of Synthesis Method

- It provides reliable information about standard time for doing different jobs. This is because it is based on many past time studies.
- It is economical because there is no need to conduct new time studies.

Predetermined Motion Time Standards

- In ’Predetermined Motion Time System’ method or simply PMTS technique, the normal times are fixed for basic human motions. These time values are used to fix the time required for doing a job. Normally, three times are fixed for one job. That is, one time is fixed for each level of performance. The level of performance may be normal, fast and very-fast.

Predetermined Motion Time Standards-contd…

- PTMS is better than motion studies because it gives the detailed analysis of the motion, and it fixes the standard time for doing that motion.
- PTMS technique is used mostly for jobs, which are planned for future. However, it can also be used for current jobs as an alternative to time study.

The Advantages of PMTS Method

- It is a very accurate method. It avoids subjective judgement or bias of rater.
- It is an effective and economical method for repetitive jobs of short duration.
- There is no interference in the normal work routine, and so it does not face any resistance from the employees.
- It helps to improve the work methods because it gives a detailed analysis of the motions.
- It is more economical and fast compared to normal time studies.

UNIT-III:
Materials Planning

Material Planning

- Material planning is a scientific technique of determining in advance the requirements of raw materials, ancillary parts and components, spares etc. as directed by the production program. It is a sub-system in the overall planning activity.

Material Planning-contd…

- There are many factors, which influence the activity of material planning. These factors can be classified as macro and micro systems.

Material Planning-contd…

- ***Macro factors:*** Some of the micro factors which affect material planning, are price trends, business cycles Govt. import policy etc.
- ***Micro factors:*** Some of the micro factors that affect material planning are plant capacity utilization, rejection rates, lead times, inventory levels, working capital, delegation of powers and communication.

Two major factors which influence materials planning are:

- The external factors, and
- The internal factors
- The external factors (or also called macro factors in economic terminology)
- include :
- National Economy
- Price Trends
- Credit Policy
- Direct and Indirect Taxes
- Foreign Exchange Regulations
- Import Policy
- International Market
- Business Cycle

The internal factors (also called micro factors) include :

- Corporate Objectives
- Technology Available
- Market Demand and Supply
- Procurement Lead Times
- Rejection Rates (both in the incoming supplies and during manufacturing)
- Working Capital Available
- Inventory Norms
- Storage Facilities
- Nearness to Sources of Supply
- Information Data (suppliers, material substitute, etc.)
- Delegation of Power
- Communication System
- Management Policy towards Stocking
- Buyer – Seller Relationships
- Company’s Financial Position
- Company’s Corporate Image

Basis For Material Planning

- The basis for material planning is the forecast demand for the end products. Forecasting techniques such as weighted average method, exponential smoothening and time series models are used for the same.

Material Planning Techniques:

Material Group	Technique
A. Direct Materials	
(a) High Value	(i) Bill of Materials/Explosion Charts
	(ii) Materials Requirement Planning
	(iii) Inventory Control
(b) Low Value	(i) Inventory Control
B. Indirect Materials Technique	(i) Past Consumption Analysis
	(ii) Exponential Smoothing
	(iii) Inventory Control

BILL–OF–MATERIALS:

- Bill – of – materials (BOM), also called part lists or building lists, is the document generated at the design stage. It details the structure of the product by dividing the final assembly into major assemblies, major assemblies into sub – assemblies and sub – assemblies into parts. The individual parts, as far as practical, are listed in the manner in which each part is assembled. Bill – of – material provides details such as part name, part number, description, quantity required, material etc.

- Bill – of – materials technique is best suited for engineering industries since here a large number of components are required for assembling of as end – product. Further, because some of the components may be common to different end – products, preparation of a explosion chart by combining bill – of – materials is a convenient method of knowing the total requirement of each of the components for the required product mix.

MATERIALS REQUIREMENT PLANNING (MRP) :

- What is MRP?
- Material requirements planning (MRP) is the scientific technique for planning the ordering and usage of a materials at various levels of production and for monitoring the stocks (inventories) during these transactions. MRP, therefore, is both inventory control and scheduling technique. It utilises the **master schedule** for the end products (a master schedule shows the quantities of each end product to be produced in each period of the planning horizon), **product structure** for determining requirements of sub – assemblies, components and raw materials (both common and unique to the products), **procurement/ manufacturing lead times and inventory status** of products, sub – assemblies, parts and materials, and utilising these data bases in a series of steps it draws up the timings of procurement/ manufacture of all the sub – assemblies, parts and raw materials required over the production horizon to meet the given end production schedules. MRP is based on the concept of independent and dependent demand.

Materials Requirement Planning (MRP) :

- Material Requirement Planning (MRP) is particularly useful when one or all of the following conditions are present:
- The final product is complex and is made up of several levels of assemblies which have many a common parts and sub – assemblies.
- The procurement lead times for components and raw materials are relatively long.
- The manufacturing cycle is long for the finished product.
- The demand for the products is known and it is desirable to make specific procurement/ manufacturing plans (especially desirable when products are expensive).

The Objectives of MRP

- Inventory reduction: MRP determines the number of components needed and the time when they are needed to meet the master schedule. It enables the managers to procure the component as it is needed thus avoiding costs of excessive inventory.

The Objectives Of MRP-contd…

- Reduction in production and delivery lead time: MRP identifies quantities, timings, availabilities, procurement and production action required of materials and components to meet delivery dead lines. By coordinating inventories, procurement and production decisions MRP helps in avoiding delays in production. It helps in arranging production activities in priorities by putting due dates on consumer job orders.

The Objectives Of MRP-contd…

- Realistic commitments: Realistic delivery promises can enhance customer satisfaction and make him delighted. By using MRP, production system can give information in time and likely delivery time to prospective customers. The potential customer orders can be added to the system to show the manager how the revised total loading can be handled with the existing capacity. This will result in more realistic delivery dates.

The Objectives Of MRP-contd…

- Increase in efficiency: MRP provides close coordination amongst various work centres as production progresses through them. Hence production can be processed with fewer indirect personnel and fewer material interruptions. The information provided encourages production efficiencies.

The Objectives Of MRP-contd…

- It reduces inventory cost by reducing inventory levels.
- It improves plant operating efficiency by making better use of productivity resources

PROCEDURAL STEPS IN MRP:

- ***Step 1:*** Determine the gross requirements of the finish products.
- The gross requirement is the aggragate quantity taken from three sources:
- Period wise pending sales orders on hand
- Period wise forecasted sales
- Management decision to alter quantities derived under (i) and (ii) above to smoothen production.
- ***Step 2:*** Determine the net requirements of finished products.
- The gross requirements obtained in step 1 are adjusted by the available inventory of the product to obtain net requirements. That is
- Net requirements = Gross requirements-Inventory available

PROCEDURAL STEPS IN MRP: -contd…

- ***Step 3:*** Develop a master production schedule.
- From the net requirements for each time period as determined in step 2, a master production schedule is prepared. Master production schedule is the key to MRP.
- A master production schedule expresses the overall plan of production. It spells out the different products to the manufactured over the given span of time.
- ***Step 4:*** Explode the bill of materials and determine gross requirements.
- For each assembly, a structured bill of material is available and it contains the information to identify each item of the assembly and the quantity required per assembly of which it is a part.

PROCEDURAL STEPS IN MRP: -contd…

- The gross requirement of each part is ascertained by multiplying the net requirement of the assembly on the master schedule by the quantity required of the part per assembly as given in the bill - of - material. The computer software is available which does the computation of requirements of parts on a level – by – level basis. (i.e., on completion of first level, it does it for next level, and so on).
- If the part is a purchased item, the order would be placed and this would conclude the procedure. Of course, the purchased quantity is adjusted for expected losses in scrap.

PROCEDURAL STEPS IN MRP: -contd…

- **Step 5 :** Screen out B and C category of items.
- **Step 6 :** Determine the net requirements of items.
- The gross requirements of an item obtained in step 4 is adjusted for the “stock on hand” and “stock on order”. At times, it may be found that the item is over stocked and does not require to be replenished. At times, it need to be ordered/ manufactured.
- **Step 7 :** Adjust requirement for scrap allowance.
- Depending upon the criticality of the dimensions there may be some rejection during manufacturing which needs to be accounted for so that correct numbers will be available for assembly. This is usually done by estimating the percentage of loss and adding it to the net requirement when the item is being ordered. In a computerised MRP system, the percentage loss is kept in the file so that it may be automatically added when the item is being ordered.

PROCEDURAL STEPS IN MRP:
-contd…

- ***Step 8:*** Schedule planned orders.
- Once the quantity of an item is determined, the next logical step is to schedule it. While scheduling, manufacturing cycle time is taken into account and to that exent the item is offset for delivery. The offset information on the item can be had on item record for ready reference.
- ***Step 9:*** Explode the next level.
- As mentioned in step 4, the entire assembly is not exploded at one time but it is done level by level after all previous steps have been completed. That is each level of explosion is followed through steps 5 to 7 and the steps from 5 to 7 are repeated again and again until the entire assembly has been exploded through all levels and quantities of items determined and time phased.

PROCEDURAL STEPS IN MRP: -contd…

- ***Step 10:*** Aggregate requirements and determine order quantities.
- Some of the items may be common to a number of assemblies and at various levels. It will be therefore, wrong to place on order each time an item appears during explosion but wait until the demand is developed after entire assembly of each product has been exploded and then aggregate the demand so that just one order can be placed.
- ***Step 11:*** Write and place the planned orders.
- After the requirement of each item has been determined their purchase orders/ work orders can be printed in the form of a computer printout.
- ***Step 12:*** Maintain the schedules.
- Writing the orders is no assurance that the product will be delivered on time. Regular follow up is necessary. Expediting may require to be done in some cases until the product is ready to be delivered to the customer

Computerised System Of Mrp :

- Since the amount of computation involved in MRP is extensive particularly when gross to net requirements are being computed down through the levels of a complex assembled product, manual computation takes lot of time and creates a lot of delay. The computer is a great boon to the material requirements planner. The material requirements planning computer software generates time period wise requirements of assemblies, sub – assemblies, components and raw materials from an input of orders and demand forecast.

