Quality Tools

BPF2123 – Quality Management System

Chapter Outline

- Check Sheets
- Process Flow Diagram
- Cause-and-Effect Diagram
- Pareto Diagram
- Histogram
- Scatter Diagrams
- Matrix Analysis

Check Sheets

- A check sheet is a data recording device
- Purpose: to ensure data is collected carefully, systematically and accurately.
- As events occur in categories, a check or mark is placed on the check sheet in the appropriate category
- Given a list of items or events, the user of a check sheet marks down the number of times a particular event or item occurs – the user checks off occurrences
- Checklist is differ where it lists all of the important steps or actions that need to take place or things that need to be remembered

Check Sheets

Example:

Door paint check sheet

Sheet number 243

Paint robot number: B32A6

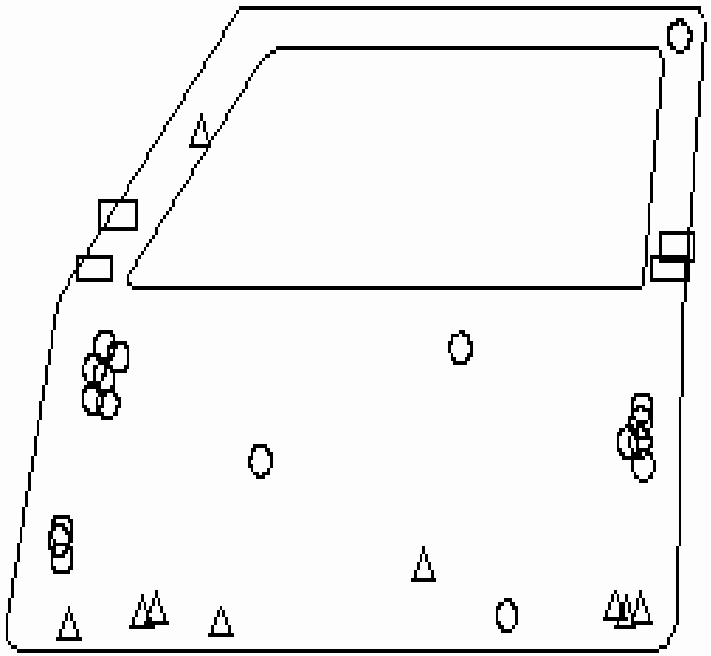
Date: 12th Oct

Paint batch number: A12583

Paint operator: Jim Withers

Doors painted: 𝍸 𝍸

Defect type	symbol	count...
bubble	○	𝍸 𝍸 𝍸 ||
run	△	𝍸 |||
scuff	▭	||||



Process Flow Diagram

- A process map / flowcharts / process flow diagrams is a graphical representation of all the steps involved in an entire process or a particular segment of a process
- Effectively used in the first stages of problem solving because the charts enable those studying the process to quickly understand what is involved in a process from start to finish
- Because processes and systems are often complex, there are various technique to create a chart - use standardized symbols, constructed with pictures or include additional details like process activities and specifications

Process Flow Diagrams

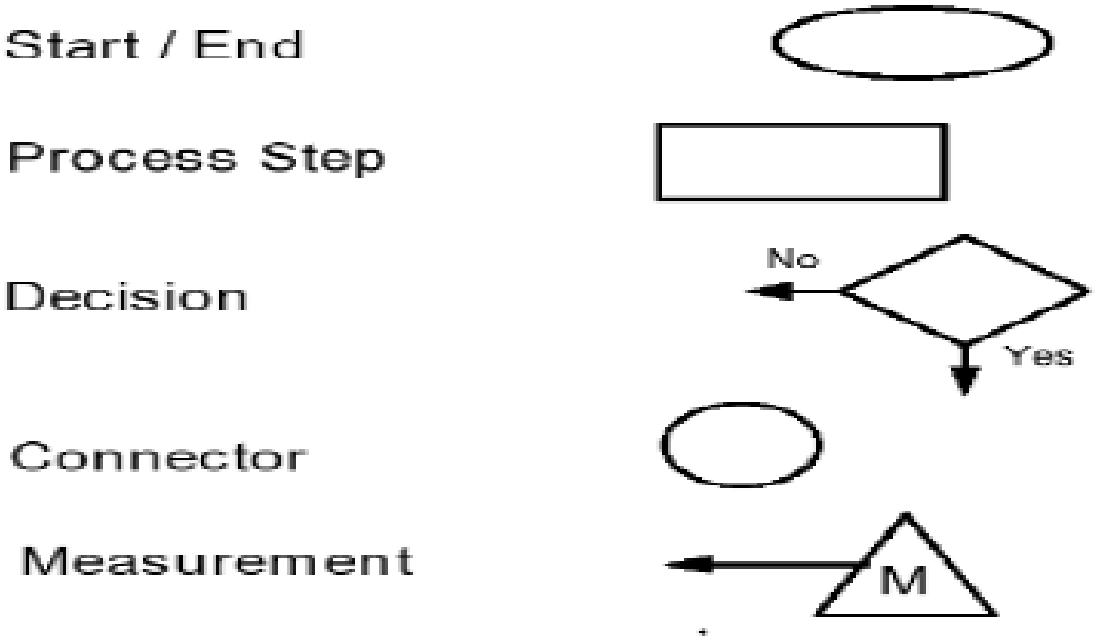
The steps to creating charts are the following:

1. Define the process boundaries. For the purpose of the chart, determine where the process begins and ends
2. Define the process steps.
3. Sort the steps into the order of their occurrence in the process
4. Place the steps in appropriate flowchart symbols and create the chart
5. Evaluate the steps for completeness, efficiency and possible problems such as non-value-added activities

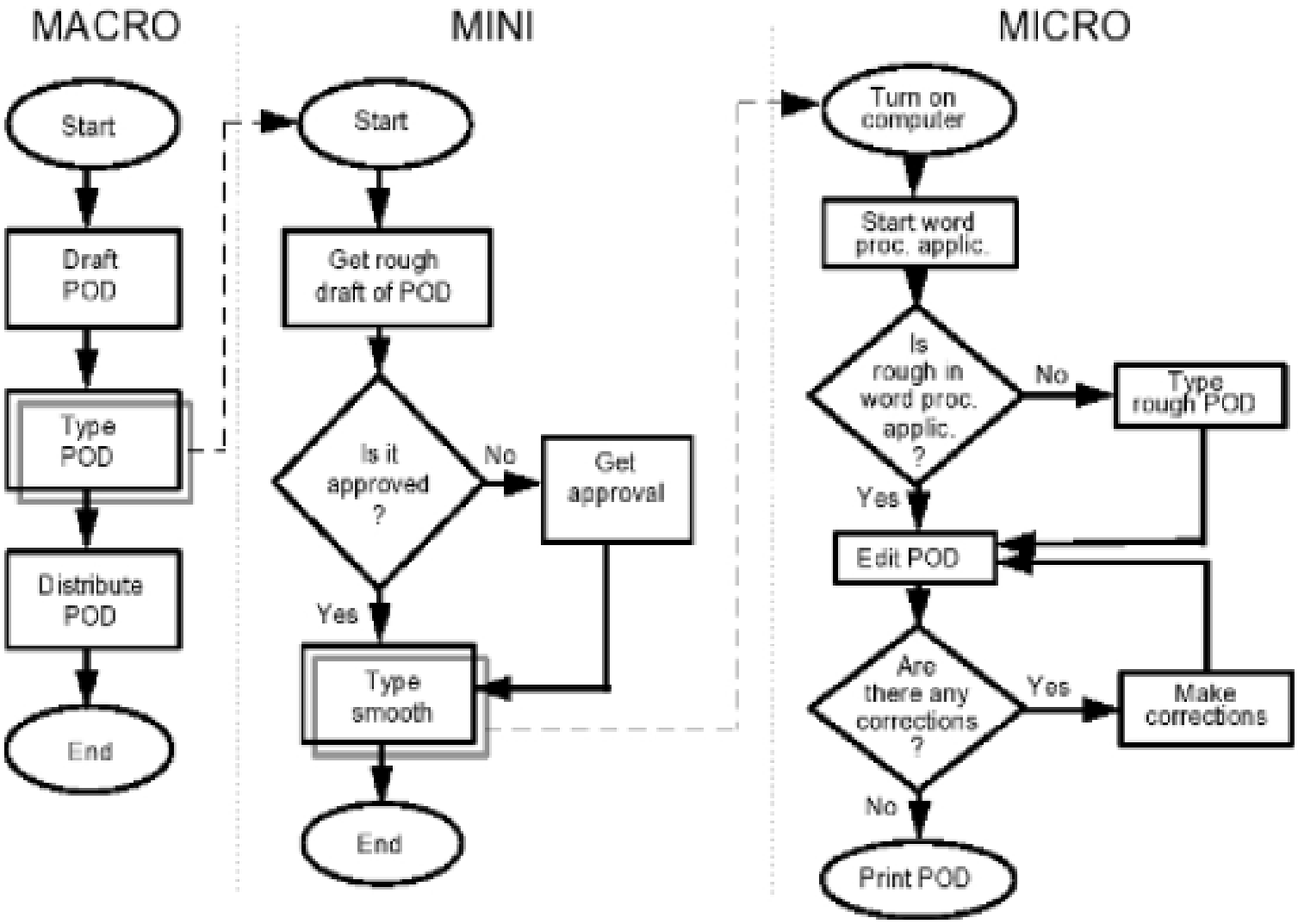
Process Flow Diagrams

Benefits of Using Flowcharts

- Promote process understanding
- Provide tool for training
- Identify problem areas & improvement opportunities



Process Flow Diagrams



Process Flow Diagrams

Ways to eliminate non-value-added activities:

- Rearrange the sequence of work steps and the physical location of the operator in the system
- Change work methods and the type of equipment used in the process
- Redesign forms and documents for more efficient use
- Improve operator training and supervision
- Identify more clearly the function of the process to all employees
- Try to eliminate unnecessary steps and consolidate process steps

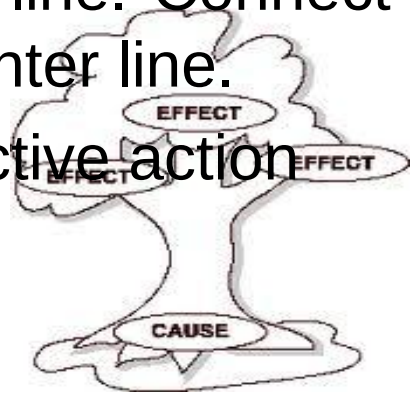
Cause-and-Effect Diagram

- A chart of this type will help identify causes for nonconforming or defective products or services
- Causes are usually broken down into the major causes of work methods, materials, machine, man / people and the environment - each major cause is further subdivided into numerous minor causes
- Diagram are useful in:
  - Analyzing actual conditions for improvement, more efficient use of resources and reduced costs
  - Elimination conditions causing nonconformities and customer complaint
  - Educate and train personnel in decision making and corrective action activities
  - Standardization of existing and proposed operations

