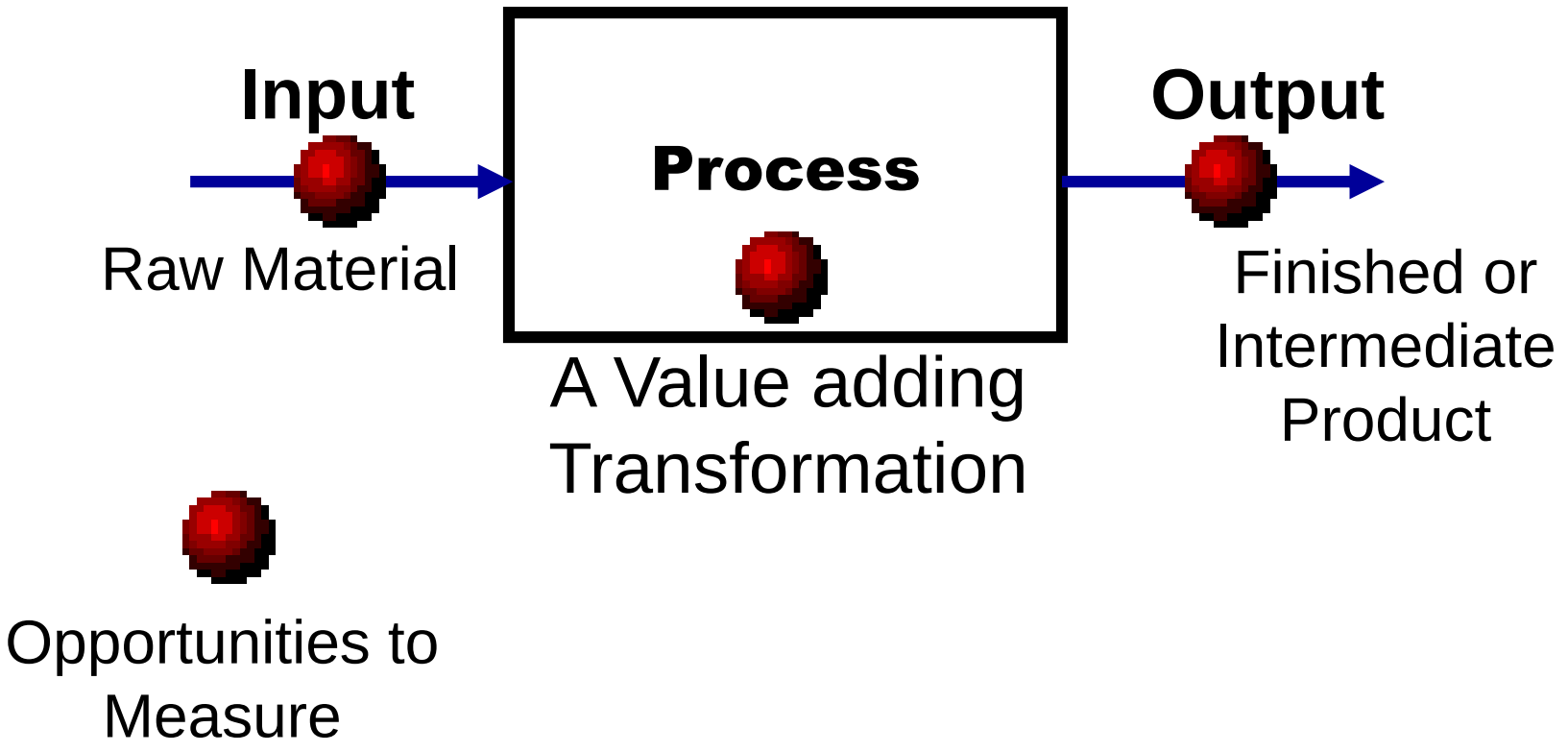
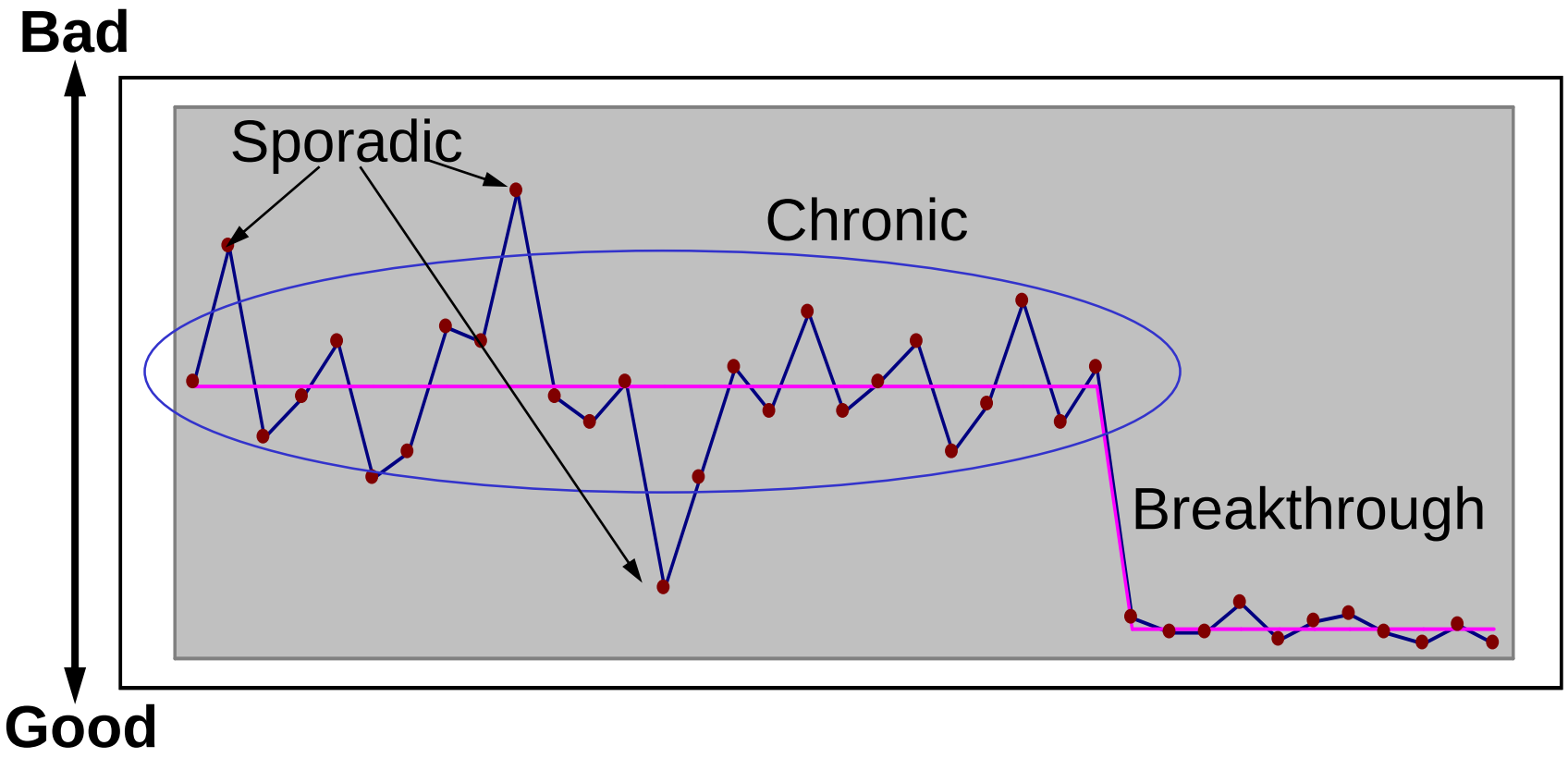
7-QC Tools

