MAQE Module IV
QUALITY CONTROL

By

Prof. Zakir Ansari

overview

- Introduction
- Definition of quality
- Quality of Design
- Quality of Conformance
- Cost of quality
- Compromise between quality and cost
- Concept of Quality Control
- Objectives of quality control

Introduction

- In addition to meet the quantitative requirements of an or ganisation, quality is also important.
- Deming was the one who created awareness to america n manufacturing industries regarding quality, they did not realize it.
- He then turned to Japanese companies they understood and started implementing this was post WW-II era.
- Before introduction of the concept of quality, the emphasi s was on production without any consideration on quality
- They started getting advantage due to quality products o ver their closet rivals.
- Thus it all started and now it has reached to a great heig ht where we are talking about zero rejections

What is Quality

- Different definitions and understandings about quality

1. FITNESS FOR PURPOSE: If the product/service is perfo rming the purpose for which it is intended. e.g fan is requ ired to give air, even if it is very attractive and appealing but not giving sufficient air it wont be a quality product.
2. CONFORMANCE TO REQUIREMENTS/SPECIFICATIO NS: e.g Ball pen requirements and then as per requirem ents deciding the product.
3. GRADE: Distinguishing feature of a product or service u nder different criteria like appearance, odour, taste, main tainability e.g. Electrical appliances SIEMENS.

What is Quality

4. DEGREE OF PREFERENCE: Preference given by the c ustomers over similar competitive product. e.g Degree o f prefernce on indian roads is Maruti suzuki for a middle class person over other automobiles
5. DEGREE OF EXCELLENCE: Measure of general degre e of excellence of a product.e.g. Before smart phones N okia was the most prefered brand due to many reasons like ease of operation etc
6. MEASURE OF FULFILMENT OF PROMISE: Fulfiment of the promise made to the customers e.g life of LED in terms of number of hours of use.

Fitness for Purpose

Great design,
No air.....

Old Fashioned,
great quality air
QUALITY PRODUCT

Conformance to Requirements

- Good grip during writing
- Thickness of line
- Continuos flow of ink
- No leakage of Ink
- Attractive looking
- Ink not to get dried up

Grade

- SIEMENS

Full range of quality electrical products

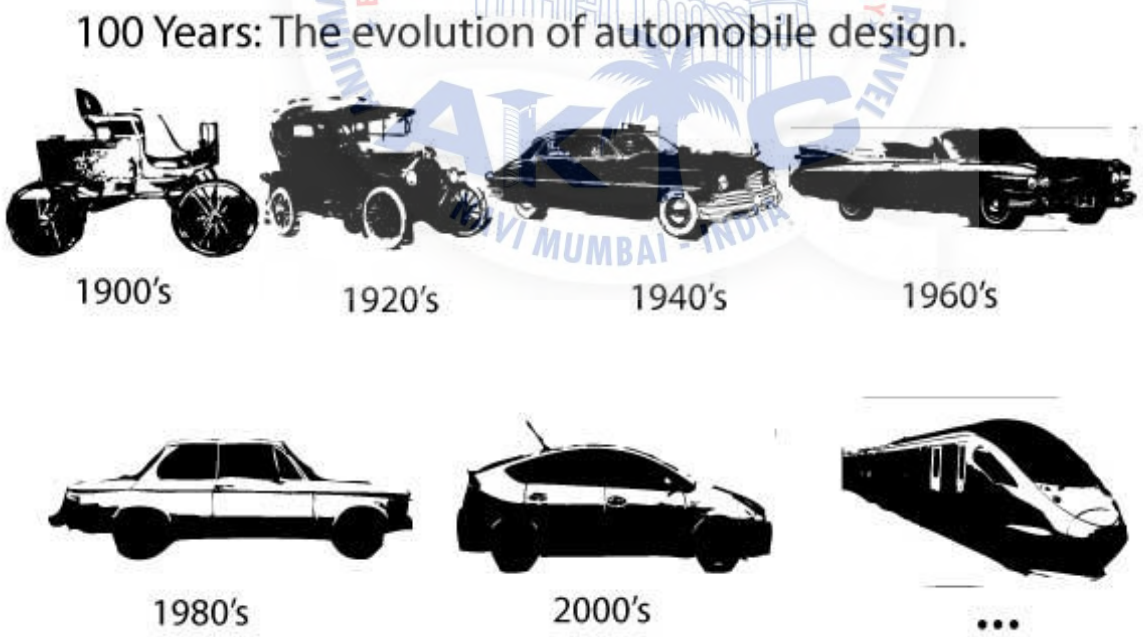
In summary quality is

- SUITABILTY for specific application
- RELIABILITY to give efficient and consistent performanc e
- DURABILITY Desired life span
- WORKABILITY safe and foolproof working
- AFFORDABILITY economical
- MAINTAINABILITY easy to maintain
- AESTHETICS looks attractive
- CUSTOMER SATISFACTION
- VERSATILITY
- A product is said to be of good quality if all the above req uirements are balanced while designing and manufacturi ng it

QUALITY OF DESIGN

- It is concerned with tightness of specifications fo r manufacturing of product or rendering the servi ce.
- e.g a part with tolerance of 0.001 mm is of better quality than another part of tolerance 0.01mm
- The product should be designed considering the parameters such as effect of stress, corrosion, w ear, distorsion, shock etc.
- e.g the guideways of machine tools not made ve ry smooth so as to retain oil,

Poor Design & Design Improvements



FACTORS CONTROLLING QUALITY OF D ESIGN

- Types of customers in the market: Obtained through mar ket survey which gives details about consuming habits of people, the prices they are willing to pay for different pro ducts, the choice of design through feedback survey fro m customers
- Profit consideration:maximising profit by providing specifi c design aspect in different segments like in cars many h igh end features are added in luxury segments and not in the normal segments of cars
- Environmental conditions: Design of cars for the regions where temperatures are below freezing should be differe nt than those designed for the tropical regions.
- Special requirements of the product: As received through customer feedback

QUALITY OF CONFORMANCE

- How well the manufactured product conforms to quality o f design
- When design is established all involved in the production should ensure the quality of conformity
- The measure of truthfuless with which the product confor ms to design specifications