Past Consumption Analysis Technique

- Materials planning of indirect materials such as tools, lubricants, stationery, electric supplies, packaging and packing materials as well as direct materials required on continuous basis can be conveniently done on the basis of their past consumption. Statistical tools like mean, mode or median are used to project future demand and statistical tools like standard deviation are employed to consider the effect of fluctuations.
- Past consumption analysis technique (i.e. mean, mode or median) can be used successfully for materials planning in the process industries where in the materials are required on continuous basis. It can be used in the engineering industries for forecasting requirements of indirect materials.

Past Consumption Analysis Technique-contd…

- For continuously needed materials and the materials where no bill of materials is possible, this technique of analysis is adopted- The past consumption data is analyzed and a projection for the future on the basis of past experience and future need is made. To prepare such a projection, "average" or "mean" consumption and the "standard deviation" are taken as bases and as guidelines for each item.

Past Consumption Analysis Technique-contd…

- These are all statistical tools and are very effective to absorb the stock of fluctuation in consumption of direct and indirect materials where no straight-forward norms of consumption can be formulated. In the process industries, this technique is particularly suitable.

Advantages of MRP

- Reduced levels of inventory: Helps in achieving better coordination among various orders for components and production plans for parent items. As a result average inventory level tends to get reduced for dependent demand items like raw materials and work in progress.

Advantages of MRP-contd…

- Better utilisation of human and non human resources: Provides accurate prior information; it helps in improving delivery systems, flow of work, avoiding intermittent delays and reducing manufacturing cycle times in jobs. All these result in optimum utilisation of all available resources.

Advantages of MRP-contd…

- Improved consumer service: Enables managers to fix delivery dates that are definitely achievable. It helps in improving the company's ability to react to changes in customer orders, improve service by providing quality products at fair prices, meet assembly dates and reduce delivery time significantly

Advantages of MRP-contd…

- Efficient financial planning: Enables to plan effective cash flow requirements. It enables to identify bottleneck work centres or capacity constraints thus helping the operations manager to take better investment decisions
- Better scheduling: Provides better knowledge about priorities hence better scheduling can be undertaken easily.

Advantages of MRP-contd…

- Improved vendor relations: Enables the purchase department to know the priorities and changes in due dates for orders so that purchaser places the orders on vendors accordingly. This helps in improving vendor relations.

Advantages of MRP-contd…

- Efficient planning: May suggest necessary changes in the Master Product Schedule (MPS) for evaluating an alternative to it. It helps in projecting facility and equipment requirement, manpower planning, etc. so that the organisation can survive and grow under competitive conditions.

Advantages of MRP-contd…

- Promoting engineering efficiency: Helps in planning the time of design releases as well as design modifications.

Advantages of MRP-contd…

- Dynamic nature: MRP is a dynamic system which is an important advantage. It reacts effectively with changing conditions. In fact it thrives on change.

Advantages of MRP-contd…

- Rational material decisions: In order to maintain planned production schedules, planned order releases for necessary items have to be acted upon immediately. Thus, it enables the manager to take rational decisions.

Limitations of MRP

- The limitations of MRP arise from the conditions that need to be met before it can be used. Thus, for implementing MRP, computers are necessary, the product structure has to be assembly oriented, bills of material and inventory status information need to be regularly collected and computerised and a valid master schedule must be prepared

Limitations of MRP-contd…

- Limitations related to data integrity. Unreliable inventory and transaction data from the shop can ruin a well- planned MRP system. Training personnel to keep accurate is not an easy task, but it is critical for the success of MRP implementation. In general, the system must be accurate and directly useful or else it becomes an expensive ornament that is bypassed in favour of ad hoc methods.

Limitations of MRP-contd…

- Top management support and proper organisation of functions such as production planning and control, materials, production, quantity, engineering and so on. Timeliness of generating information, effective communication systems, proper motivation of people, efficient leadership are necessary things for the successful implementation of MRP. Most of these can be lacking in many organisations.

MRP II

- Resource Planning (MRP II) evolved from early material requirements planning (MRP) systemsby including the integration of additional data, such as employee and financial needs.

MRP II-contd…

- This system is designed to centralise, integrate and process information for effective decision making in scheduling, Manufacturing design engineering, inventory management and cost control in manufacturing.

MRP II-contd…

- MRP II is a computer-based system that can create detail production schedules using real-time data to coordinate the arrival of component materials with machine and labour availability. MRP II is used widely by itself, but also as a module of more extensive Enterprise Resource Planning (ERP) systems.

MOVING AVERAGE METHOD:

- The past data of sales of a firm may show peaks and valleys on account of seasonal variations and random variations. To compute average demand for the entire period to obtain an estimate of the future requirement shall be meaningless since trend is an important factor. The forecasting method used must :
  - emphasis the recent demand
  - estimate the trend effect
  - account for expected seasonal variations when making an estimate of demand for the up-coming period.
  - not be influenced by the random variations in demand when making an estimate of demand for the upcoming period.

MOVING AVERAGE METHOD: -contd…

- Moving average is a simple statistical method to establish and extrapolate trend of past sales. The method makes use of old data and computes a rolling average for a constant number of periods, n. It discards old figures as new ones come in. i.e. Fresh average is computed at the end of each period be adding the demand of the most recent period and omitting the demand of the oldest period. Since the data used in this method changes from period to period, hence the expression “moving average” is used.
- Selection of the period of the moving average requires a great amount of care. An inappropriate period can distort the data thereby giving wrong picture of the trend.

Forecasting From The Moving Average:

- The principle underlying the moving average is that future demand shall be average of the past demands. The method thus bases the forecast for the next period on the average of the "n" preceding periods.

Exponential Smoothing :

- Simple “n” period moving average gives equal weightage to the last “n” periods and it ignores the data for (n+1) or earlier periods. This provides a smoothing effect. But is mere smoothing effect enough? No! The forecasting method must ensure that the forecast derived from it keeps pace with the changing business trends. To have this, it must emphasis more on the recent demand data and less on old data (i.e. give greater weightage to recent data and lesser weightage to older data). Weighted average can achieve this objective. One of the most convenient methods to give differential weightage to different periods of the time series and extend smoothing effect to the forecast is exponential smoothing.

Forecasting Method:

Forecast for the period “t” = (Ft) = Forecast of the last period +

[Actual demand Forecast]

x[of the last - of the last]

[period period]

= Ft-1+ x[Dt-1-Ft-1]

= x.Dt-1+(1-x)Ft-1

Inventory Control

- Inventory control involves usage value classification of items (i.e. ABC classification), determination of preferred quantities to buy/ manufacture (economic lot size), fixation of lead time and safety stock needs, and fixation of inventory levels (re-order levels, maximum levels etc).
- Inventory control technique is best suited for low value indirect materials which are economical to procure them in certain pre – fixed quantities as well as high value items which are desirable to be reviewed and replenished as pre – fixed intervals say every month.

Other Operation Research Techniques :

- Other sophisticated operation research techniques used in materials planning include
- Linear programming
- Decision Theory (including decision trees)
- Simulation
- Dynamic Programming
- Time Series Analysis (Regression Analysis, Decomposition of Time Series etc).

UNIT-IV:

PRODUCTION PLANNING AND CONTROL-PROCESS PLANNING

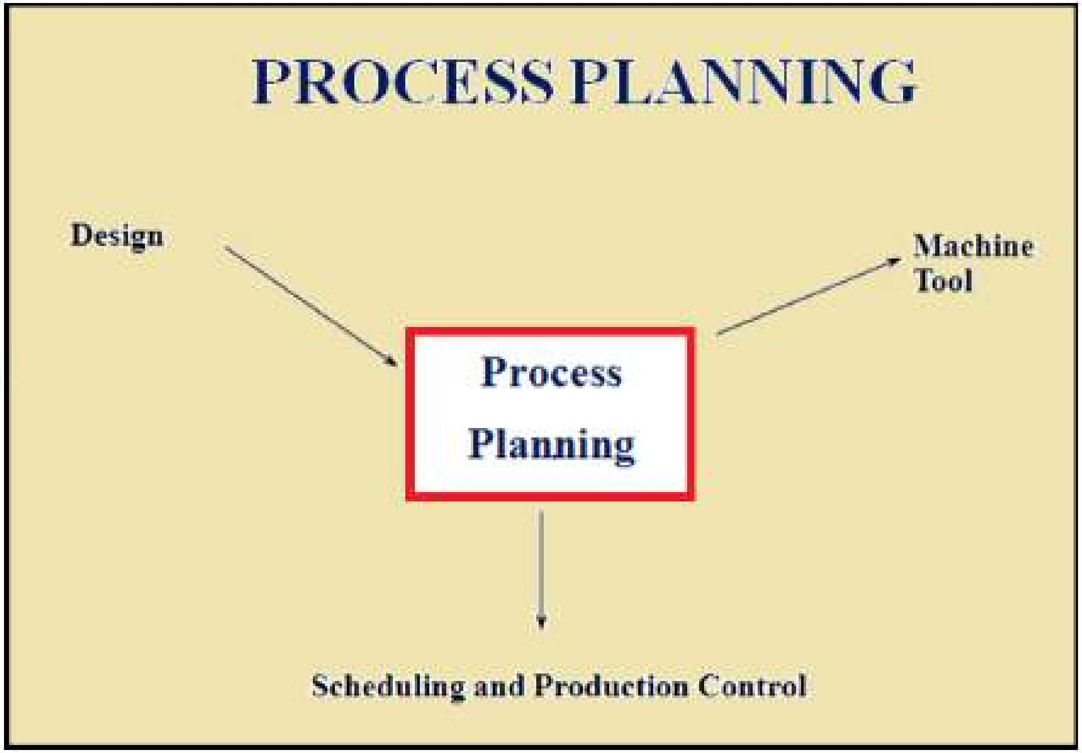
Process Planning

- A process is described as a set of steps that result in a specific outcome. It converts input into output. Process planning is also called manufacturing planning, material processing, process engineering, and machine routing. It is the act of preparing detailed work instructions to produce a part. It is a complete description of specific stages in the production process.