What is a Process



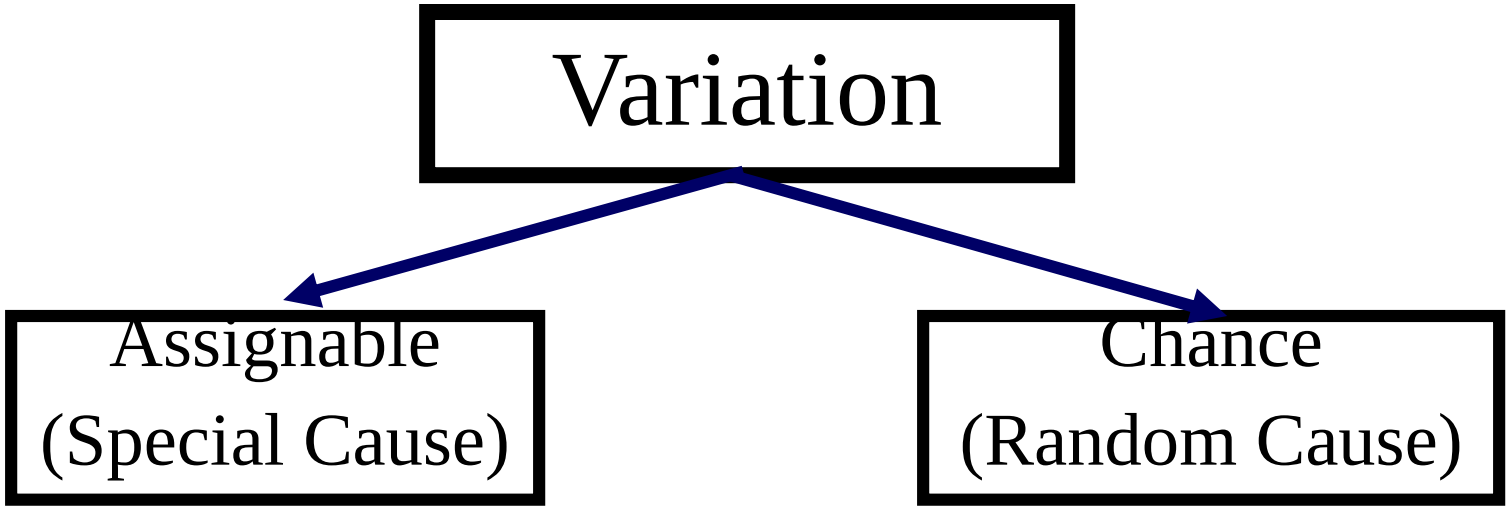
All work is accomplished by a process

Improvement



- **Change from current level of performance to a superior level and staying there**