FACTORS CONTROLLING QUALITY OF C ONFORMANCE

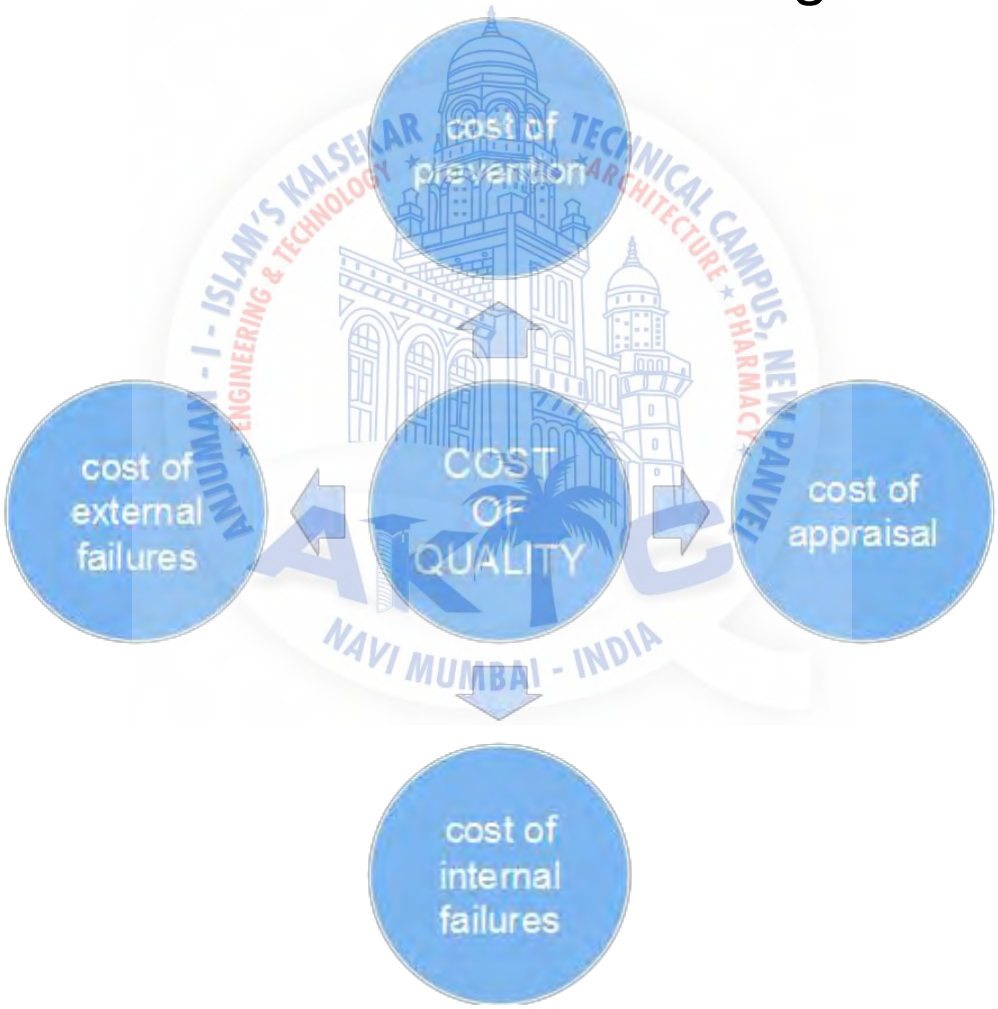
- The incoming raw material quality
- Proper process selection and process control
- Trained, skilled and quality concious operators
- Care for shipment and storage of finished product.
- Inspection program should be accurate to ensure that de fective product is identified and removed from the lot.
- SQC techniques to be employed to account for variability in manufacturing process
- Quality of performance would depend upon both quality of design and quality of conformance

COST OF QUALITY

- The cost of carrying out companys quality functions is ca lled cost of quality this may include
- Market research
- Product R&D cost
- The cost of manufacturing planning so as to meet requir ed specifications
- Cost of inspection and testing
- Cost of defect prevention
- Cost of scrap or quality failure
- Cost of quality assurance

COST OF QUALITY

- American Society for Quality Control has recomended th at quality costs be defined in four categories



COST OF QUALITY

Sub category	Quality function
Cost of prevention	cost of quality assurance
Cost of appraisal	
Cost of internal failures	cost of work and repair
Cost of external failures	

COST OF QUALITY

- COST OF PREVENTION
- It consists of costs associated with personnel engaged in designing implementing and maintaining quality systems
- cost of prevention includes

1. cost of quality planning: cost for creating overall quality plan, market research, product development, inspection plan etc
2. Cost of documenting: procedures and manuals for imple menting quality
3. Process control cost: costs incurred for achieving fitness for use trough processs control
4. Cost of training:
5. Cost for preventing recurring defects

COST OF QUALITY

- COST OF APPRAISAL
- it includes the cost associated with evaluating and auditi ng products, components and purchased material to ass ure conformance with quality standards
- It consists of

1. receiving/incoming tests and inspection
2. lab acceptance testing
3. inspection and tests
4. setup for inspection and test
5. Inspection and test material
6. maintenace and caliberation of inspection equipment

COST OF QUALITY

- COST OF INTERNAL FAILURE (COST OF REWORK A ND REPAIR)
- it includes the cost associated with defective products, c omponents and materials that fail to meet quality require ments
- It consists of

1. Costs associated with scrap
2. Cost of rework and repair
3. Cost of reinspection and retest after defective parts are r epaired
4. Cost associated with material review
5. Cost of disposition that is effort to find if rejected part can be reused somewhere or disposed off
6. The cost of lower process yield due to non conforming pr oduct

COST OF QUALITY

- COST OF EXTERNAL FAILURE
- It includes the cost associated with defective products, c omponents being shipped to the customers
- It consists of

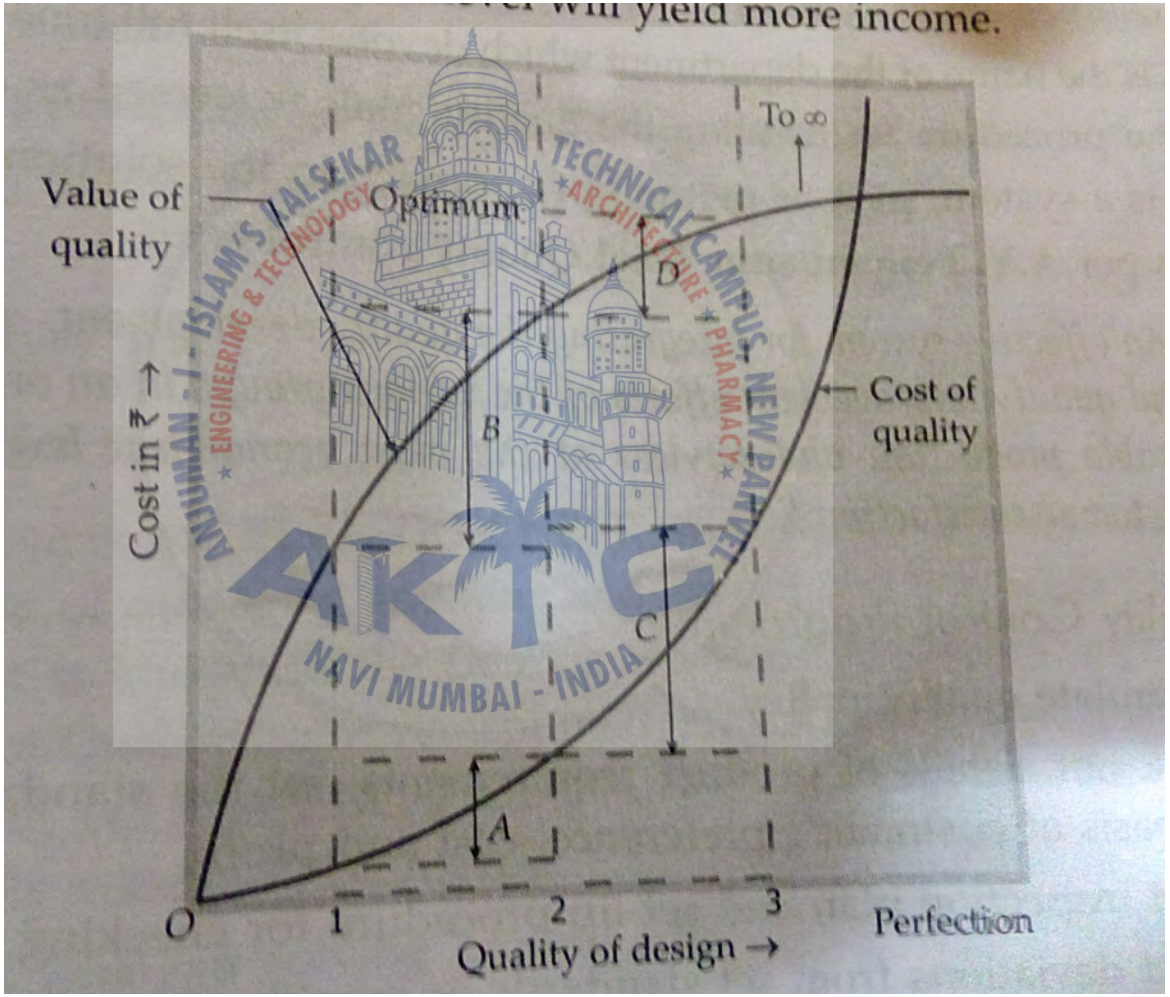
1. Costs of processing complaints from customers
2. cost of service to customers who received defective prod ucts
3. cost of repairing the defective items received from custo mers
4. Cost of replacing the defective product
5. Cost of concessions given to customers for seling of the non conforming products.