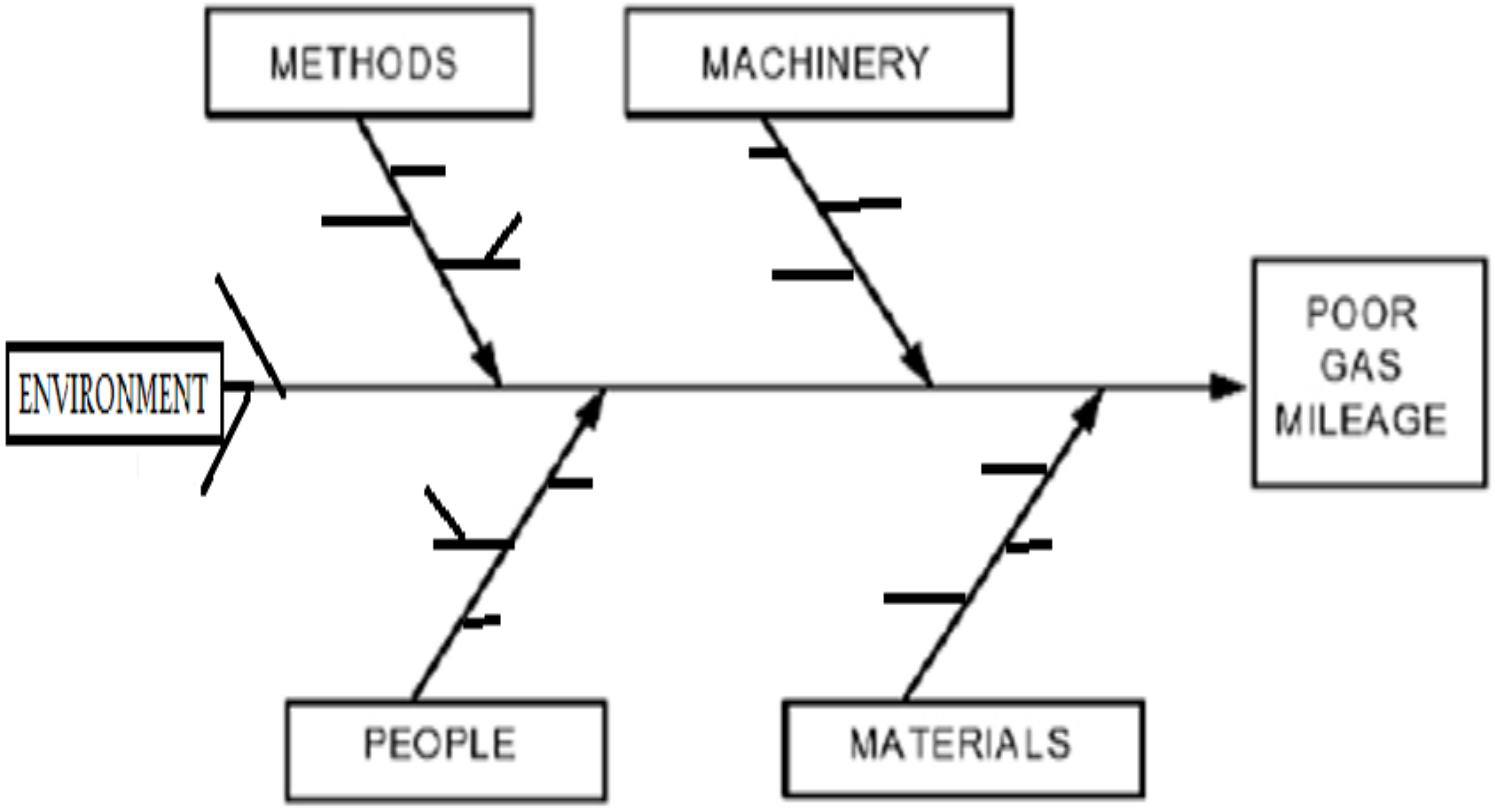
Cause-and-Effect Diagram

To construct a cause-and-effect diagram:

1. Clearly identify the effect or the problem. Problem statement is placed in a box at the end of a line
2. Identify the causes. Brainstorming is the usual method for identifying these causes.
3. Build the diagram. Organize the causes and sub-causes in diagram format.
4. Draw the effect box and the center line. Connect the potential causes boxes to the center line.
5. Analyze the diagram and take corrective action



Cause-and-Effect Diagram



Pareto Diagram

- Identified by Vilfredo Pareto (1848 to 1923), conducted studies of the distribution of wealth
- Dr. Juran recognized the concept as a universal - he coined the phrases vital few and useful many (also known as the 80/20 rule)
- Examples of the vital few are:
  - A few problems account for the bulk of the process downtime
  - A few items account for the bulk of the inventory cost
  - A few suppliers account for the majority of rejected parts
- A Pareto diagram is a graph that ranks data classifications in descending order from left to right

Pareto Diagram

Pareto chart is constructed using the following steps

1. Determine the method of classifying the data: by problem, cause, nonconformity and so forth
2. Determine what data to be gathered
3. Collect data for an appropriate time interval or use historical data
4. Determine the total number of nonconformities, calculate the percentage in each category and rank order categories from largest to smallest
5. Construct the diagram and find the vital few

- It is applicable to problem identification and the measurement of progress

Pareto Diagram

From the available data calculate the contribution of each individual item.