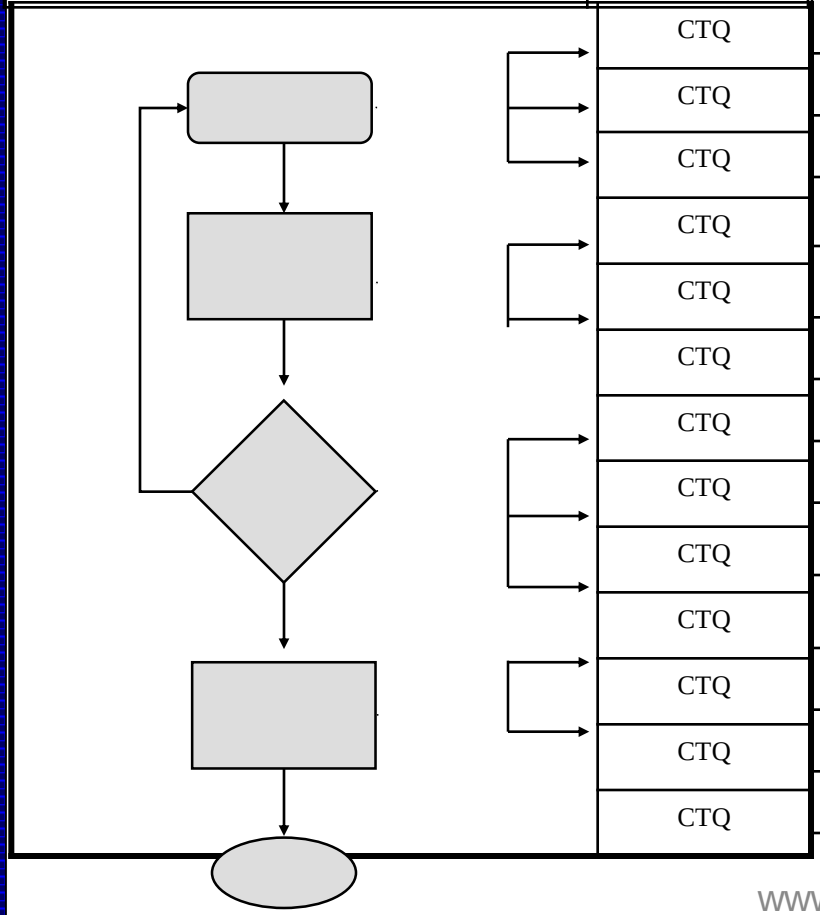
Understanding Variation



- Sporadic
- Very Few
- Large contribution
- Easy to identify and eliminate

- Random
- Large in number
- Small contribution
- Difficult to identify and eliminate

Product Process Mapping

Process flow diagram	Process CTQs
	CTQ CTQ CTQ CTQ CTQ CTQ CTQ CTQ CTQ CTQ CTQ CTQ

Product CTQs

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

High correlation

What is a problem?

Problem is an unsatisfied performance in product/ service.

A problem could be

- nonconformance
- scrap
- chronic rework
- recurring accepted on deviation poor yield
- customer complaint
- machine breakdown
- low process capability
- loosing customers
- reducing market share
- late delivery, etc.

Known approaches for problem solving

Traditional method: requires no factual analysis or observations

Symptom → **Remedy**

Scientific and methodical.

Symptom → **Root Cause** → **Remedy**

Steps of Problem Solving

1. Definition - Identify and defining the problem
2. Observation/Measure - Investigating the features of the problem
3. Analysis - Finding the root causes
4. Actions - Establishing and implementing countermeasures
5. Check - Ensuring the effectiveness of the remedies & countermeasures
   - Results v/s Plan
6. Standardization - Holding the gains
7. Conclusion - Reviewing the problem solving approach and identifying next problem

7-QC Tools

- Check sheet
- Pareto Diagram
- Stratification
- Cause and Effect Diagram
- Scatter diagram
- Histogram
- Graphs & Charts

Check Sheet

What is check sheet?

A convenient and compact format to facilitate data gathering & to quantify the current status or magnitude of the problem

Data Collection

What is Data ?

Data is a numerical expression of an activity

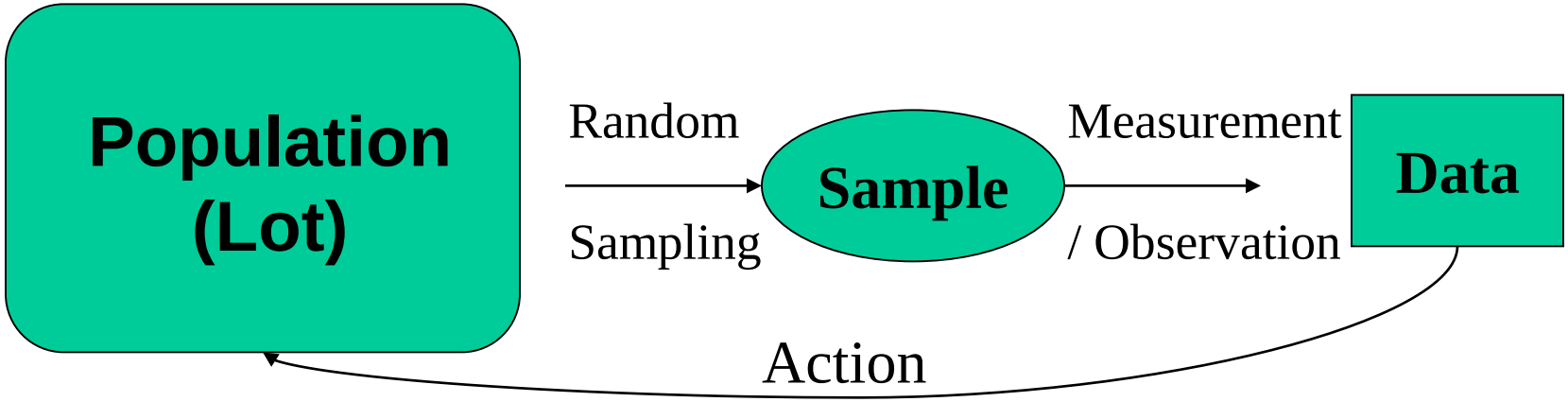
Quantitative

- Measurable
  - _ e.g. :Length, Temperature
- Countable
  - _ e.g. :Number of defects

Qualitative

- Subjective assessment
  - _ e.g. :Score in a beauty contest

Population, Sample and Data



Objectives of Data Collection

- To know and quantify the status
- To monitor the process
- To decide acceptance or rejection
- To analyse and decide the course of action

How to collect data?