Process Planning

- Process planning determines how the product will be produced or service will be provided. Process planning converts design information into the process steps and instructions to powerfully and effectively manufacture products. As the design process is supported by many computer-aided tools, computer-aided process planning (CAPP) has evolved to make simpler and improve process planning and realize more effectual use of manufacturing resources.

Process Planning



Process Planning

Process Planning

- **Process planning** is a preparatory step before manufacturing, which determines the sequence of operations or **processes** needed to produce a part or an assembly. This step is more important in job shops, where one-of-a-kind products are made or the same product is made in frequently.

Objective of Process Planning

- The chief of process planning is to augment and modernize the business methods of a company. Process planning is planned to renovate design specification into manufacturing instructions and to make products within the function and quality specification at the least possible costs. This will result in reduced costs, due to fewer staff required to complete the same process, higher competence, by eradicating process steps such as loops and bottlenecks, greater precision, by including checkpoints and success measures to make sure process steps are completed precisely, better understanding by all employees to fulfill their department objectives.

Objective of Process Planning

- Process planning deals with the selection of the processes and the determination of conditions of the processes. The particular operations and conditions have to be realized in order to change raw material into a specified shape. All the specifications and conditions of operations are included in the process plan.

Objective of Process Planning

- The process plan is a certificate such as engineering drawing. Both the engineering drawing and the process plan present the fundamental document for the manufacturing of products. Process planning influences time to market and productions cost. Consequently the planning activities have immense importance for competitive advantage.

The Information Contained In The Process Sheet Can Be Put To A Variety Of Uses:

- **Scheduling:**
- **Materials Movement:**
- **Cost Reduction & Cost Control:**
- **Costing:**
- **Method of Working:**
- **Requirement of Manpower and Machines:**
- **Shop Efficiency:**

Inputs to Process Planning

- **Components and assembly drawings** to know the general description of the parts, materials from which parts are made, originating process of raw materials, heat treatment process, basic dimensions and their tolerances, and the surface finish required.

Inputs to Process Planning-contd…

- **Machine capacity charts** to indicate the limitations of the available machines. A machine capacity chart usually gives the following details:
  - Operations Possible
  - Maximum and Minimum (length, diameter, depth, etc.) dimensions that can be machined
  - Maximum tool travel
  - Maximum depth of cut
  - Accuracy within which the dimensions can be machined
  - Available speeds and feeds

Inputs to Process Planning-contd…

- **Standard elemental time data** to compute standard time and set – up time of different operations. The process engineers can use this data to compare the alternative processes (or machines) and thereby select the most economical process (or machine).

Inputs to Process Planning-contd…

- **Cutting speeds and feeds charts** to establish the requirements of speeds and feeds for the job under study thereby enabling the process engineer to select proper machine.
- Some materials such as aluminum alloys, brass, bronze, fibre, plastic, etc. for example can be machined using high cutting speeds and feeds and hence such jobs require to be loaded on the machines having high spindle speeds.

Inputs to Process Planning-contd…

- **Available tooling** to establish the operations and their sequence. A gear blank for example may have to be ground to H7 tolerance size if reamer is not available. Similarly, a spur if required gear to be cut on the hobbing machine if the required gear shaper cutter is not available though the company's machinery include gear shapers.

Factors Influencing Process Planning

- Order quantity and job life
- Delivery dates of components and products
- Process capability of the machines
- Skill of the available manpower
- Material from which part is made
- Originating process of raw material
- Heat treatment process
- Surface finish
- Accuracy requirements

Steps In Process Planning

- Study the component drawings to enlist the features that would influence the selection of the manufacturing processes, machines etc.
- Draw a list of the surfaces to be machined.
- Prepare a list of basic operations by combining as many surfaces into a single operations as are physically and economically possible.

Steps In Process Planning-contd…

- Fix sequence of the basic operations.
- Insert auxiliary operations (such as inspection operations and deburring operations) between the basic operations.
- Fix in – process dimensions and tolerances.
- Write down the route sheets.

Process Planning Aids

- ***Time Planning:*** It is important to allocate a predicted amount of time to specific tasks in the design and make process so that you share the time allocated for the whole project among the time requirements of various tasks.

Process Planning Aids-contd…

- Remember, some parts of the design process will take up more time than others so you must consider this in the distribution of the time available.
- If you want your project to flow smoothly, it is a good idea to start your planning with the production of a **flow chart**

Process Planning Aids-contd…

- This flow chart will reflect the design process but will be specifically based on the type of project you are undertaking.
- Although the flow chart will help you organize the sequence of operation for your project, you still need to allocate specific time to each activity.

Process Planning Aids-contd…

- Commercial designers use planning charts to help them **map out** the tasks they have to complete against the time allocated. These charts are no different to a geographical map in the sense that they provide an overview of the project very much like a geographical map shows an overview of the land. To designers and engineers these are called **Gantt** charts.

Process Planning Aids-contd…

- Determine how long you need or want to take to complete the project.
- Decide on the unit of time you will use across the top of the chart under the heading of date/period: this could be hours, days or weeks.
- Consider the advantages and disadvantages of each unit of time.
- Decide how long you will need to complete each of the project stages indicated on the left of the chart.
- You will need to base this on previous project experience or talk to your teacher for advice.

Route Sheet

- Identification data such as part name, part number, product etc. to indicate what the part is, what assembly or product it is in.
- Material specifications such as type, size and originating process, hardness etc.
- Basic operations and their sequence.
- Machine tool for each operation.
- Tooling such as cutting tools, jigs and fixtures, measuring instruments and gauges for each operation.
- Speeds, feeds, depth of out, number of cuts.
- Skill of labour
- Part sketch. Use of part sketch on the route sheet is generally not standard.

Processing Planning In Different Situation

- Process planning in process or continuous units and mass production units is dictated by the plant layout itself. The process is prepared to get the best out of the existing layout.
- Process planning in batch production units is comparatively less troublesome. The process sheets for parts are prepared once and maintained as standard or master process sheets.
- Process planning in case of job order production units poses a considerable problem. The process sheets require to be prepared each time a new item requires to be run on the shop floor.

Documents In Process Planning

- **Process Sheet or Route Sheet** to show basic operations and their sequence, machine tool for each operation, cutting tools, jigs and fixtures, speeds and feeds, set – up and standard times, etc.

- **Operational layouts** to give for each operation, the part sketch, method of manufacturing, and other variable information such as cutting tools, jigs and fixtures, speeds and feeds, set – up and standard time.

Activities Associated With Process Planning

- Analyse the part requirements
- Determine operation sequence
- Select the equipment
- Calculate processing times
- Select inspection methods
- Estimate manufacturing cost
- Document process plan
- Communicate to manufacturing engineer

Conclusion

- To summarize, Process Planning is important action in a production enterprise that verifies which processes, materials, and instructions will be used to produce a product. Process planning describes a manufacturing facility, processes and parameters which are to be used to change materials from a primary form to a predetermined final stage.

UNIT-V:

PRODUCTION PLANNING AND CONTROL-(LOADING AND SCHEDULING)

Loading

- A load means the quantity of work, and allocating the quantity of work to the processes necessary to manufacture each item is called loading.
- It is performed in the CRP (Capacity Requirements Planning) of the manufacturing planning. Each item planned in MRP is first explored to the processes necessary to manufacture it, which is usually called process explosion. Next loading is performed for the explored process. In loading, each load is usually piled up by time (hour), by which a setup time and a real operating time are determined. The real operating time may be set by manufacturing lot or by real operating time per item unit.

Loading- contd…

- In the former case, the time of hour is piled up as load, while in the latter case, loading is performed after calculating the real operating time per manufacturing unit by multiplying the number of manufacturing items by real operating time.

Loading-contd..

- Machine loading is the process of converting operation schedule into practices in conjunctions with routing. Machine loading is the process assigning specific jobs to machines, men, or work centers based on relative priorities and capacity utilization.

Loading-contd…

- Loading ensures maximum possible utilization of productive facilities and avoid bottleneck in production. It's important to either overloading or under loading the facilities, work centers or machines to ensure maximum utilization of resources.

Loading-contd…

- **Loading** involves assigning jobs to work centers or machines in the work centers while sequencing is concerned with determining the order in which jobs will be processed.
- The process of assigning jobs to work centers or out sources is referred to as **loading**, sequencing, or **scheduling**.

Why Scheduling?

- Every order whether it is from a customer or from the assembly benches must be completed on or before the contracted date (i.e. promised). To ensure that the delivery date is met, each component entering the assembly should be made available on time. Scheduling function of PPC makes it possible by determining starting and completion data of each of the operations listed on the process sheet.

Scheduling

- Scheduling is the process of fitting a shop order into the uncommitted time available for a machine or a group of machines required for the manufacture of the item and within the total time which is no than the promised delivery period.