VALUE OF QUALITY

- The returns (direct/Indirect) gained by the manufacturer due to impar ting quality in the product.
- It is composed of
- Value inherent in the design
- Value inherent in the conformance to that design
- As a rule higher quality of design means higher cost quite often it me ans higher value.
- It is comparatively easy to evaluate cost of quality but difficult to ass ess value of quality.
- The following factors might be useful for assessing the value of quali ty

1. Savings due to increased production due to good quality product.
2. Reduction of scrap and rework cost
3. Increased sales
4. Indirect benefits like reputation of company etc

VALUE OF QUALITY Vs COST OF QUALITY



COMPROMISE BETWEEN QUALITY AND COST

- In order to get quality at optimum cost the different cost aspects as mentioned in previous slides are to be compromised
- If during deployment of quality, cost of prevention is high then the co st of quality should be optimised by reducing the appraisal cost.
- On the contrary if more emphasis is given on cost of appraisal then t he cost of prevention should be kept lower so as to get the desired q uality at optimum cost.

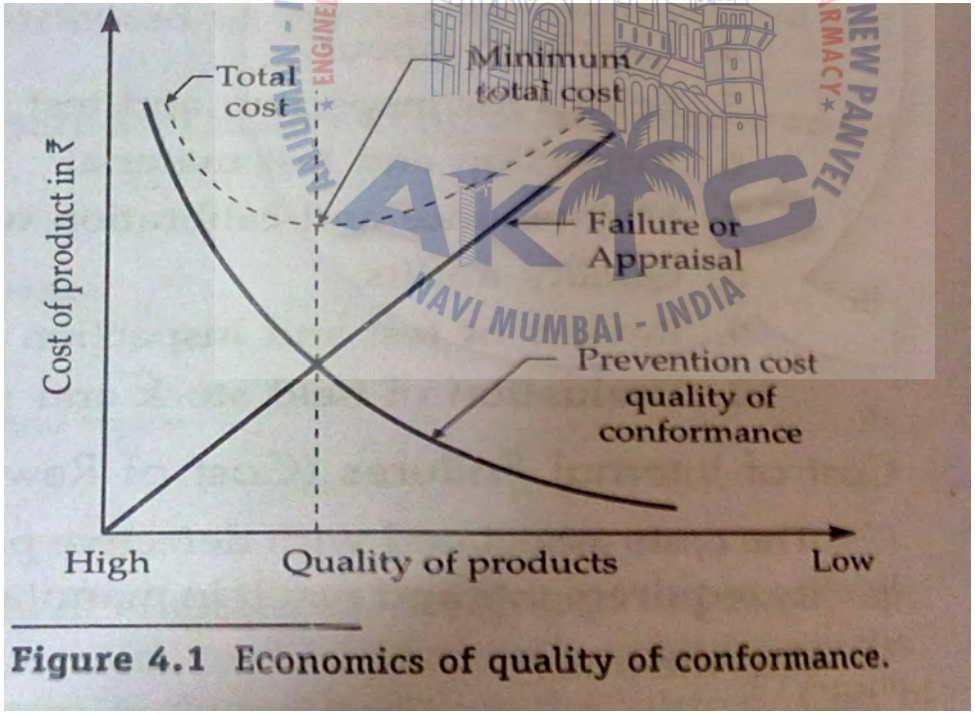


Figure 4.1 Economics of quality of conformance.

CASE STUDY

A company involved in the manufacturing of some product has the following costs involved for manufacturing of the quality product

1. Incoming material inspection Rs 200000 per annum,
2. Final product inspection cost Rs 300000 per annum
3. Training of the employees towards quality conciousness Rs 500 000.
4. Documentation for quality 1000000
5. Internal rejections of parts are limited up to 100 ppm

The company is following the work in the field of quality since last 7 years and have the ISO 9001:2008 certificate also. Now the man agement of the company is very keen to reduce the cost of the pro duct through reducing the cost of quality.

What cost shall be reduced so as to reduce the unit cost of produc t.

Concept of Quality Control

- It has variety of meanings
- A process through which we measure the actual quality performan ce, compare it with the standard and take corrective action in case of any deviation.
- Systematic control of various parameters that affect quality of pro duct.
- Entire collection of activities which ensures that the operation will produce quality product at minimum cost.
- Tools, devices or skills through which quality activities can be carri ed out.

Steps in Quality Control

The following steps are involved in quality control

1.Formulate quality policy

2.Work out details of product requirements,set the standards on the basis of customer feed back, cost and profit

3.Select inspection plan and procedures

4.Detect deviations from set standards

5.Take corrective actions so as to meet the standard

6.Decide the disposition plan of defective items

7.Developing quality conciousness in the organisation

Objectives of Quality Control

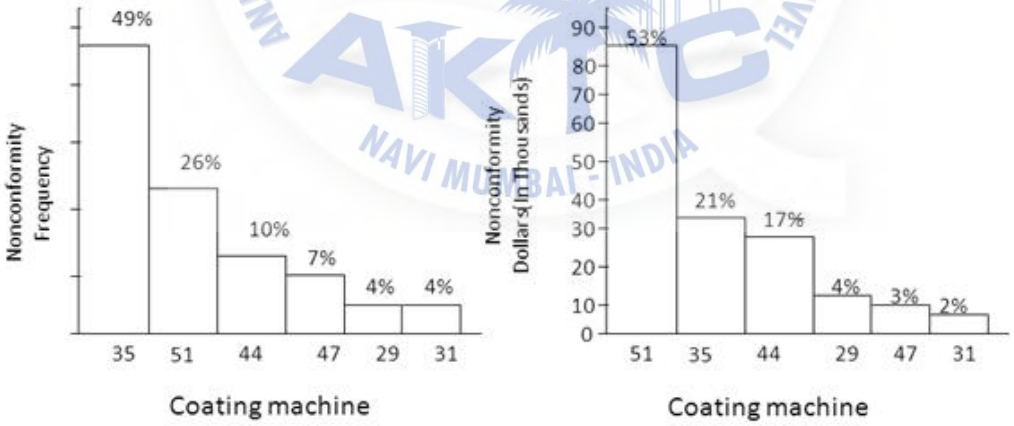
- To increase profit by making the product acceptable to customers like enhancing life of product, aesthetic appearance etc
- To reduce company's cost through reducing scrap
- To achieve interchangibility
- To provide optimum quality at minimum cost
- Judging the conformity of the product in context to the standard or specifications
- To improve productivity by process control.
- Developing quality conciousness in the organisation

7 QC tools

- Pareto diagram
- Process flow diagram
- Cause & Effect diagram
- Check sheets
- Histogram
- Run charts
- Scatter diagram

Pareto diagram

- Alfredo Pareto (1848-1923) conducted extensive studies of distrib ution of wealth in Europe.
- A few people with lot of money and many with less money
- Later Joseph Juran recognised this as a universal concept prevail ing every where.
- VITAL FEW TRIVIAL MANY
- A Pareto diagram is a graph that ranks data (on say types of defe cts) in descending order from left to right



Pareto Diagram

STEPS FOR PARE TO DIAGRAM

- Step-1: Determine method of classifying data: by problem, cause, nonconformity, and so forth.
- Step-2: Decide if dollars (best), frequency, or both are to be used to rank the characteristics.
- Step-3: Collect data for an appropriate time interval or use historical data.
- Step-4: Summarize data and rank order categories from largest to smallest.
- Step-5: Construct the diagram and find the vital few problem are a.