Arrange the items in descending order of their individual contributions

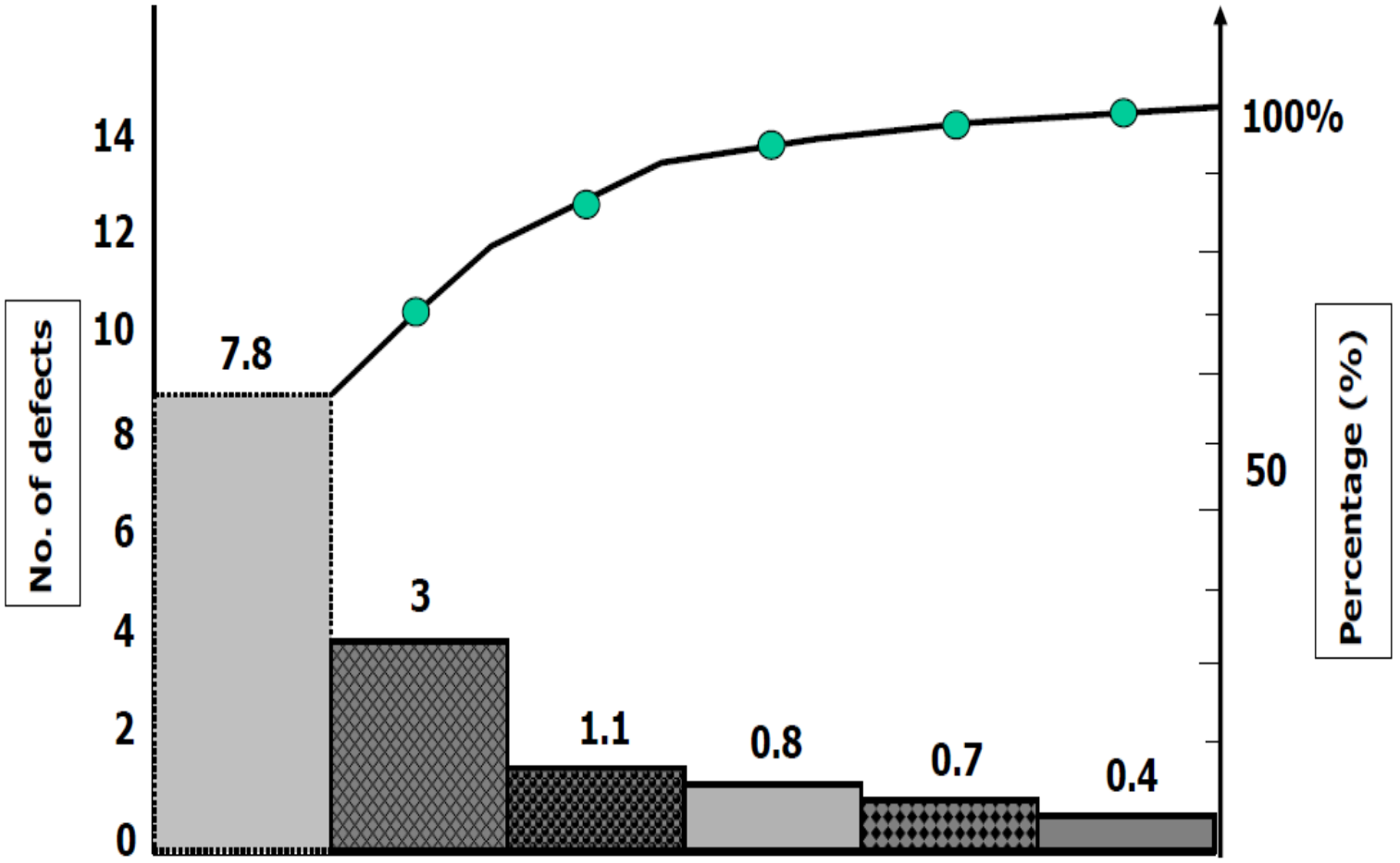
Tabulate the items, their contributions in absolute number as well as in percent of total and cumulative contribution of the items.

Draw X and Y axes. Various items are represented on the X-axis. Pareto Diagrams have two Y-axes - one on the left representing numbers and the one on right representing the percent contributions.

Draw bars representing the contributions of each item and

Plot and connect points for cumulative contributions at the end of each item

Pareto Diagram



Histogram

- Consists of a set of rectangles that represent the frequency in each category
- It represents graphically:
  - Frequency
  - Relative frequency
  - Cumulative frequency
  - Relative cumulative frequency

No. Non-conforming	Frequency	Relative Frequency	Cumulative Frequency	Relative Cumulative Frequency
0	14	14 / 42 = 0.33	14	14 / 42 = 0.3
1	20	20 / 42 = 0.48	14 + 20 = 34	34 / 42 = 0.8
2	8	8 / 42 = 0.19	34 + 8 = 42	42 / 42 = 1.0
Total	42	1.00		

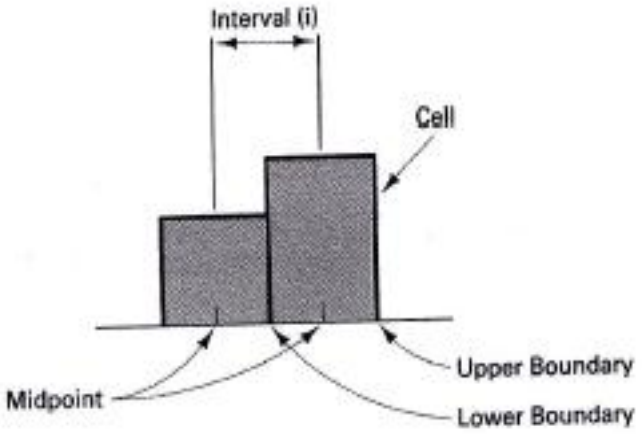
Histogram

Construction of a histogram for grouped data:

1. Collect data and construct a tally sheet
2. Calculate the range

   $\text{Range} = R = X_{high} - X_{low}$
3. Create the cells

   Determine cell interval, cell midpoints and cell boundary
4. Label the axes
5. Post the values
6. Interpret the histogram