Objectives of Scheduling

- Meeting customer and finished goods inventory delivery requirements.
- To achieve the required rate of output with a minimum of delay and disruption in processing.
- To have maximum utilization of men, machine and materials by maintaining a smooth flow of materials along the production line.

Objectives of Scheduling

- To prevent unbalanced use of time among departments and work centres with a view to eliminate idling of men and machines.
- To complete the production at minimum total cost and to reduce the manufacturing cycle time to the minimum.
- To deliver products in time as per the delivery schedule committed to the customers.

Problems in Scheduling

- Lack of correct and up to date information concerning lead time, production time, lot size.
- Resources constraints, capacity shortages, delay in supply of materials, machine break downs etc.
- Absenteeism, lack of skill and experience in labour and labour inefficiency resulting in actual time taken to complete a job exceeding the allowed time (i.e., standard time).

Problems in Scheduling

- Type of production i.e., job, batch, process or continuous production.
- Problems to balance the capacities of machines in the production line and also of work centres in an assembly line.

Inputs to Scheduling

(a) Performance Standards

(b) Unit of Measurement

(c) Unit of Loading and Scheduling

(d) Effective Capacity per work Centre

(e) Extent of Rush Orders

(f) Overlapping of Operations

(g) Individual Job Schedules

Performance Standards

- Performance standards is the first and the foremost requirement of good scheduling. Performance Standards enable the scheduler to determine the machine capacity in order to assign required machine hours and man hours for the various operations. Good scheduling always possible if the time study or industrial engineering departments exists in the plant. The performance standards for repetitive jobs in such plants are available and for new jobs they can be estimated from tables of synthetic standards prepared by the department.

Unit of measurement

- Unit of measurement refers to the unit in which the loading and scheduling is to be extended.
- This unit of measurement is usually different for different industries. Industries such as sugar, cement, fertilizers, foundries, steel mill etc. generally use weight (kg/tons) as a unit of measurement while in textile mills, it is in length (meters).The most common unit of measurement in engineering firms is “man-hours” or "machine-hours".

Unit Of Loading and Scheduling

- Unit of loading and scheduling refers to the duration for which loading & scheduling should be done. The unit of loading and scheduling - scheduled start and finishing timings - depends on the company's scheduling needs and the operating cycles. This implies that scheduling hand be done on daily basis if the company makes promises in days and
- it should be done on daily or weekly basis if promises are made in weeks.

Effective Capacity Per Work Centre

- Effective capacity per work centre implies effective hours available for production on a machine or on a work centre in a week, or in a month. Theoretical capacity equals number of normal working hours of that machine.

Types of interruptions

* Power Failure

* Preventive Maintenance

* Waiting for Inspection

* Operators engaged in other than production activities (functions or celebrations)

* Machine engaged for technical studies

* Tool tryouts, jigs and fixture tryouts

* Operator left work place for official discussion

* Machine breakdown (electrical or mechanical)

* Waiting for transport

The Effective Capacity of Work Center is Calculated as Under :

- Calculate theoretical capacity per period. Theoretical capacity is obtained by multiplying number of machines by normal hours available per machine per period.
- Establish utilization index after allowing time for delays and interruptions which can not be avoided even by scientific production planning and control.
- Calculate net available capacity per period by multiplying theoretical capacity by the average utilization index.
- Establish average labour efficiency against performance standards.
- Calculate effective capacity per period by multiplying net capacity per period by the average labour efficiency.

Extent of Rush Orders

- Provision of rush orders is another important consideration in scheduling. No machine should be scheduled for its
- cent percent (100%) effective capacity because if a rush order comes in. scheduling has to be changed to allow rush order to be put through the shops. Such rush orders, if received frequently, are bound to put the company's scheduling out of gear.
- The disturbance due to rush orders can be avoided by not scheduling the machine for 100% effective capacity thereby leaving some
- un-committed capacity per period per machine. This un-committed capacity is utilised to accommodate rush orders and thereby avoiding the need to alter the remainder of the scheduling. Time needed for rush orders depends on the frequency of rush orders

Extent of Rush Orders-contd..

- Each firm should work out its own average time spent on processing rush orders There are different methods of accommodating rush orders: i) The easiest method is to leave some capacity (depending upon
- the average time spent on rush orders per period)un scheduled on each machine per period. This method is useful when semi-centralised system of scheduling is adopted.
- ii)Another method of scheduling of rush orders is to leave un scheduled capacity between two scheduled jobs. This method is useful when centralised system of scheduling is followed.
- If no-rush-order is received, the unscheduled capacity may be utilised for the new jobs or for early completion of the jobs previously scheduled.

Over Lapping of Operations

- Over lapping of operations is yet another useful consideration in scheduling. Overlapping of operations refers to running of a job simultaneously on more than one machine and it occurs in jobs which involve two or more operations. Over lapping of operations helps to reduce the manufacturing cycle time and hence the delivery period to the customer.

Individual Job Schedules

- A part or component generally undergoes a number of operations some of which may be carried out simultaneously while others may need to be completed before the next operation is started. The process sheet of the component does not indicate overlapping of operations whereas the job schedule does. The job schedule of the component is generally fixed and does not require to be changed unless there is change in method of manufacture

How Many Job Schedule?

- One job schedule is prepared for each component. A company which manufactures a wide range of products, therefore, prepares large number of schedules which are filed to be used as a basis for production control.
- Such schedules are not dated but specify the time required for each operation. Once delivery date is fixed, the job schedule is dated and starting and completion dates of each operation are derived considering the load chart.

Main Information To Be Entered?

A job schedule should contain the following information:

- **Identification** data such as part name, part number etc.
- Batch quantity.
- Variable information in the form of columns to show:
    - Operation Number
    - Operation Description
    - Machine/ Work Centre
    - Effective Capacity/ Day
    - Set Up Time
    - Standard Time
- Columns to record the running time for each operation.

How to Draw a Job Schedule?

(i) The constant information is entered first in the schedule which is followed by batch quantity. The variable information such as operation numbers, operation descriptions, machines and effective capacity/ day is then entered in the schedule.

How to Draw a Job Schedule?-contd…

(ii) The time (hrs) is then calculated for each operation as under:

- Time(hrs) for an operation = (Std.time/ Piece x Batch quantity) ÷ 60
- From the time figure calculated above, the length of operation run (days) is calculated:
- Operation run (days) =

(Time (hrs) for an operation) ÷Effective capacity/ day (hrs/ day)

How to Draw a Job Schedule?-contd…

(iii) Each operation run is shown in the schedule by extending it by the suitable length which equals the time (days) required to complete the batch quantity for that operation. Overlapping of operations, wherever possible is also considered.

How to Draw a Job Schedule?-contd…

(iv) ***Loading Charts***: Rarely a company manufactures one or few jobs at a times. They manufacture a number of job simultaneously. It is therefore, essential to know machine wise/work centre wise work load on hand and this is precisely the purpose of load charts. A load chart specifies the work to be carried out in each section or the department of the company during the period under review.

Loading and Scheduling Devices

- In one operation, the scheduling device may be in the form of a sheet or a card for each machine.
- In more than one operations but in a fixed sequence of operations, the scheduling device still can be in the form of a sheet or a card for each machine.
- In different operations on various machines in varying operation sequences, the scheduling device should consist of:

  (i) a separate sheet or a board for each job which should give at a glance the scheduling of various operations involved in a job and the starting and the completion time for each of the operations. Such a chart is called **work schedule.**

  (ii) another board which should show different tasks against different work centers or departments. Such a board or chart is called **load chart.**

Scheduling Example

Suppose there are three jobs in a production department that are to be processed on four categories (types) of machines. We designate the jobs as A, B, and C; and the machine types are designated as M1, M2, M3, and M4.

The three jobs consist of 4, 3, and 4 operations respectively; and there are four machines - one machine of each type. We designate them as M1, M2, M3, and M4 based on their categories.

The operations for job A are designated as A1, A2, A3, and A4. The operations of job B are designated as B1, B2, and B3. Similarly the four operations of job C are designated as C1, C2, C3, and C4.

Scheduling Example-contd…

- Each job is characterized by its routing that specifies the information about the number of operations to be performed, the sequence of these operations, and the machines required for processing these operations.
- The times required for processing these operations are also required for developing a production schedule.

Scheduling Example - Data

The table on right hand side (RHS) gives the data for this example.

The table gives the machine required for each operation of each job. For example, the first operation of job A, A1, is processed on machine M1; second operation, A2, is processed on machine M3 and so on.

The operations of all jobs have to follow their processing sequences. For example operation A3 of job A can not be processed before operation A2.

The processing time for each operation is also given in this table.

Job	Operation Number	Machine Number	Processing Time (Days)
A	A1	M1	5
	A2	M3	3
	A3	M4	7
	A4	M2	4
B	B1	M2	2
	B2	M3	6
	B3	M4	8
C	C1	M1	4
	C2	M2	6
	C3	M3	8
	C4	M4	2

Scheduling Example – Objective Function

- The objective is to schedule these jobs so as to minimize the time to complete all jobs. This time is called *make-span* or the *schedule time*.

GANTT CHARTS

- Gantt Chart, developed by an American Engineer, Henry L. Gantt. is a very useful aid in loading and scheduling, dispatching and progressing. The chart is normally drawn on a printed or ruled sheet. Alternatively, it may be drawn on a ruled board.

GANTT CHARTS-contd…

- The chart consists of a simple grid formed by a series of horizontal and vertical lines. The vertical lines divide horizontal lines into small squares representing units of measurement which may be days, weeks or months. The horizontal lines divide vertical lines into sections which are used to represent either operations (job schedule) or to represent work centres (load chart).