- Define the purpose
- Decide the type of analysis
- Define the period of data collection
- Is the the required data already available ?

For Proper Data Collection

- Proper sampling procedure
- Proper choice of instruments
- Calibration of instruments used
- Availability of standards for sensory characteristics
- Adequate lighting and other test/ inspection facilities.

Purpose of Check Sheet

- Simplify of data gathering
- Provide preliminary summarisation
- Provide a basis for statistical analysis
- Problem monitoring
- Direction of trouble shooting

Areas of application

Production: Measurements on process parameters,
No. of defects in products,
Location of defect.

Raw Material: No of defects,location of defects,
Measurement on Quality Characteristics.

Maintenance: Maintenance time, down time,
Machine wise break-down,
Causes of break down.

Type of check sheets

Purpose of Checking	Type of Check Sheet
Determine defect details	Defective item check sheet
Determine occurrence of defects by day, week, operator, machine etc	Defect factor check sheet
Determine where defects occur	Defect location check sheet
Determine dispersion of dimensions, hardness, weight etc.	Process distribution check sheet
Inspect machines or equipment or check the operating procedure	Inspection and validation check sheet

Production Process Distribution Check sheet

Diameter of Component X										
Department :					**Operator :**					
Specification :					**Dates :**		**to**			
Measurement (cms)										
	///	///	///	//	//	/	/	/		

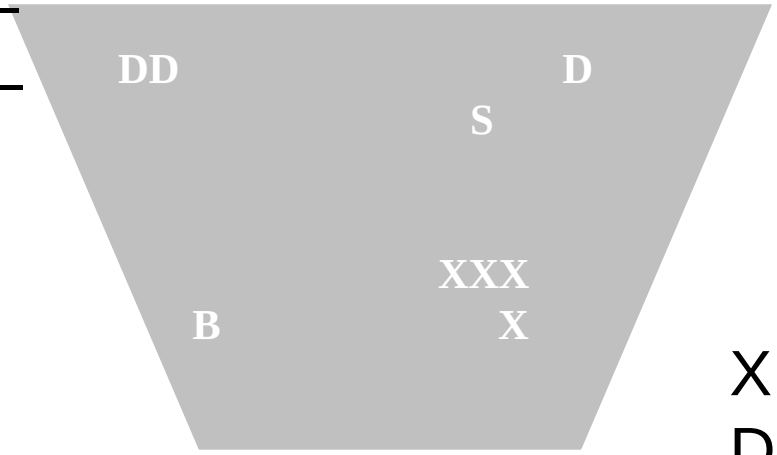
Location Check sheet

Hood Paint Defects

Name: _____

Date: _____

Model: _____



X = Dirt

D = Dent

S = Scratch

B = Bubble

No. inspected: _____

PARETO DIAGRAM

A tool to select vital few and few trivial many.

80-20 Rule

Pareto chart by effect

To find out what the major problem is Viz.

- **Quality:** Defects, Faults , Failures, Complaints, Repairs, Returned items etc.
- **Cost:** Amount of loss, Expenses
- **Delivery:** Stock, Shortages, Delay in delivery, Default in payment.
- **Safety:** Accidents, Breakdowns, mistakes.

Pareto chart by Cause

To find out what the major problem is Viz.

- Operator — Shift, Group, Experience, Skill.
- Machine — Machines, Equipment, Tools
- Raw material — Manufacturer, lot
- Operational method — Conditions, Order, Method

Uses of Pareto diagram

Find out the most important item/defect.

Ratio of each item to the whole.

Degree of improvement after remedial action in some limited area.

Improvement in each item/defect compared before and after correction.