Histogram

Determine the cell interval, *i*

- Cell interval is the distance between adjacent cell midpoints
- Whenever possible, an odd interval such as 0.001, 0.07, 0.5 or 3 is recommended
- Use Sturgis' rule :

$$i = \frac{R}{1 + 3.322 \log n}$$

or

- Use trial and error technique :

Assume that $i = 0.003$; then $h = \frac{R}{i} = \frac{0.044}{0.003} = 15$

Assume that $i = 0.005$; then $h = \frac{R}{i} = \frac{0.044}{0.005} = 9$

Assume that $i = 0.007$; then $h = \frac{R}{i} = \frac{0.044}{0.007} = 6$

Deciding number of cells to use:

a. Less than 100 data : 4 – 9 cells
b. 100 to 500 data : 8 – 17 cells
c. More than 500 data : 15 – 20 cells

Histogram

Determine the cell midpoints, MP_l

- It is important to remember two things:
  - Histograms must contain all of the data
  - One particular value cannot fit into two different cells
- Cell midpoints are selected to ensure that these problems are avoided
- The simplest technique is to choose the lowest value measured or
- Use the formula :

$$MP_l = X_l + \frac{i}{2} \quad \text{(Do not round answer)}$$

Histogram

Determine the cell boundaries

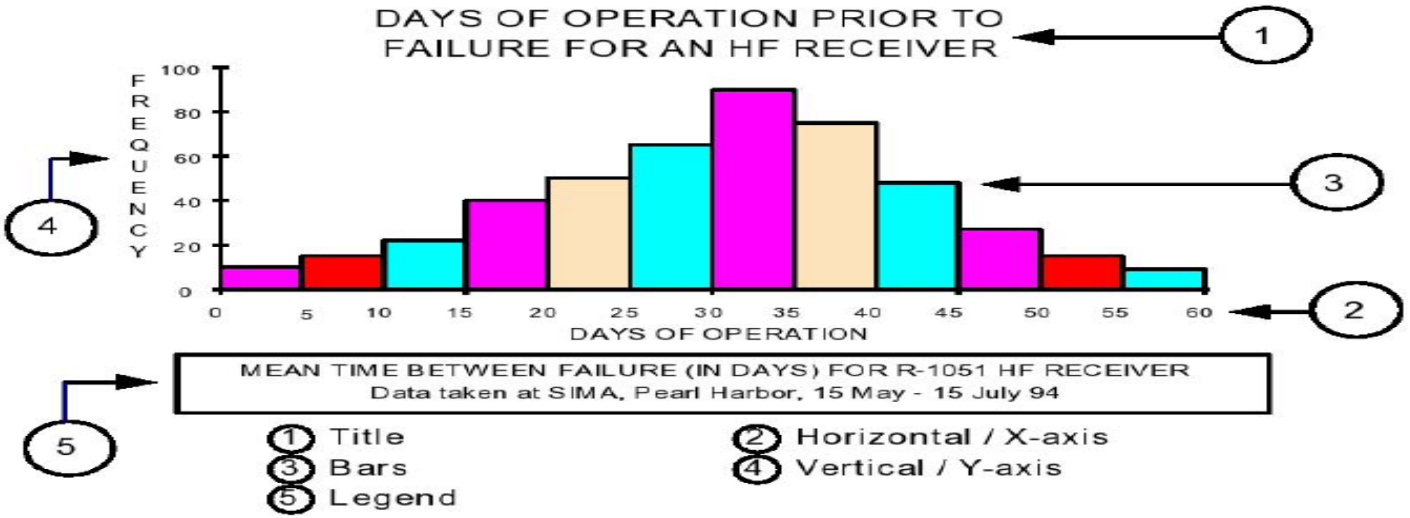
- Cell boundary are the extreme or limit values of a cell, refer to as the upper boundary and the lower boundary
- Boundaries are established so there is no question as to the location of an observation
- Determine the lower cell boundary :

  Divide the cell interval by 2 and subtract that value from the cell midpoint
- Determine the upper cell boundary :