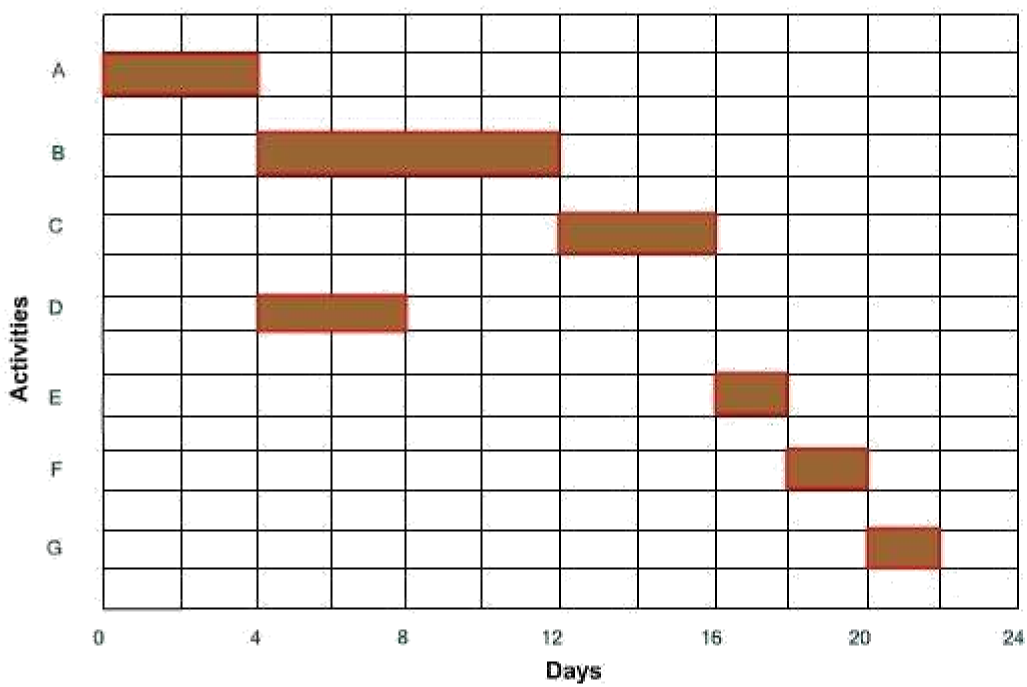
GANTT CHARTS-contd…

- The chart may be drawn to show at a glance the scheduling of various operations involved in a job or it may be drawn to show work ahead of each machine or work centre with respect to time i.e. in days or weeks.

GANTT CHART-contd…

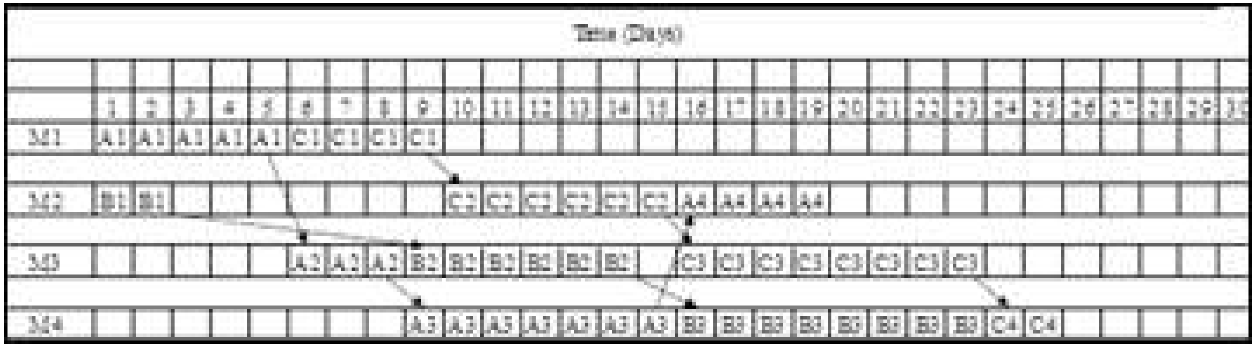
- Simple graphical display technique – suitable for less complex situations
- This does not provide any rules for choosing but simply presents a graphical technique for displaying results (and schedule) and for evaluating results (idle time, waiting time, machine utilization, etc.)

GANTT CHARTS-Figure



Scheduling Example Solution–Gantt Chart

- One of the schedules for this example is presented below in the form of a Gantt Chart.
- The Gantt chart, for each machine, shows the start and finish times of all operations scheduled on that machine.



Scheduling Example - Alternative Schedules

- Several alternative schedules can be generated for this example.
- The schedules differ in the order in which the jobs are processed on the four machines. Three of these schedules are:

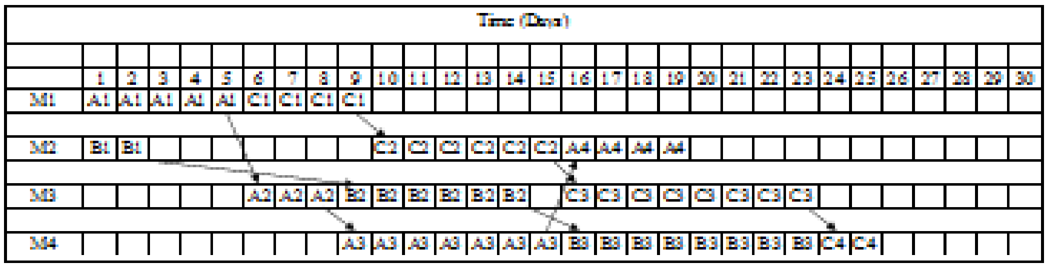
- The first schedule orders jobs as: A first, then B and then C (A-B-C).
- The second schedule orders jobs as: B first, then A, and then C (B-A-C).
- The third schedule orders jobs as: C first, then A, and then B (C-A-B).

- The Gantt charts for these schedules are shown in next slide.

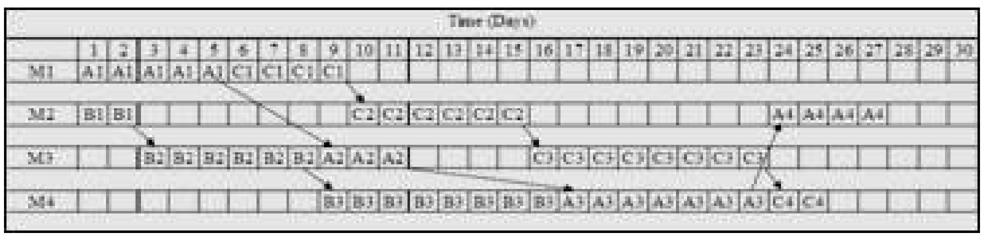
- The values of make-span for these three schedules are 25, 27 and 30 days respectively.

Schedule A-B-C is the best of these three schedules.

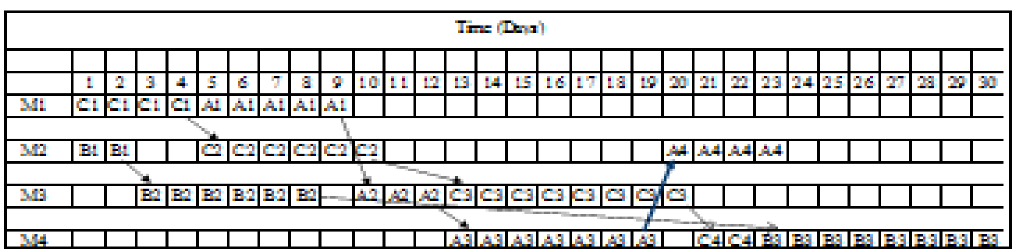
Scheduling Example - Alternative Schedules-contd…



Sequence A-B-C (Make-span = 25 days)



Sequence B-A-C (Make-span = 27 days)



Sequence C-A-B (Make-span = 30 days)

Scheduling Example - Alternative Schedules-contd…

- Is sequence A-B-C the global optimal? Can we find a better sequence than this? The scheduling techniques attempt to answer these questions.

- It should be mentioned that there are different effectiveness measures of a schedule in different situations. Minimizing make-span is only one of them. We will study other effectiveness measures also.

Scheduling Example - Assumptions

- Once a job is started on a machine, its processing can not be interrupted, that is, preemption is not allowed.

- The machines are continuously available and will not break down during the planning horizon. This assumption is rather unrealistic but we make this assumption to avoid complexity in discussing scheduling concepts.

- A machine is not kept idle if a job is available to be processed.

- Also, each machine can process only one job at a time.

How To Reduce Scheduling Problem?

- Product Simplification
- Multi – Skilling
- Sub – Contracting
- Re – Allocation of Resources to Suit Work Content
- Minimization of Rush Orders
- Creating Controlled WIP Banks
- Reducing Job - Split – Ups
- Simplifying Available Resources
- Avoiding Last Minute Rush
- Improving Progress Chasing

Product Simplification

- The total sales of an organization follow a lopsided distribution with 20% of the products contributing 80%of the total sales. The exclusion of products which produce little income and less contribution though is unlikely to change the above ratio and thereby effect adversely the profit of the company yet it simplifies the scheduling problems.

Multi-skilling

- Unauthorised employees' absenteeism is one of the factors which puts the scheduling of the company out of gear. Abnormal absenteeism tends to delay the timely completion of the Jobs. Training of employees for their ability to perform a number of jobs rather than one job improves their flexibility and morale. This enables the foreman to shift any employee from a lesser important job to a critical job in case of absenteeism.

Sub-Contracting

- Sub-contracting is generally more rewarding than processing peak loads at the home plant by overtime working. Sub-contracting can be compared to the process of delegation of authority. Simple operations and those less liable for rejection and requiring use of general purpose machines can be economically off loaded to small sub-contractors.