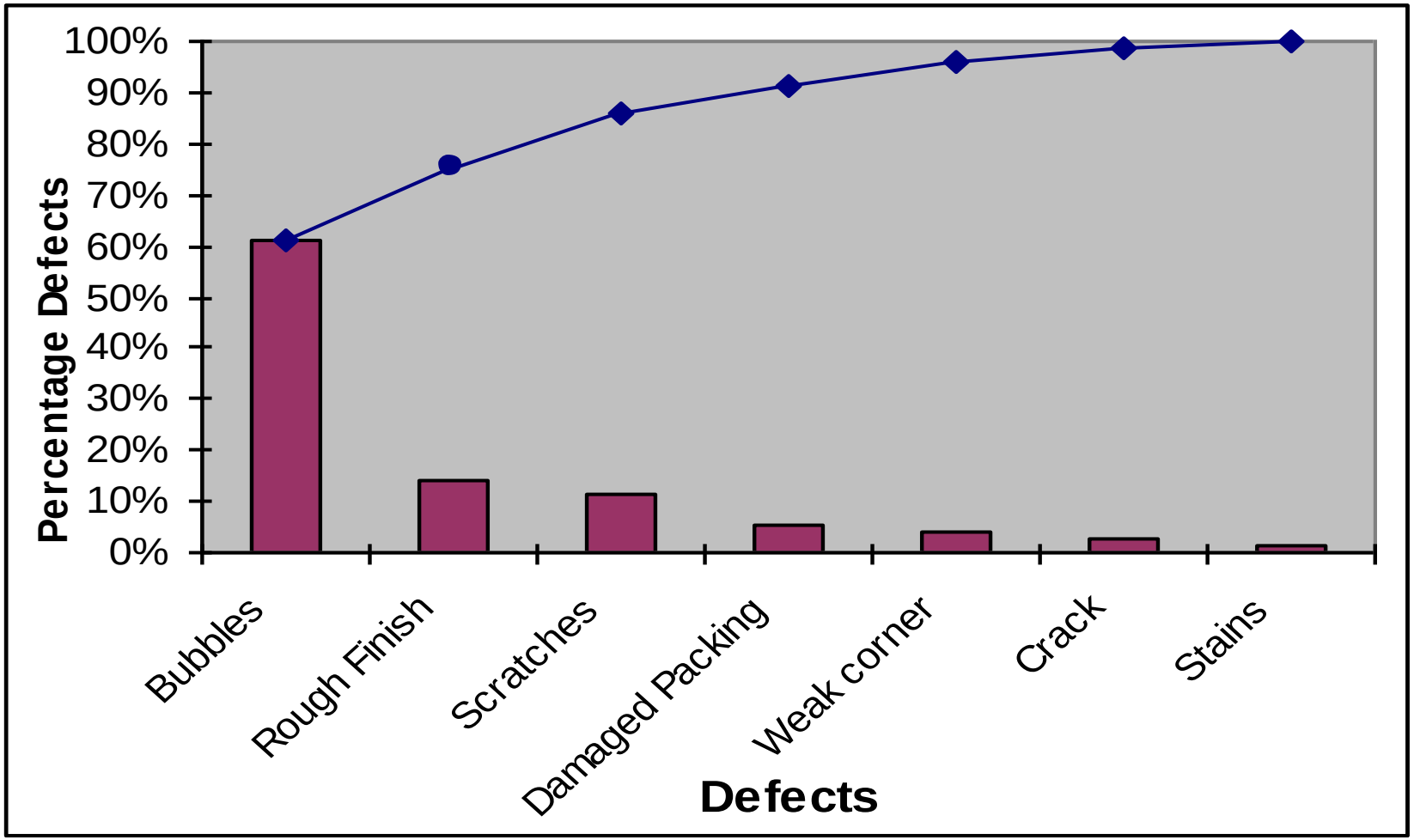
How to prepare a Pareto diagram

Decide which item to be studied.

Stratify the problem according to sources (by defects, by supplier etc.) and tabulate the corresponding data.

Arrange the stratified items in descending order of value and draw a bar diagram.

Draw a curve showing the cumulative % above the bar chart starting from the greatest value.


100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percentage Defects
Bubbles
Rough Finish
Scratches
Damaged Packing
Weak corner
Crack
Stains
Defects

STRATIFICATION

The method of grouping data by common points or characteristics to understand similarities and characteristics of data is called stratification.

Such classification helps in obtaining vital information by distinguishing and comparing data in different class or strata.

It also identifies the key strata to concentrate on

The stratification may be based on machines, operators, shifts or any other source of variation.

The purpose of stratification is to ascertain the difference between different categories and to analyse the reasons behind abnormal distribution.

STRATIFICATION

IDENTIFY STRATIFICATION CRITERIA FOR COLLECTING DATA ON HOUSE KEEPING DEFECTS:

RESULT: # OF DEFECTS PER AUDIT

STRATIFICATION CRITERIA:

- TYPE OF DEFECTS
- LOCATION
- DATE & TIME
- AUDITED BY
- PEOPLE IN THE LOCATION
- INFRASTRUCTURES AVAILABLE

TYPE OF STRATIFICATION CRITERIA:

- IDENTITY: e.g. product name, reference no. …
- MACHANICAL:
- OPERATIONAL:
- TECHNICAL:
- ENVIRONMENTAL
- MEASUREMENT:
- BEHAVIOURAL/SKILL RELATED
- TIME RELATED:
- ROLE, RESPONSIBILITY & AUTHORITY RELATED:

Areas of application

Raw material

Rejection % in supplier wise and batch wise.

Production

Stratification as per Machine, Shift, operator etc. of rejections.

Engineering and design

Stratification of drawing errors draftsman wise.

USE OF STRATIFICATION:

- REVIEW ADEQUACY OF PRESENTLY USED DATA COLLECTION MODE LIKE REGISTER, LOGBOOK etc.
- INTRODUCING NEW DATA COLLECTION MODE
- COLLECTION OF DATA FOR ANY SPECIFIC PURPOSE
- BEFORE CHECKSHEET

BRAIN STORMING

Basic Rules for Brainstorming

- Defer evaluation
- Fantasize freely
- Generate quantity
- Build on ideas

Generate Quantity

Generate as many ideas as possible.

A pearl diver will be more successful in finding pearls, when he brings up 200 oysters than when he surfaces only 15-20 oysters.