  Add the cell interval to the lower cell boundary

Histogram

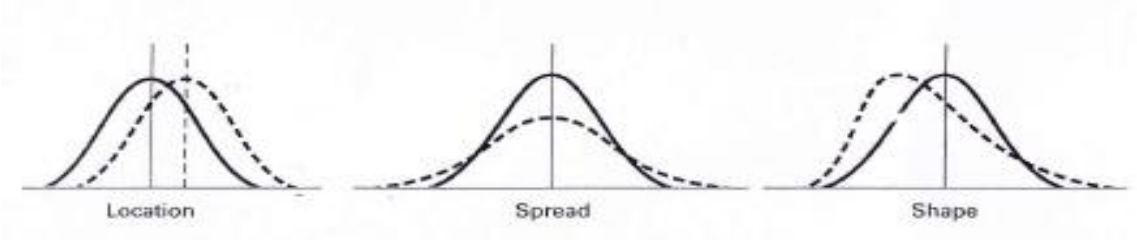
- When are Histograms used?
  - Summarize large data sets graphically
  - Compare measurements to specifications
  - Communicate information to the team
  - Assist in decision making
- Parts of a histogram



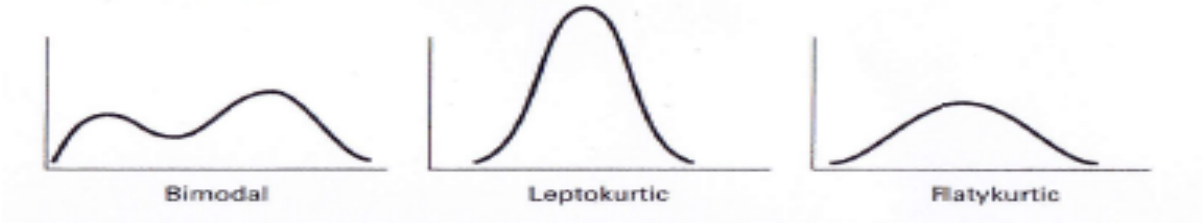
Histogram

Analysis of Histograms :

1. Shape – Symmetry / Skewness
2. Location and Spread



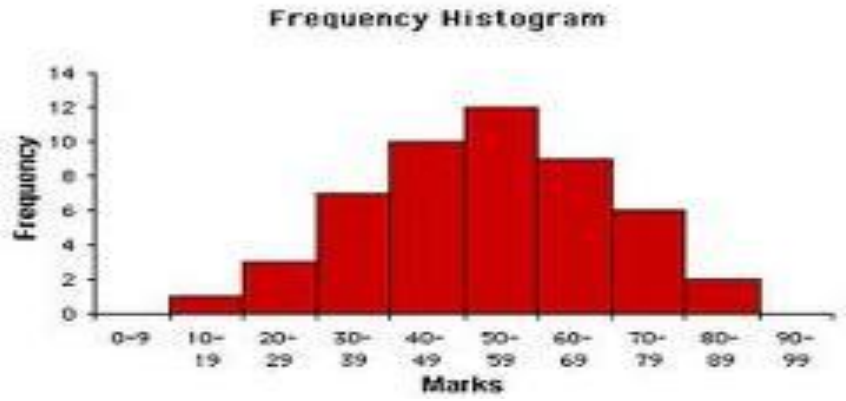
3. Kurtosis – Peakedness of the distribution
   - Leptokurtic – distribution with a high peak
   - Platykurtic – flatter curve
   - Bimodal – distribution with 2 distinct peaks



Histogram

The histogram describes the variation in the process. It is used to :

- Solve problems
- Determine the process capability
- Compare with specifications
- Suggest the shape of the population
- Indicate discrepancies in data such as gaps



Scatter Diagrams

- Two sets of data are plotted on a graph
  - The independent variable – the variable that can be manipulated is recorded on the x axis
  - The dependent variable – the one being predicted, is displayed on the y axis
- When all the plotted points fall on a straight line, there is perfect correlation
- In order to fit a straight line to the data mathematically, need to determine slope and its intercept with the y axis

$$m = \frac{\Sigma xy - [(\Sigma x)(\Sigma y)/n]}{\Sigma x^2 - [(\Sigma x)^2/n]}$$

$$a = \Sigma\frac{y}{n} - m(\Sigma\frac{x}{n})$$

$$y = a + mx$$

Scatter Diagrams

- Another useful statistic is the coefficient of correlation which describes the goodness of fit of the linear model
- It is a dimensionless number, r, that lies between +1 and -1
- Positive and negative signs tell whether there is a positive / negative correlation
- The closer the value is to 1.00, the better is the fit, with a value of one meaning that all points fall on the line

$$r = \frac{\Sigma xy - [(\Sigma x)(\Sigma y)/n]}{(\Sigma x^2 - [(\Sigma x)^2/n])\ (\Sigma y^2 - [(\Sigma y)^2/n])}$$