Re-allocation of Resources To Suit Work Content

- A company generally has "big" jobs which consume a great deal of machine or labour hours and "small" jobs which require few man or machine hours.
- To process "big" and "Small" jobs on the same machines is usually uneconomical as well as difficult. Separate machines, if reserved for small and big jobs, not only simplifies scheduling but also reduces manufacturing cycle time of the jobs.

Minimization of Rush Orders

- Occasional rash order to accommodate customers are welcome. Too many rush orders cause disturbances, loss of productive capacity, failure of delivery of other jobs etc. The company must exert discretion in accepting rush orders.

Creating Controlled WIP Banks

- Starting every job from the beginning and processing through all the operations during each scheduling period (say every month) usually requires priority over others. This causes job split ups and last minute rush. Creating controlled WIP banks eases scheduling problems. Some methods are: Run simpler operations, where capacity is available, in big lots; e.g. Individual production schedules for blanking and gear cutting wherever possible.

Reducing Job-Split-Ups

- Job split-ups are always associated with large machine set-ups which eat into company's productive capacity. Minimization of job split-ups creates a great deal of productive capacity

Simplifying Available Resources

- Many a machines are apparently complex. Uniformity in machine types can substantially ease scheduling problems

Avoiding Last Minute Rush

- Don't sit tight on the job thinking that there is still sufficient time. This causes job split-ups.

Improving Progress Chasing

- A job may be held back because:
- vendors have not supplied the jobs on date
- tool room has not prepared the necessary tooling on time
- purchase department has failed to get the raw materials, standard tools or gauges as per schedule

Improving Progress Chasing-contd…

- The effect of the above problems can be minimized by efficient progress chasing thereby reminding everyone concerned repeatedly for the necessary action

Classification of Scheduling Problems

- The scheduling problems can be classified based on the following criteria:

- Sequence of machines
- Number of machines
- Processing times
- Job arrival time
- Objective functions

Sequence of Machines

- The sequencing problems, based on the sequence of machines, are classified as:
  - Flow Shops
  - Job Shops

Flow Shop

- In a flow-shop , processing of all jobs require machines in the same order.
- The following table gives an example of a flow-shop in which three jobs, A, B, and C are processed on four machines, M1, M2, M3, and M4.
- The sequences of machines to process these jobs are same (M1-M3-M4-M2).

Example of a Flow Shop

Job	Operation # 1	Operation # 2	Operation # 3	Operation # 4	Machine for Operation # 1	Machine for Operation # 2	Machine for Operation # 3	Machine for Operation # 4
A	A1	A2	A3	A4	M1	M3	M4	M2
B	B1	B2	B3	B4	M1	M3	M4	M2
C	C1	C2	C3	C4	M1	M3	M4	M2

Job Shop

- In a job shop the sequence of machines will be mixed, that is, the jobs may require machines in different sequences.

Example of a Job Shop								
Job	Operation # 1	Operation # 2	Operation # 3	Operation # 4	Machine for Operation # 1	Machine for Operation # 2	Machine for Operation # 3	Machine for Operation # 4
A	A1	A2	A3	A4	M1	M3	M4	M2
B	B1	B2	B3		M2	M3	M4	
C	C1	C2	C3	C4	M1	M2	M3	M4

Number of Machines

- Based on the number of machines, the scheduling problems are classified as:
  - Single machine problems
  - Two-machine problems
  - Multiple (3 or more) machine problems

Processing Times

- ***Deterministic***: If processing times of all jobs are known and constant the scheduling problem is called a deterministic problem.
- ***Probabilistic***: The scheduling problem is called probabilistic (or stochastic) if the processing times are not fixed; i.e., the processing times must be represented by a probability distribution.

Job Arrival Times

- Based on this criterion, scheduling problems are classified as static and dynamic problems.
  - ***<u>Static</u>***: In the case of static problems the number of jobs is fixed and will not change until the current set of jobs has been processed.
  - ***Dynamic***: In the case of dynamic problems, new jobs enter the system and become part of the current set of unprocessed jobs. The arrival rate of jobs is given in the case of dynamic problems.

Objective Functions

- Scheduling researchers have studied a large variety of objective functions.

In this presentation, we will focus on the following objectives.

- Minimize make-span
- Minimize average flow time (or job completion time)
- Average number of jobs in the system
- Minimize average tardiness
- Minimize maximum tardiness
- Minimize number of tardy jobs

Objective Functions-contd…

- Minimizing make span is relevant for two or more machines.

- In this presentation we will discuss the scheduling rule for static and deterministic flow shop problems consisting of two machines where the objective is to minimize make-span.

- The other five objectives can be used for any number of machines, both deterministic and probabilistic processing times, and for static as well as dynamic problems.

- However, we will study these objective functions for a single machine, deterministic and static problems.

- The scheduling rule for job shops and for more than three machines are complex and beyond the scope of this presentation.

Techniques Of Scheduling :

- Johnson's Two Machine Algorithm
- Index Method
- Critical Path Analysis
- Critical Ratio Scheduling

Johnson's Rule
to Minimize Make-span

- We use the following four step process to find the optimal sequence.
- **<u>Step 1:</u>** Find the minimum processing time considering times on both machines.
- ***<u>Step 2:</u>*** Identify the corresponding job and the corresponding machine for the minimum time identified at Step 1.

Johnson's Rule-contd…

- ***Step 3***: Scheduling Rule

  (a) If the machine identified in Step 2 is machine M1 then the job identified in Step 2 will be scheduled in the first available schedule position.

  (b) If the machine identified in Step 2 is machine M2 then the job identified in Step 2 will be scheduled in the last available schedule position.

- ***Step 4:*** Remove the job from consideration whose position has been fixed in Step 3; and go to Step 1.

Continue this process until all jobs have been scheduled.

Johnson's Rule-contd…

- Johnson's rule makes the following assumptions:

- The same optimal sequence is used on both machines.

- Preemption is not allowed, that is, once a job is started it is not interrupted.

Iteration 1

Step 1: The minimum time is 1.

Step 2: The job is D and the machine is M2.

Step 3: Since the machine identified at Step 2 is machine M2, job D will be assigned to the last available sequence position which is position 5; and the resulting partial sequence is given below.

Position 1	Position 2	Position 3	Position 4	D

Step 4: Delete job D from consideration.

Job	Operation # 1	Operation # 2	Machine for Operation # 1	Machine for Operation # 2	Time for Operation # 1 (Days)	Time for Operation # 2 (Days)
A	A1	A2	M1	M2	8	3
B	B1	B2	M1	M2	5	7
C	C1	C2	M1	M2	6	9
D	D1	D2	M1	M2	7	1
E	E1	E2	M1	M2	4	6

Iteration 2

Step 1: The next minimum time is 3.

Step 2: The job is A and the machine is M2.

Step 3: The job A will be assigned to the last available schedule position, which is position 4. After assigning job A to position 4, the partial sequence is given below.

Job	Operation # 1	Operation # 2	Machine for Operation # 1	Machine for Operation # 2	Time for Operation # 1 (Days)	Time for Operation # 2 (Days)	
A	A1	A2	M1	M2	8	3	
B	B1	B2	M1	M2	5	7	
C	C1	C2	M1	M2	6	9	
~~D~~	~~D1~~	~~D2~~	~~M1~~	~~M2~~	~~7~~	~~1~~	Scheduled
E	E1	E2	M1	M2	4	6	

Step 4: Delete job A from consideration.

Position 1	Position 2	Position 3	A	D

Iteration 3

Step 1: The minimum time is 4.
Step 2: The job is E and the machine is M1.
Step 3: The job E will be assigned to the first available schedule position, which is position 1. The partial sequence after assigning job E to position 1 is given below.

E	Position 2	Position 3	A	D

Step 4: Delete job E from consideration

Job	Operation # 1	Operation # 2	Machine for Operation # 1	Machine for Operation # 2	Time for Operation # 1 (Days)	Time for Operation # 2 (Days)	
~~A~~	~~A1~~	~~A2~~	~~M1~~	~~M2~~	~~8~~	~~3~~	Scheduled
B	B1	B2	M1	M2	5	7	
C	C1	C2	M1	M2	6	9	
~~D~~	~~D1~~	~~D2~~	~~M1~~	~~M2~~	~~7~~	~~1~~	Scheduled
E	E1	E2	M1	M2	4	6	

Iteration 4

Step 1: The minimum time is 5.

Step 2: The job is B and the machine is M1.

Step 3: The job B will be assigned to the first available schedule position, which is position 2. The partial sequence after assigning job B to position 2 is given below.

Job	Operation # 1	Operation # 2	Machine for Operation # 1	Machine for Operation # 2	Time for Operation # 1 (Days)	Time for Operation # 2 (Days)	
~~A~~	~~A1~~	~~A2~~	~~M1~~	~~M2~~	~~8~~	~~3~~	Scheduled
B	B1	B2	M1	M2	5	7	
C	C1	C2	M1	M2	6	9	
~~D~~	~~D1~~	~~D2~~	~~M1~~	~~M2~~	~~7~~	~~1~~	Scheduled
~~E~~	~~E1~~	~~E2~~	~~M1~~	~~M2~~	~~4~~	~~6~~	Scheduled

Step 4: Delete job B from consideration

E	B	Position 3	A	D

Iteration 5

- The only unscheduled job at this stage is C and; it will be assigned to the remaining unassigned position 3.

- The final sequence is given below.
- The value of make-span for this sequence will be determined by drawing the Gantt chart.