Cause & Effect Diagram

(Optional)

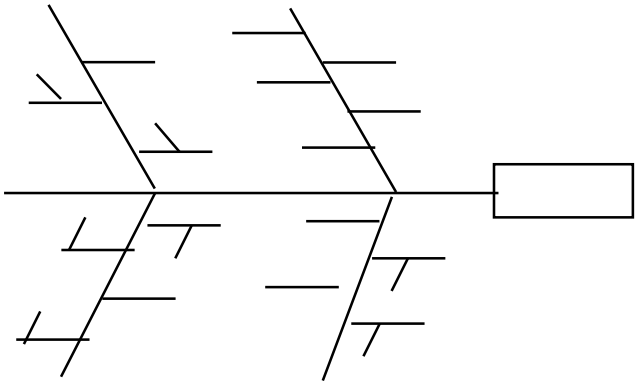
Tree Diagram
&
Affinity Diagram

Organizing Potential Causes

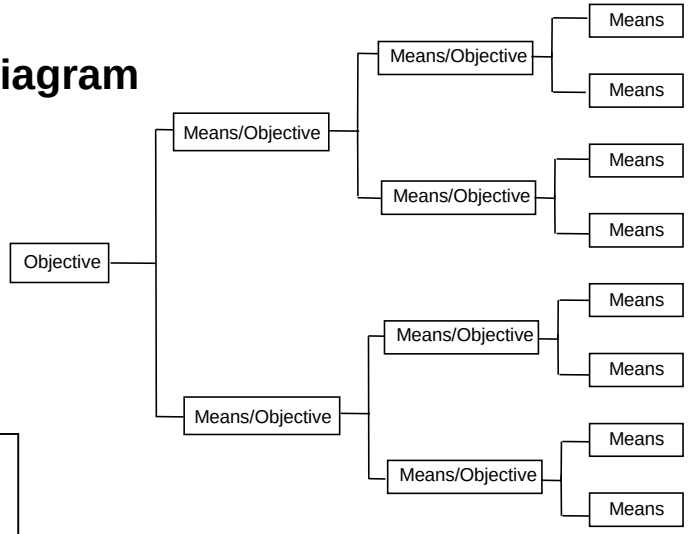
Looking for Relationships

Graphic displays can help you structure possible causes in order to find relationships that will shed new light on your problem.