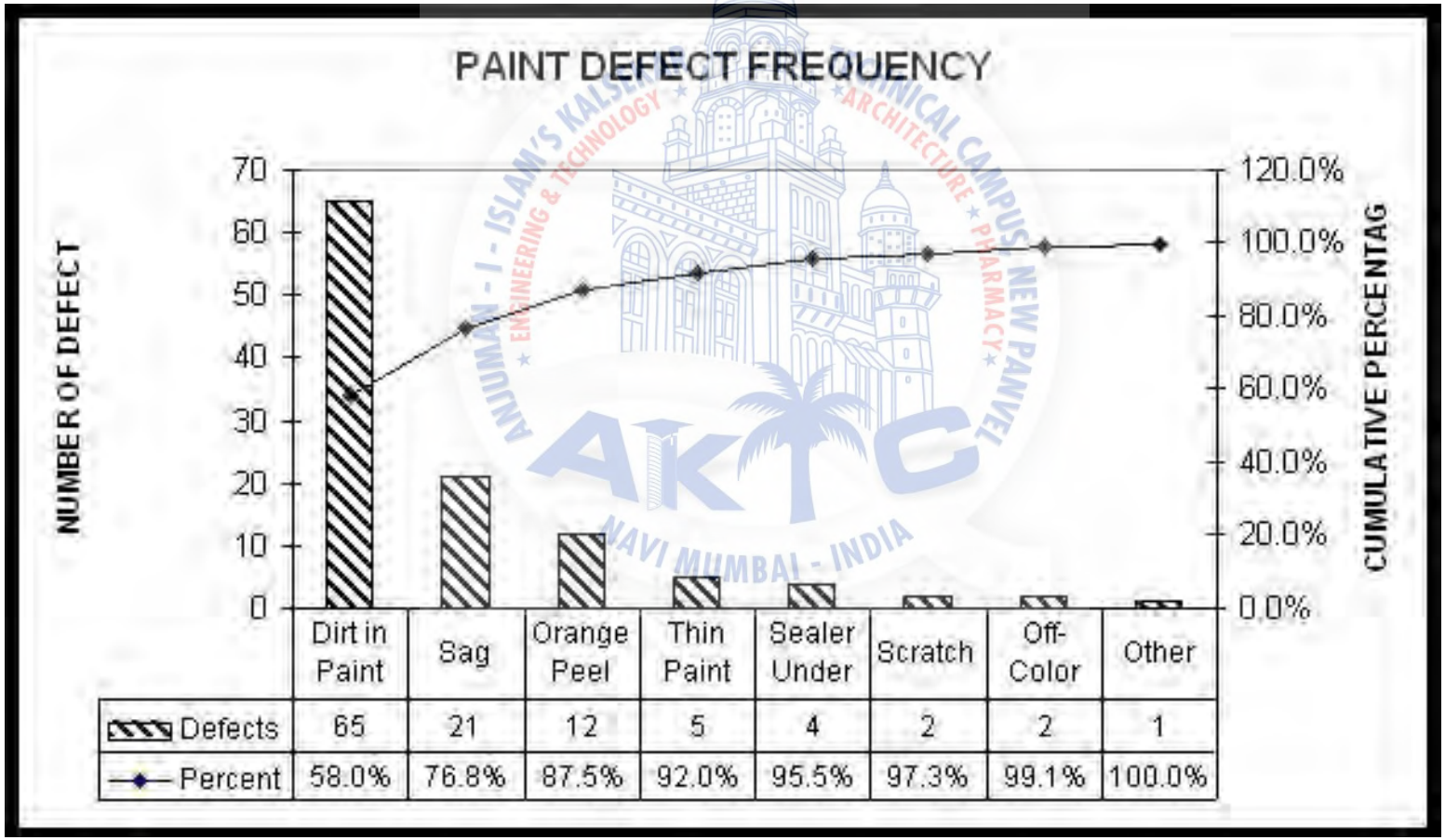
EXAMPLE

Example:

In the paint shop of a certain manufacturing company, the following defects were identified, draw pareto chart to categorise the defects as per their frequency.

Defect	Thin Paint	Orange peel	Sag	Dirt	Scratch	Off co lour	Sealer under	othe rs
Freque ncy	5	12	21	65	2	2	4	1
%								

Excercise


PAINT DEFECT FREQUENCY
NUMBER OF DEFECT
CUMULATIVE PERCENTAG
70
60
50
40
30
20
10
0
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
Dirt in Paint
Sag
Orange Peel
Thin Paint
Sealer Under
Scratch
Off-Color
Other
Defects 65 21 12 5 4 2 2 1
Percent 58.0% 76.8% 87.5% 92.0% 95.5% 97.3% 99.1% 100.0%