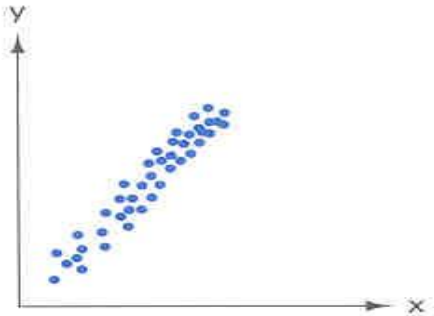
Scatter Diagrams

To construct scatter diagram, use these steps:

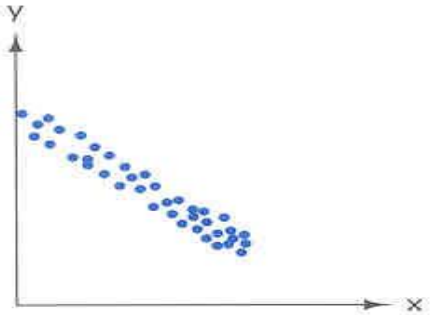
1. Select the characteristic, the independent variable that wish to study
2. Select the characteristic, the dependent variable that suspect affects the independent variable
3. Gather the data about the two characteristics
4. Draw, scale and label the horizontal and vertical axes
5. Plot the points
6. Interpret the scatter diagram to see if there is a relationship between the two characteristics

Scatter Diagrams

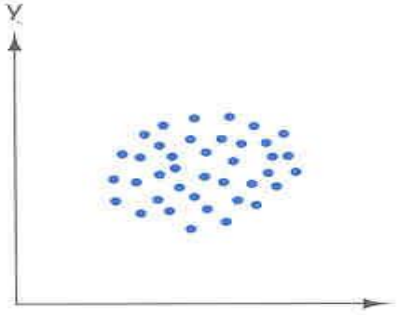
- Used to study and identify the possible relationship between the changes observed in two different sets of variables



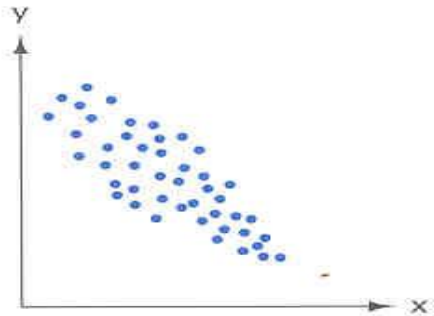
(a) Positive Correlation



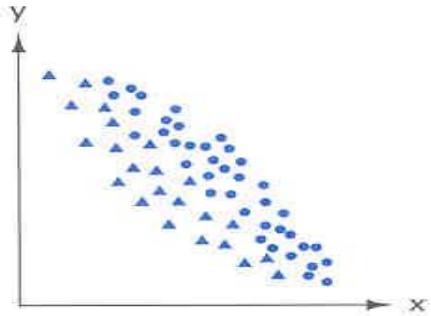
(b) Negative Correlation



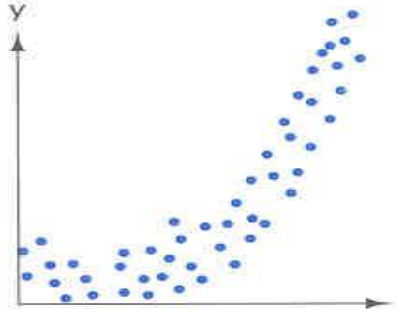
(c) No Correlation



(d) Negative Correlation May Exist



(e) Correlation by Stratification



(f) Curvilinear Relationshi

Matrix Analysis

- A simple, but effective technique to compare groups of categories such as operators, salespersons, machines and suppliers.
- All the elements in each category must be performing the same activity.
- Example:

TYPES OF NONCONFORMITY	PREPARER A	B	C	D	F	TOTAL
1	0	0	1	2	0	3
2	1	0	0	1	0	2
3	0	16	1	2	0	19
4	0	0	0	1	0	1
5	2	1	3	4	1	11
6	0	0	0	3	0	3
Totals	3	17	5	13	1	39

Matrix Analysis

- Analysis of the columns shows that the preparer with the fewest nonconformities is F, followed by A.
  - Once the best preparers are determined, it is usually not too difficult to discover their ‘knack’ and impart this wisdom to the poorer preparers.

- Analysis of the rows shows those conformities that are causing all preparers difficulty.
  - Nonconformity type 3 requires some type of corrective action, such as retraining.
  - Nonconformity type 4 is a problem for preparer D, however the other preparers are not having any difficulty.