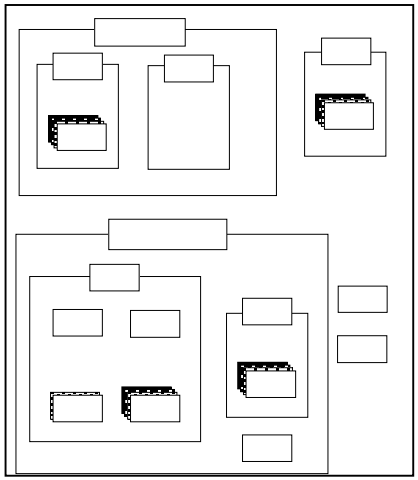
Cause & Effect Diagram



Tree Diagram

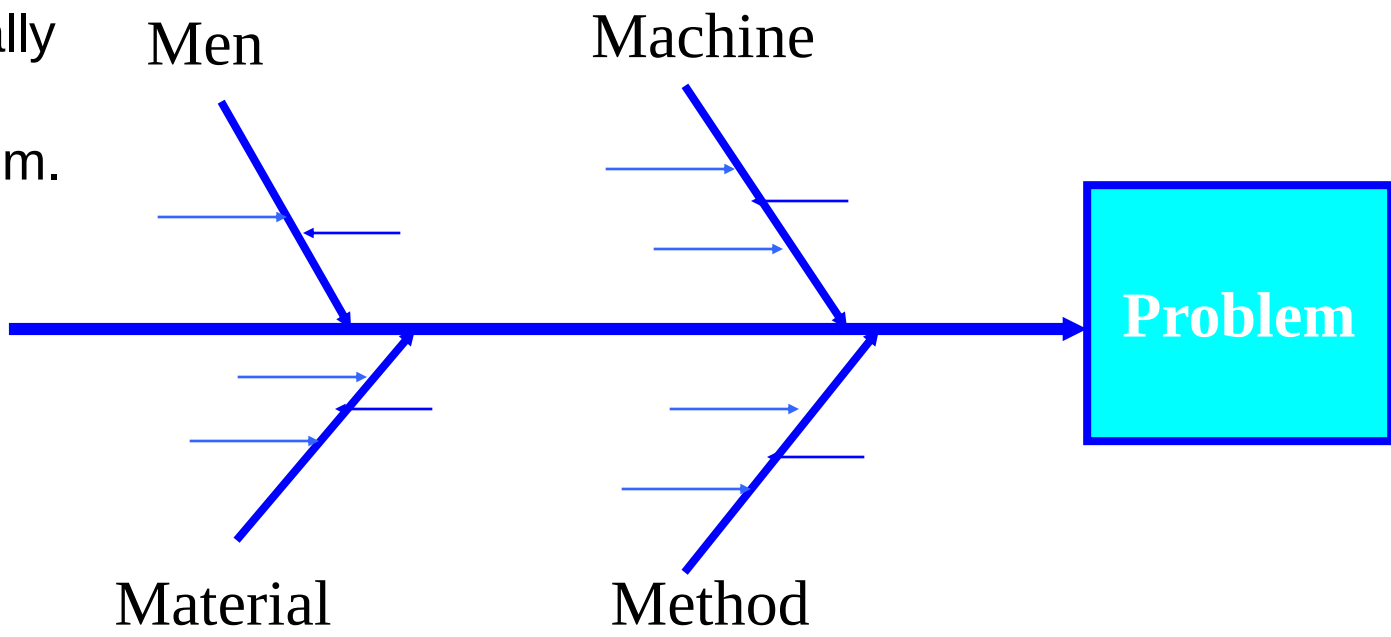


Affinity Diagram

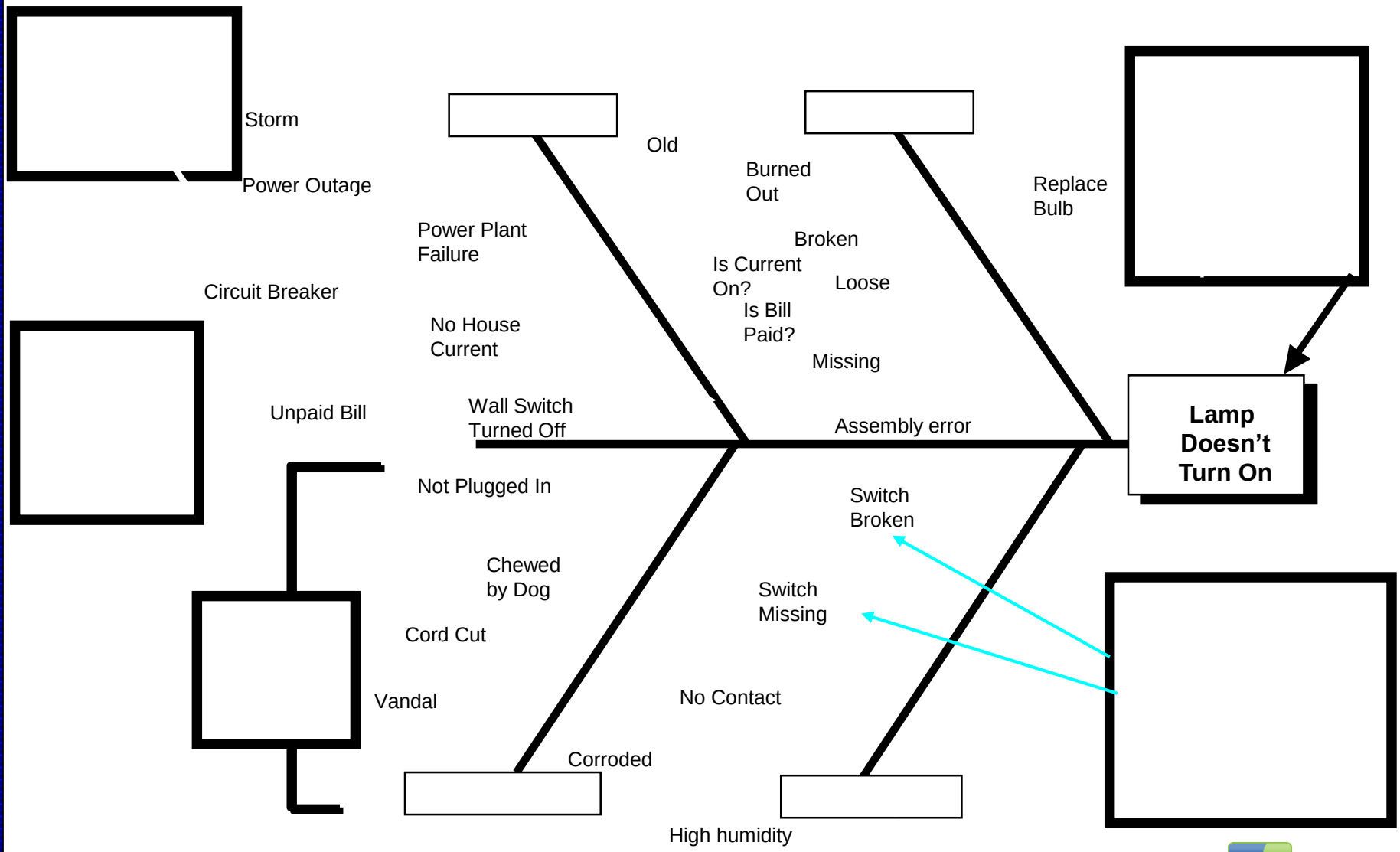


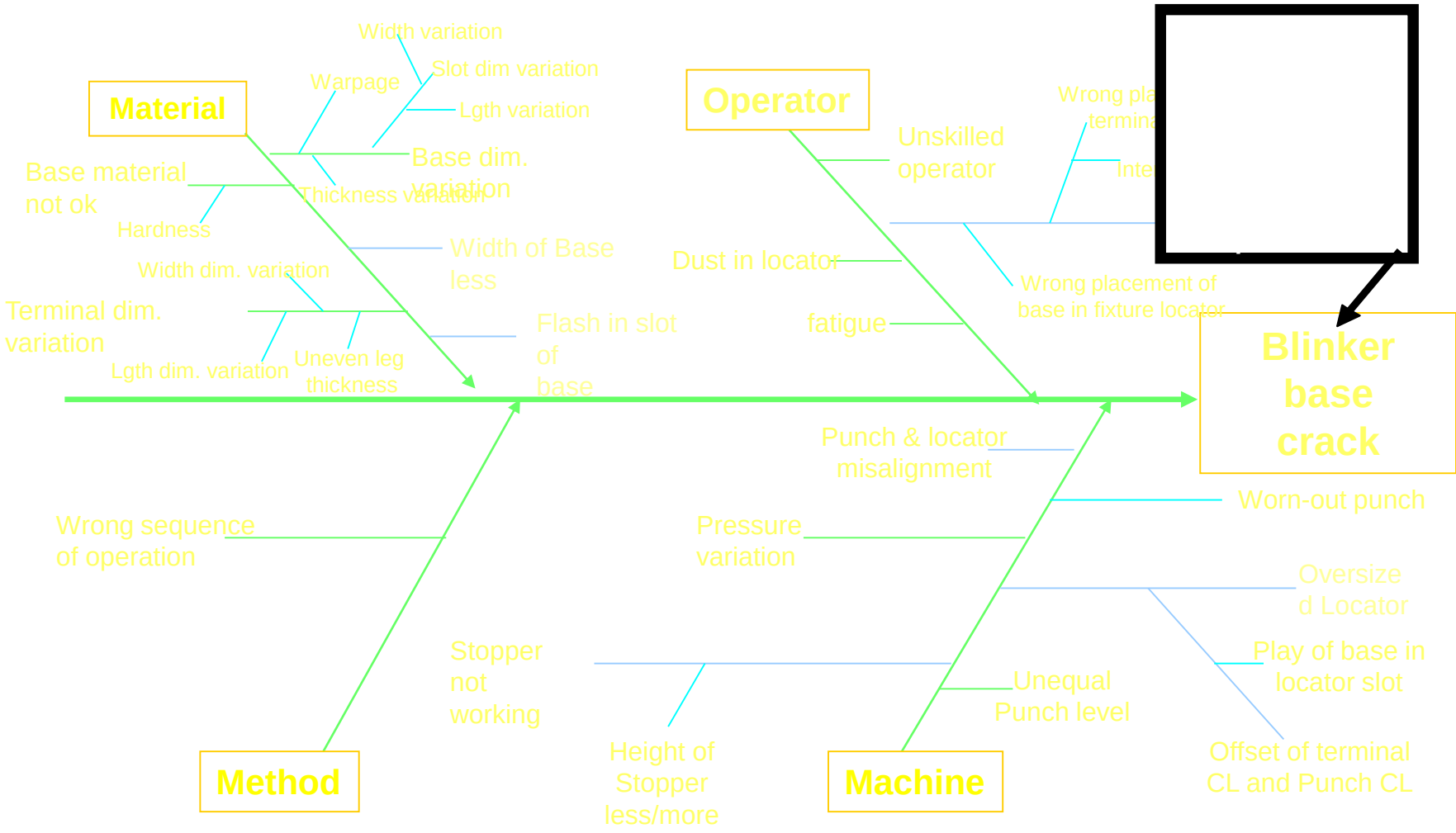
Cause-and-Effect Diagram

Cause-and-effect diagrams graphically display potential causes of a problem. The layout shows cause-and-effect relationships between the potential causes.



Cause-and-Effect Diagram Features




Material
Width variation
Slot dim variation
Warpage
Lgth variation
Base dim. variation
Base material not ok
Thickness variation
Hardness
Width of Base less
Width dim. variation
Terminal dim. variation
Flash in slot of base
Lgth dim. variation
Uneven leg thickness
Operator
Unskilled operator
Dust in locator
fatigue
Wrong placement of base in fixture locator
Blinker base crack
Punch & locator misalignment
Worn-out punch
Wrong sequence of operation
Pressure variation
Oversized Locator
Play of base in locator slot
Stopper not working