Job	Operation # 1	Operation # 2	Machine for Operation # 1	Machine for Operation # 2	Time for Operation # 1 (Days)	Time for Operation # 2 (Days)	
~~A~~	~~A1~~	~~A2~~	~~M1~~	~~M2~~	~~8~~	~~3~~	Scheduled
~~B~~	~~B1~~	~~B2~~	~~M1~~	~~M2~~	~~5~~	~~7~~	Scheduled
C	C1	C2	M1	M2	6	9	
~~D~~	~~D1~~	~~D2~~	~~M1~~	~~M2~~	~~7~~	~~1~~	Scheduled
~~E~~	~~E1~~	~~E2~~	~~M1~~	~~M2~~	~~4~~	~~6~~	Scheduled

E	B	C	A	D

Finding Make-Span

- The sequence E-B-C-A-D identified by Johnson's rule guarantees the minimum value of make-span.
- However, Johnson's rule does not give the value of make-span. It only identifies the best sequence.
- The value of make-span is obtained either by drawing the Gantt chart or a computerized algorithm can be developed.
- The Gantt chart for this optimal sequence is given in the next slide.

Sequence E-B-C-A-D

- The Gantt chart for the sequence E-B-C-A-D is given below. The value of make-span is 31 days.

- The optimal (minimum) value of make-span for this problem is therefore, 31 days.

Gantt Chart for Sequence E-B-C-A-D

Time (Days)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
M1	E1	E1	E1	E1	B1	B1	B1	B1	B1	C1	C1	C1	C1	C1	C1	A1	A1	A1	A1	A1	A1	A1	A1	D1	D1	D1	D1	D1	D1	D1						
M2					E2	E2	E2	E2	E2	E2	B2	B2	B2	B2	B2	B2	B2	C2	C2	C2	C2	C2	C2	C2	C2	C2	A2	A2	A2		D2					

Index Method

- Used for the purpose of the loading and also for allocating the different jobs to the different machines.
- Generally orders are assigned on the basis of the "first come first assigned" **method**

Critical Path Method (CPM)

- Critical path method (CPM) is a resource-utilization algorithm for scheduling a set of project activities. The essential technique for using CPM is to construct a model of the project that includes the following:

- A list of all tasks required to complete the project
- The dependencies between the tasks
- The estimate of time (duration) that each activity will take to complete

The Types of Scheduling in Production Planning and Control

- Master Production Scheduling
- Manufacturing and Operation Scheduling or Detailed scheduling
- Advanced Planning and Scheduling (APS) Software

Master Production Scheduling

- Master Production Scheduling (MPS) is a scheduling strategy that dictates when and how much of each product is going to be produced based on criteria such as demand, capacity, and inventory availability.
- This type of scheduling focuses on a planning horizon that is divided into equal time period (called ‘time buckets’). It includes a plan for the production of certain products and defines resources, staffing, inventory, etc required for the allotted time period.

Master Production Scheduling-contd…

- MPS aids in decision making by generating a set of output data based on inputs such as:
- Forecasted demand
- Production costs
- Inventory costs
- Customer needs
- Production lead time
- Capacity

Master Production Scheduling-contd…

- The resulting output information includes:
- The amounts to produce
- Staffing requirements
- Quantity of products Available to Promise
- Projected available funds for production
- It also sets the expectations of the revenue that the business is likely to generate. These outputs can then be used to create a Material Requirements Planning (MRP) schedule.

Manufacturing and Operation Scheduling or Detailed Scheduling

- Manufacturing Scheduling (also called ‘Detailed Scheduling’ or ‘Production Scheduling’) focuses on a shorter horizon than MPS.
- This type of scheduling fixes a time and a date to each operation in a continuous timeline rather than in time buckets. Each process can then be visualized in terms of its start time and completion time-frame. The subsequent stages of production planning and control depend on this timeline.

Manufacturing and Operation Scheduling or Detailed Scheduling-contd…

- Scheduling looks to optimize the use of time in each step of the production process, from raw or intermediate materials to the delivery of the finished good to the customer.

Manufacturing and Operation Scheduling or Detailed Scheduling-contd…

- The goal is to maximize throughput (output) and on-time delivery within the constraints of equipment, labor, storage, and inventory capacity. This usually involves maximizing the utilization of critical bottleneck resources by:
- Minimizing changeovers
- Minimizing cleanout intervals
- Avoiding material starvation

Advanced Planning and Scheduling (APS) Software

- Advanced Planning and Scheduling (APS) Software have become a must for modern-day manufacturing operations as customer demand for increased product assortment, fast delivery, and downward cost pressures become prevalent. These systems help planners save time while providing greater agility in updating ever-changing priorities, production schedules, and inventory plans.

Advanced Planning and Scheduling (APS) Software-contd…

- APS systems can be easily integrated with ERP/MRP software to fill the gaps where these systems lack planning and scheduling flexibility, accuracy, and efficiency.

Advanced Planning and Scheduling (APS) Software-contd…

- The implementation of APS will take your manufacturing operations to the next level of production efficiency by taking advantage of the operational data you already possess in your ERP system.

Advanced Planning and Scheduling (APS) Software-Merits-contd…

- Create optimized schedules that balance production efficiency and delivery performance
- Maximize throughput on bottleneck resources to increase revenue
- Synchronize supply with demand to reduce inventories
- Provide company-wide visibility to resource capacity
- Enable scenario data-driven decision making

UNIT-VI:
PRODUCTION CONTROL-(DISPATCHING)

Dispatching

- This is concerned with the execution of the planning functions. It gives necessary authority to start a particular work which has already planned under routing and scheduling functions. Dispatching is release of orders and instructions for starting of production in accordance with routing sheet and scheduling charts.

Function of Dispatching

- Release of Manufacturing Orders
- Stores Issues
- Return of “Surplus” or Left Over Material
- Tools Issue
  - (i) Consumable Tools
  - (ii) Machine Aids
  - (iii) Work Aids
  - (iv) Inspection Aids
- Shop and Inter – Departmental Transport
- First Off and Stage Inspection
- Co-ordination with Scheduler
- Allocation of Jobs to Machines
- Forwarding Material to Dispatch or to Finished Parts Stores
- Collection of Route Sheets and Operational Layouts at the End of Production Run

Release of Manufacturing Orders

- The primary function of dispatching is to prepare manufacturing-order-set which consists of shop orders, operational layouts, pre-filled-stores-issue orders, tool orders, move orders, inspection orders and the like. These documents are generally drawn from respective files, collated together and kept ready for issue at the right time to the concerned persons.

Release of Manufacturing Orders-contd..

- Scheduled start of an operation is authorized by issuing a job-card (time ticket). The job card is prepared in duplicate. The original is given to the operator and its copy is retained by the dispatcher. The job-card before issue is stamped for the start date. On completion of the work, the job card (or time ticket) is routed through the PPC department where it is again stamped for completion and is forwarded for costs and payroll work.

Stores Issues

- Another important function of dispatcher is to withdraw required quantity of materials from stores and deliver it to the machine where the first operation is to be performed well before the scheduled start of the job. The most common practice is to make use of stores issue order.

Stores Issues

- Stores issue order is though prepared for the item as soon as the route sheet is ready yet it is not desirable to issue it too early because:
- \- material may or may not be available at the time of preparation of stores issue order
- \- It will cause congestion on the shop floor if the material is moved too early in advance of the scheduled start of the job.

Stores Issues

- Stores issue order, therefore, is filed along with other papers of the job and is handed over to the dispatcher a day or two before the scheduled start of the first operation. The dispatcher then passes on this order to the stores to issue of ready materials to the shop when authorized.

Return of Surplus" or Left Over Material

- At times materials issued against stores issue orders are not fully consumed. There are number of reasons why surplus material is left on the shop floor after the quantity on the shop order is completed. Return of such surplus materials is the responsibility of the dispatcher which he does through a stores return note.

Tools Issue

- Equally important is the dispatcher's function of movement of tooling to the work centre where it is required.
- Tooling includes:

Consumable tools such as drills, reamers, metal cutting saws,inserts, carbide tools, hobs, gear shaping cutters, broaches, milling cutters, etc.

Tools Issue

- Consumable tools are stored at the company's subsidiary Stores - tool cribs and are issued to the workmen against tool vouchers or token numbers.

Machine Aids

- Machine aids such as vices, chucks, collets, tool arbors etc. Machine aids are usually kept in a separate fixture store and require to be issued at the time of the set-up of the machine tool.

Work Aids

- Work aids such as jigs and fixtures, work arbors, copying templates broaching fixtures and broach holders, etc.
- Work aids are also stored at the fixture stores and require to be issued at the time of set-up of the machine tool.

Inspection Aids

- Inspection aids such as verniers, micrometers. Gauges, inspection fixtures, etc.
- Inspection aids are stored at the company's subsidiary stores-tool cribs and require to be issued to the workmen against tool vouchers.

Shop And Inter-Departmental Transport

- Shop and Inter-departmental transport constitutes yet another important function of dispatching.
- Materials movement from stores to the first work centre is generally the responsibility of the dispatcher which may be organised by the issue of move order to the shop labourers, truck drivers, or specialist move men.

Shop And Inter-departmental Transport

- The materials movement between work centres is achieved by fixing responsibility on the shop supervisors who are expected to inform the move men when a particular batch has been completed and it is ready to be moved on.

First Off and Stage Inspection

- First off and stage inspection is undertaken by the inspection department on the receipt of Inspection orders from dispatcher's office. A written inspection order is necessary to authorise Inspection to verify the correctness of the machine tool set-up. The most common method is produce one /two pieces on the machine after it has been set up and offer the same to the inspection together with the inspection order.

First off and stage inspection

- No inspection order is needed for simple jobs which can be inspected by the shop inspector with the tooling available on the shops. An inspection order is necessary when the job requires detailed verification of one or more of the job characteristics with the help of special equipment which is not available at the producing company.