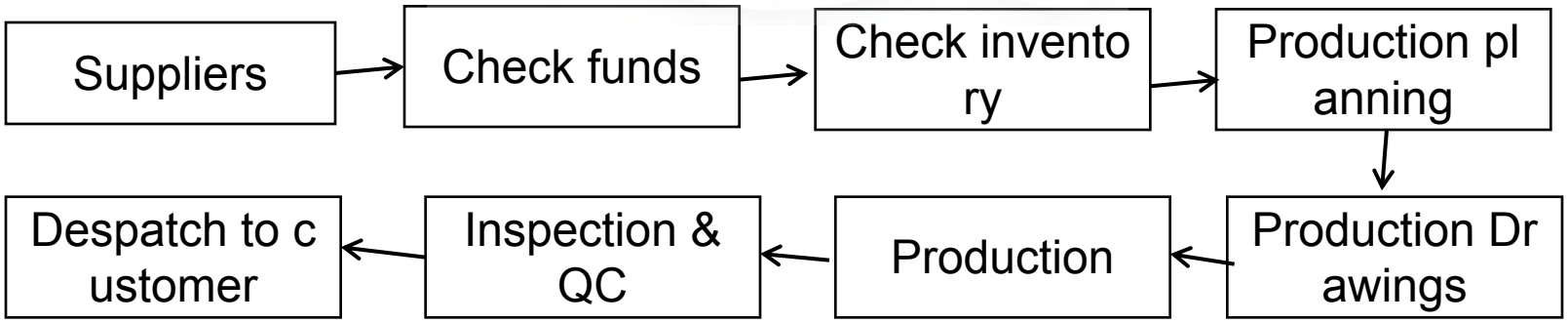
Excercise

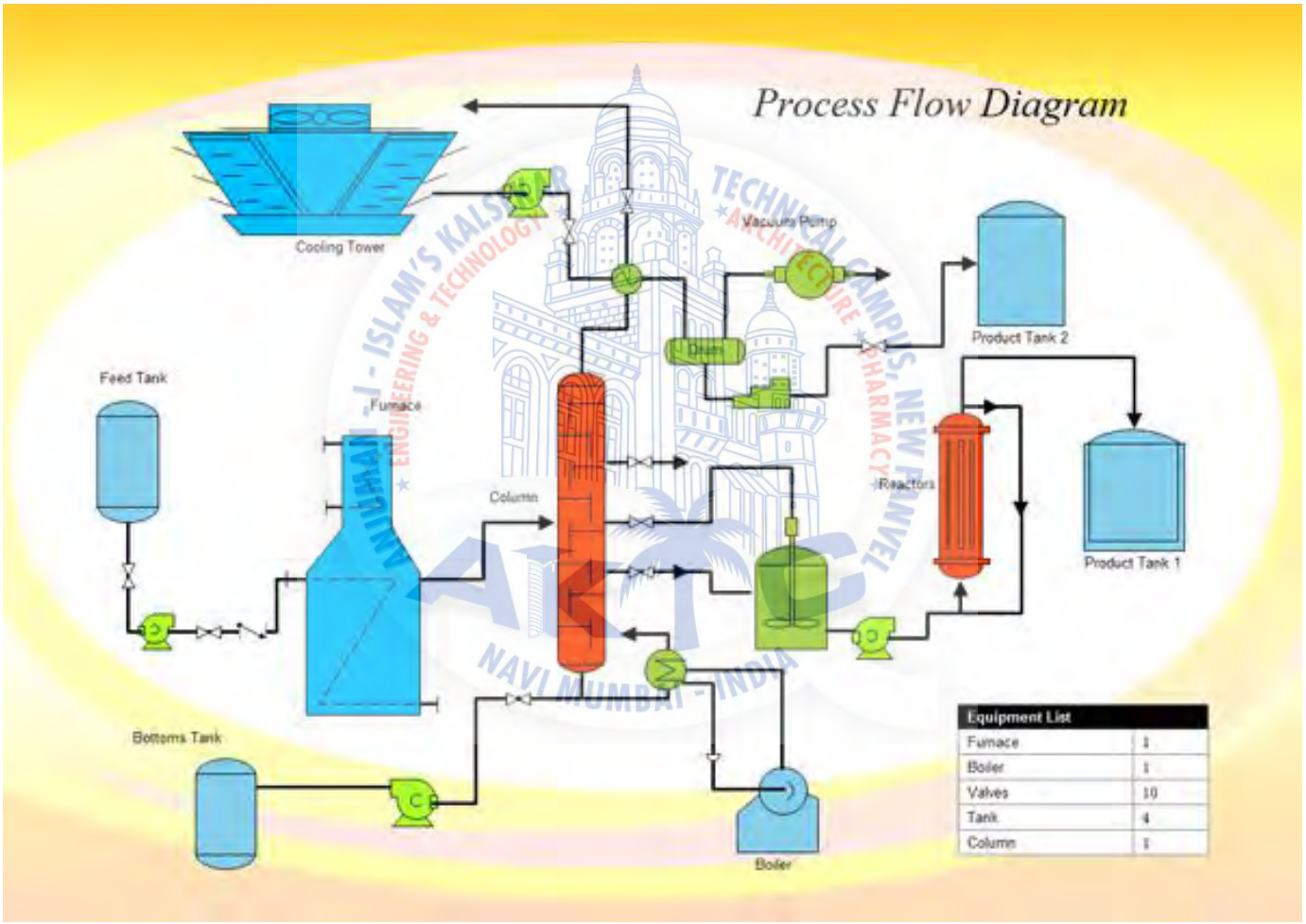
- “Reasons for the poor performance of AIKTC TE ME II student s in the end sem exams”

1. More Assignments so less time for preparation
2. Time lost in commuting(traveling) to and fro from college
3. Very tight lecture practical schedule
4. Lack of motivation to do something better
5. No clear career objective

Process Flow Diagram

- For many products and services, it may be useful to construct a process flow diagram.
- These diagrams show flow of product or service as it moves th rough various processing stages.
- The diagram makes it easy to visualize the entire multistage pr ocess, identify potential trouble spots, waste activities, and loc ate control points.
- Improvements can be accomplished by changing (reengineeri ng), reducing, combining, or eliminating process steps.

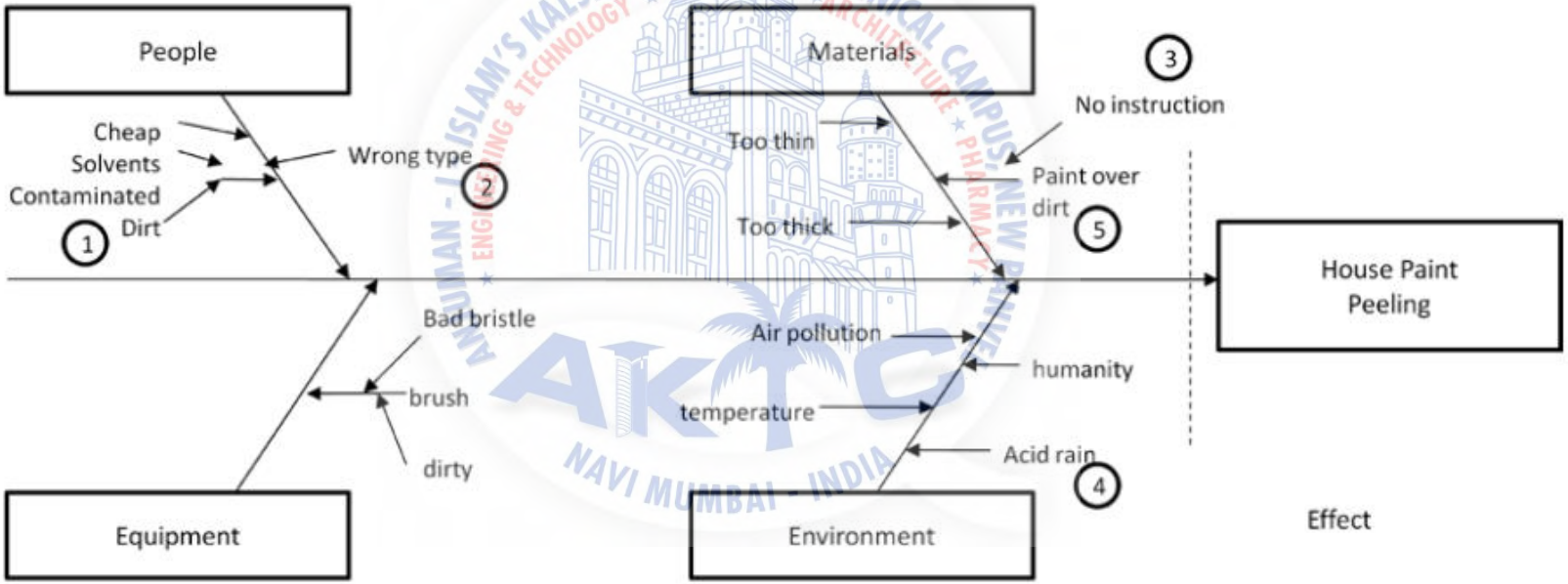



Process Flow Diagram
Cooling Tower
Vacuum Pump
Drum
Product Tank 2
Feed Tank
Furnace
Column
Reactors
Product Tank 1
Bottoms Tank
Boiler
Equipment List
Furnace 1
Boiler 1
Valves 10
Tank 4
Column 1

Cause & Effect Diagram

- It was developed by Dr. Kaoru Ishikawa in 1968, and sometimes referred to as the ‘Ishikawa diagram’ or a ‘fish bone diagram’.
- A cause-and-effect (C&E) diagram is a picture composed of lines and symbols designed to represent a meaningful relationship between an effect (say Y) and its potential causes (say X).
- C&E diagram is used to investigate either a "bad" effect and to take action to rectify the potential causes or a "good" effect and to learn those potential causes that are responsible for the effect.
- Causes are sometimes broken down into major sub causes related to work method, material, measurement, man (people), machinery (equipment), and environment (5M & 1E)

Cause & Effect Diagram



Cause-and-effect Diagram of house Paint Peeling

Cause & Effect Diagram

- C & E diagrams are useful to

1) Identify potential causes and not all possible causes,

2) Analyze actual conditions for the purpose of product or service quality improvement

3) Eliminate conditions which cause nonconformities and custome r complaints.

4) Statistical Experimentation, Decision-making and corrective-act ion activities.

Check sheets

- Main purpose of check sheets in earlier days is to ensure that data was collected carefully and accurately by concerned pers onnel.
- Data is to be collected in such a manner that it can be quickly and easily used and analyzed.
- The form of check sheet is individualized for each situation an d is designed by the project team.
- Figure shows a check sheet for paint nonconformities for bicyc les.

Check sheets

CHECK SHEET

Product Bicycle 32
Nonconformity type

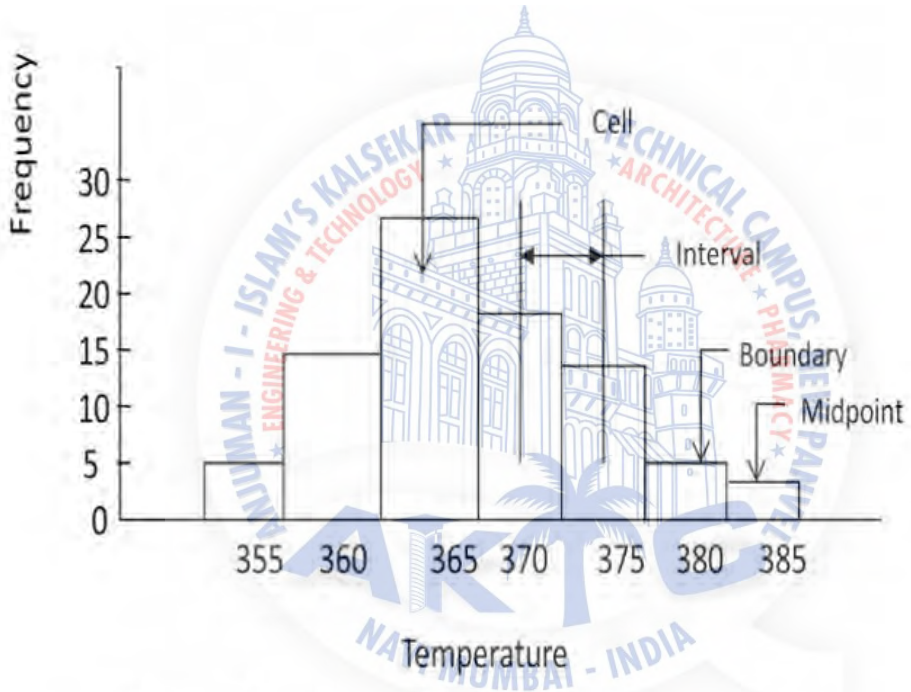
Number inspected: 2217
Check

Nonconformity type	Check	Total
Blister	𝍸 𝍸 𝍸 𝍸 I	21
Light spray	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 III	38
Drips	𝍸 𝍸 𝍸 𝍸 II	22
Overspray	𝍸 𝍸 I	11
Runs	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 II	47
Others	𝍸	5
	Total	144
Number	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	113
Nonconforming	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 III	

Histogram

- Histogram provides variation information of the characteristic o f interest.
- It suggests probability distribution shape of the sample observ ation and also indicates possible gap in the data.
- Horizontal axis in Figure indicates scale of measurement and v ertical axis represents frequency or relative frequency.
- One characteristic of the distribution concerns symmetry or lac k of symmetry of the data.
- Is the data equally distributed on each side of the center of me asurement (e.g. Temperature), or it is skewed to right or left?
- Another characteristic concerns the kurtosis of the data. A fina l characteristic concerns number of modes, or peaks, in the da ta. There can be one mode, two modes (bi-modal) or multiple modes.