Co-ordination with Scheduler

- Routing lays down the operations and their sequence while scheduling assigns timings to the different operations to be performed by different men and machines. These two activities are co-ordinated on the shop floor by dispatching cell of the PPC. Rarely, the progress of work is the line with its plan. It is either ahead of the schedule or it is the behind the schedule

Allocation of Jobs to Machines

- Dispatcher at times in consultation with the shop foreman may also perform the final stage of planning, i.e, allocation of individual operations to individual machines. This becomes possible only when scheduling is semi-centralised wherein weekly or fortnight work load is given to each shop.

Forwarding material to dispatch or to finished parts stores

- Forwarding material to dispatch or to finished parts stores constitutes yet another important function of dispatching .Goods after final inspection are forwarded to either dispatch section or finished parts stores. They need to be accompanied by the document called forwarding note to enable despatch department to identify the items and draw correct reference.

Collection Of Route Sheets And Operational Layouts At The End Of Production Run

- Operational layouts, after goods have been manufactured, require to be collected back from the shops and filed so that they can be re-issued at a later date. If operation layouts are not collected and are allowed to remain with the shops, they get dirty or even lost, thus requiring to be replaced at the time of repeat production run. This adds unnecessary cost to the product.

How Dispatching Function Is Performed?

(i) The top compartment contains the copy of the job card or time ticket of the item currently being worked on the machine.

(ii) The middle compartment contains the copy of the time ticket of the item to be processed next on the machine.

(iii) The bottom compartment contains the bunch of time tickets of the items, arranged one after another in the sequence in which they are to be processed.

(iv) As the work progresses and the time ticket in ‘top’ compartment is completed, the time ticket from the ‘middle’ compartment is transferred to the top compartment, and next held in ‘bottom’ compartment is moved into middle compartment.

Documents In Dispatching

(i) Job cards/ time ticket (one for each operation) to provide foreman with instructions to perform the operation as shown in it.

(ii) Stores issue order to instruct stores department to issue material

(iii) Tool order (one for each operation) to instruct toolcrib to keep necessary tools ready for issue.

(iv) Move order to instruct movemen for movement of material from stores to the first machine and between departments.

(v) Inspection order (one for each stage of inspection) to report inspection results.

(vi) Machine set – up order to instruct setters to set – up machine tools mentioned there in.

(vii) Forwarding note to inform dispatch/ finished parts stores regarding the description of the goods accompanying the note.

Dispatching Under Different Situations

- The complexity of dispatcher's works varies with the type of manufacture. The dispatching function is of very little importance in flow and mass production units as the dispatcher's work is merely limited to the dispatch of the material necessary to manufacture the product. The materials automatically pass though different stages of the production line.

Dispatching Under Different Situations

- Dispatching in jobbing production units is usually complex. New tools are often necessary.
- As the flow of the materials is discontinuous , it therefore, becomes the duty of the dispatcher to control the movement of materials between machines.

Dispatching Under Different Situations

- Dispatching as a principle needs to be a centralized function.
- The most desirable method is to have posting record which is department wise and within the department it is machine wise.

The Responsibilities of the Dispatchers Include :

- Release of manufacturing orders.
- Issue and movement of material/ jigs and fixtures to the first machine.
- Return of surplus material back to store.
- Shop and inter – departmental transport.
- Indicating priorities to stage and final inspection.
- Co-ordination with scheduler.
- Allocation of jobs to machines.
- Forwarding finished parts to stores.
- Collection of route sheets and operational layouts at the end of the production run.

Progressing or Follow Up

- After the dispatching function is completed, processing of various operations has been authorized to begin in time as planned by scheduling department, the follow up is to check the progress of the order undertaken as it is being produced from the first operation until the order is converted into final product. Thus it regulates the progress of material and parts through the production processes.

Progressing or Follow Up

- Follow up or expediting or progressing is that branch of production control procedure which regulates the progress of materials and parts through production process.
- Following up closely interrelates with the activities of a dispatcher to whom the scheduling responsibility is delegated.

Progressing or Follow Up

- Follow up is checking the manufacturing activities systematically so that production may be carried out according to plan. It is the measurement of output against plan, analysis of the performance for shortcomings if any and following up the management in order to apply corrective action to prevent excessive shortfall.

Progressing or Follow Up

- Expediting or progressing ensures that, the work is carried out as per the plan and delivery schedules are met.

Progressing or Follow Up

- Progressing includes activities such as status reporting, attending to bottlenecks or holdups in production and removing the same ,controlling variations or deviations from planned performance levels following up and monitoring progress of work through all stages of production, co-ordinating with purchase, stores, tool room and maintenance departments and modifying the production plans and re plan if necessary.

Need For Expediting

- Need for expediting may arise due to the following reasons:

  1. Delay in supply of materials.

  2. Excessive absenteeism.

  3. Changes in design specifications.

  4. Changes in delivery schedules initiated by customers.

  5. Break down of machines or tools, jigs and fixtures.

  6.Errors in design drawings and process plans.

FUNCTION OF PROGRESSING

- Collecting information from manufacturing shops.
- Recording progress of work and comparison of actual progress against manufacturing plan.
- Expediting to rush up remaining operations.
- Communicating anticipated delays in deliveries to sales and customers.

DOCUMENTS IN PROGRESSING

- Daily Production Report

  Or Job card

  Or Perforated route sheet\

  Or Detachable ticket

  to collect information of work completed on different machines on a certain date.

- Progress card to record the progress of work and compare actual progress against manufacturing plan.
- Revised delivery schedule to express inability to adhere to previous delivery Commitment and revised fresh delivery date.

Job Card

- **Job Card** stores actual **production** information about a particular Operation performed on a particular Workstation.
- **Job Card** completion will changes the **production** status in Work Order, we can track the completion of **production** progress for each of the Operations defined in the Work Order. .

Job Card

- It gives details of the time taken to do a piece of work and the **materials** used in the process. This is used to allocate direct labour and **materials** costs. It leaves a record of daily tasks that can be later audited.

Job card

JOB CARD

DOC No	
REV No	
Date	

ORDER STARING DATE	
CUSTOMER	
WORKODER NO.	

DETAILS

SR. NO	DATE	PRODUCTION LINE DESCRIPTION	TIME (MINUTES) START TIME	END TIME	TOTAL TIME	LOCATION NAME	REMARKS

Progress Card In Production

Daily Production Report

Your Company, Inc.

WORK CENTER	Carlington Center
SHIFT	7am - 3pm
DATE	05/19/12

SCHEDULE				PRODUCTION					
PRODUCTION NUMBER	CUSTOMER	PRODUCT SIZE AND DESCRIPTION	ORDER QTY	START	STOP	HOURS	CHARGED WEIGHT	PRODUCT WEIGHT	SCRAP LOSS
JJ-005	Customer	10 ounce jars	15500	7:00	11:45	4:45 hrs	1365.8	1327.4	38.4
LL-9009	Customer	15 ounce jars	54000	10:00	23:55	13:55 hrs	6750.0	6687.0	63.0

DELAYS		EXPLANATION
FROM	TO	

PREPARED BY ______________________ APPROVED BY ______________________

Purpose of Doing Follow Up

- Follow Up for Materials
- Follow Up of Work in Progress
- Follow Up for Assembly and Erection

Follow Up For Materials

- Logically it is the duty of the purchase department to ensure that the requisitioned material should reach the requisitioner on or before the date of delivery to meet the production schedule promises.
- But in case of very important orders which must be met in time, the follow up section of the production control department, takes steps for collection of the materials. In such cases follow up is accomplished by filing one copy of the requisition slip in a daily follow up file according to the due date the material is to be received.

Follow Up of Work in Progress

- In case of serialized production, it consists of check on the required materials for specific process and recording the production output of the production deptt. to see whether it is in accordance with schedule.

Follow Up of Work in Progress

- In order to meet schedule promises, some priority may be given to the late jobs. In case of job order manufacture, where the different products are produced at the same time, the sequence of orders may be changed in order to meet certain specific situations.
- The section in charge or production engineer should be advised by the follow-up man regarding the best sequence in which orders should be taken up in order to provide the completion of the assembly at proper time and place. A time record of job or order showing the start and completion time, number of pieces produced and rejection is made.

Follow Up For Assembly And Erection

- In such situations one follow up man is given the entire responsibility. The various parts and components being manufactured at various work stations may be temporarily stored at those very places so that the follow up man shall release them when the rest of the component parts forming the assembly are ready for final assembly purposes.
- In case of very complex and large equipment/products, the work of installation erection and servicing is done at purchaser's place. The requirement will be that the follow up man should be well acquainted with the engineering details, trouble shooting and servicing of the equipment/machine at the consumer's plant.

Tasks of Follow up or Progress Reporting

- Recording of actual production
- Compare the actual production with the planned production.
- Can measure the production variability.
- Can report the excessive variance to the production planning department for corrective action.

Summary

- Production planning and control is necessarily concerned with implementing the plans, i.e. the detailed scheduling of jobs, assigning of workloads to machines (and people), the actual flow of work through the system. Production is an organized activity of converting row materials into useful products.

Summary-contd...

- Production system requires the optimal utilization of natural resources like men, money, machine, materials and time. Production planning and control coordinate with different departments: such as production, marketing, logistics, warehouse and other departments depending upon the nature of organization. Production planning and control receives data related to orders from marketing departments.

Summary-contd…

- Production plan based on marketing and production data is prepared in production planning and control. This production plan provides clear idea about utilization of manufacturing resources for production. Prepared production plan is delivered to production department. Production department manufacture products according to that plan.

Summary-contd…

- The ultimate objective of production planning and control, like that of all other manufacturing controls, is to contribute to the profits of the enterprise. As with inventory management and control, this is accomplished by keeping the customers satisfied through the meeting of delivery schedules.