Histogram



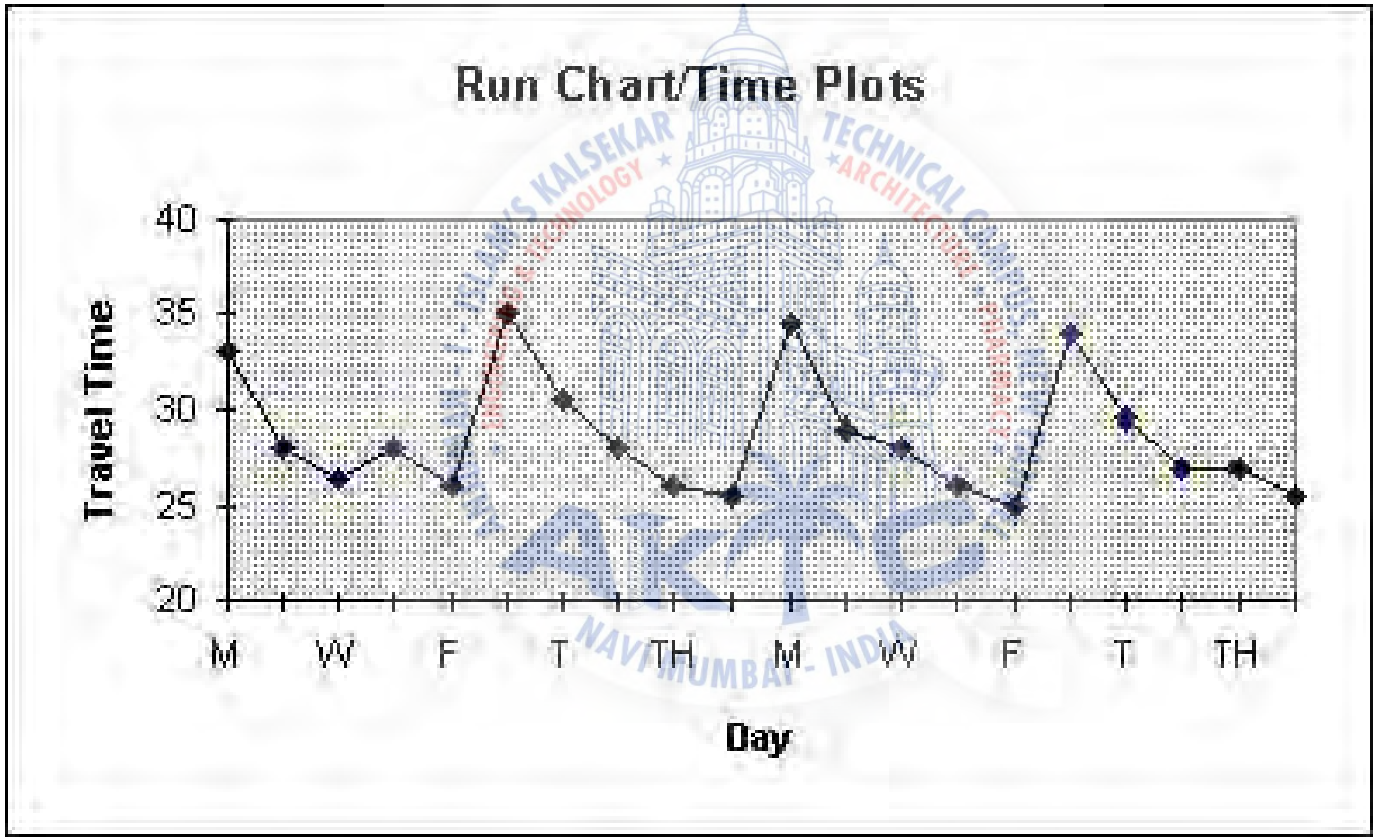
Histogram for Grouped Data

Figure 2-8. : Histogram

Run Chart

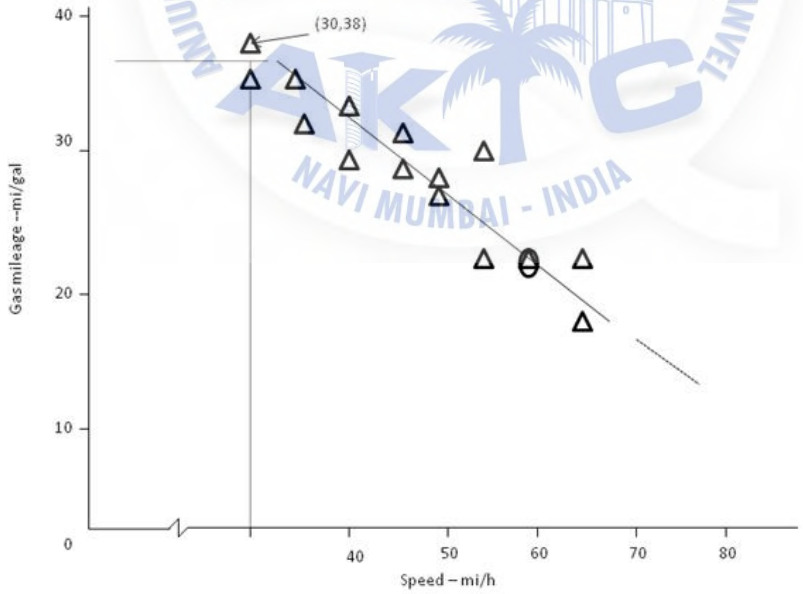
- A run chart, which is shown is a very simple quality tool for ana lyzing process with respect to (w.r.t) time in development stag e or,
- for that matter, when other charting techniques are not quite re levant.
- The important point is to draw a picture of the process w.r.t. ti me and let it "talk" to you.
- Plotting time oriented data points is a very effective way of hig hlighting any pattern observed w.r.t. time.
- This type of plotting should be done before doing histogram or any other statistical data analysis.

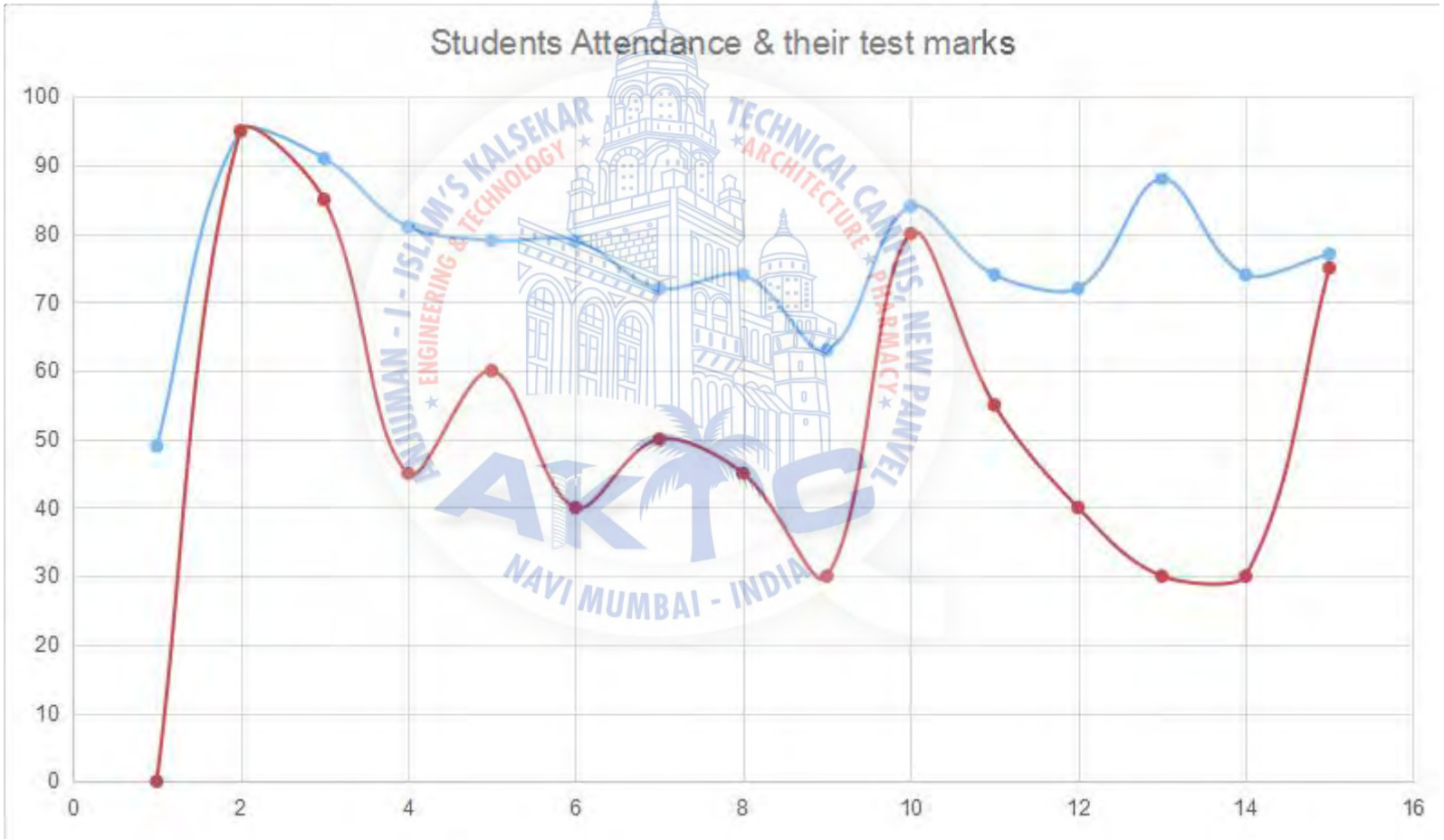
Run Chart


Run Chart/Time Plots
Travel Time
40
35
30
25
20
M
W
F
T
TH
M
W
F
T
TH
Day

Scatter Diagram

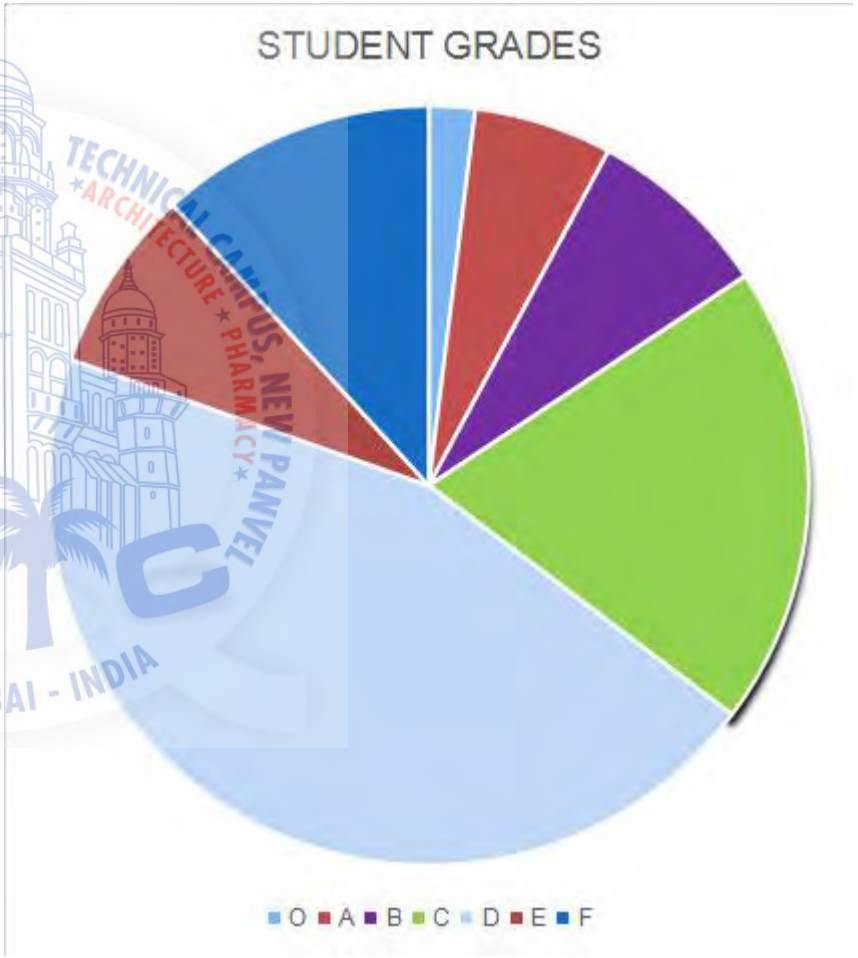
- The simplest way to determine if a relationship exists between TW O variables is to plot a scatter diagram.
- Figure shows a relationship between automotive speed and gas mileage.
- The figure indicates that as speed increases, gas mileage decreas es or a negative relationship exist between the variables of interes t.
- Once the scatter diagram is complete, relationship or Pearson corr elation between two variables can be found out.




Students Attendance & their test marks
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14
16

PIE CHARTS

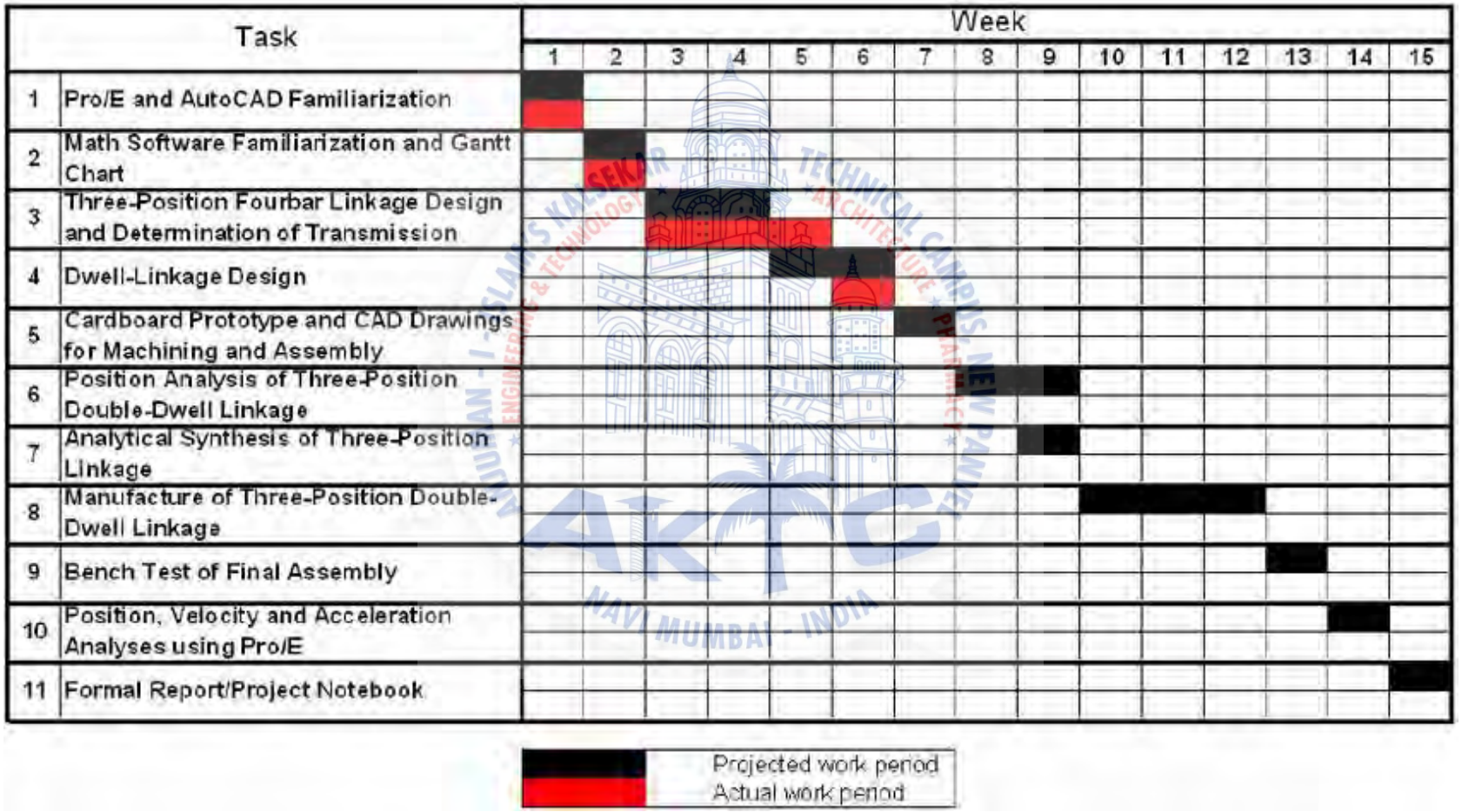
- These are useful to see the co ntributions of various factors at a given time.
- In the given example
- O 1
- A 3
- B 4
- C 10
- D 23
- E 04
- F 06



GANTT CHART

- It is used to schedule the activities as per the sequence so as to ac count for any overlapping activities which can be done.

Activity ID	Activity Name	TIMESCALE (WEEKS)																			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
WBS 1 : GROUND WORKS																						
1	Excavation																					
2	Backfill and Compaction																					
WBS 2 : STRUCTURAL WORKS																						
3	Reinforced Concrete Works																					
4	Steel Works																					
WBS 3 : FINISHING WORKS																						
5	Brick Laying																					
6	Wall Plastering																					
7	Painting																					
8	Floor Covering																					
WBS 4 : ELECTRICAL WORKS																						
9	Conduit Works																					
10	Cable Pulling																					
WBS 5 : MECHANICAL WORKS																						
11	Plumbing Works																					
12	Fittings																					


Task
Week
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1 Pro/E and AutoCAD Familiarization
2 Math Software Familiarization and Gantt Chart
3 Three-Position Fourbar Linkage Design and Determination of Transmission
4 Dwell-Linkage Design
5 Cardboard Prototype and CAD Drawings for Machining and Assembly
6 Position Analysis of Three-Position Double-Dwell Linkage
7 Analytical Synthesis of Three-Position Linkage
8 Manufacture of Three-Position Double-Dwell Linkage
9 Bench Test of Final Assembly
10 Position, Velocity and Acceleration Analyses using Pro/E
11 Formal Report/Project Notebook
Projected work period
Actual work period