Unequal Punch level
Height of Stopper less/more
Offset of terminal CL and Punch CL
Method
Machine

Why Use Cause-and-Effect Diagrams

- To stimulate thinking during a brainstorm of potential causes
- To understand relationships between potential causes
- To track which potential causes have been investigated, and which proved to contribute significantly to the problem

When to Use Cause-and-Effect Diagrams

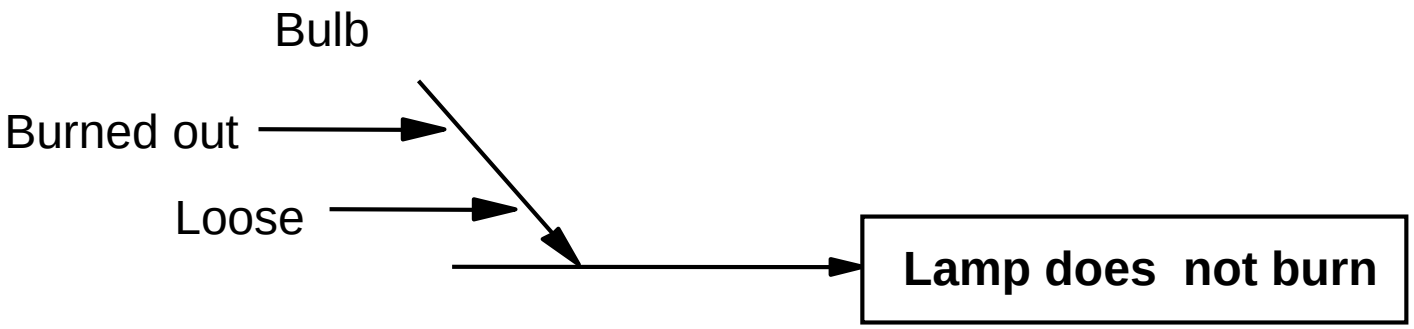
Use a Cause-and-Effect Diagram:

- When there is so large a number of potential causes that it is difficult to focus the analysis.
- When there is a lack of clarity about the relationship between different potential causes.

Effective Use of Cause-and-Effect Diagrams

- Have a narrowly defined problem to start with.

  This should come from your work in Measure.
- Capture **cause-and-effect** relationships between units and sub-units.



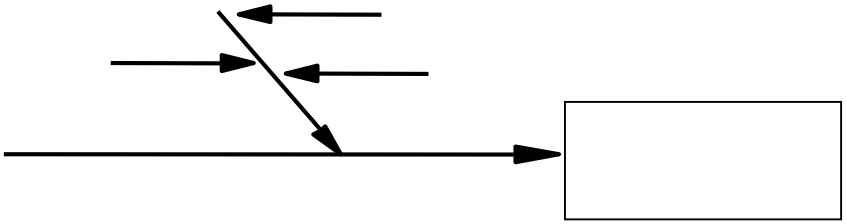
- Causes on the diagram must be **verified with data** to confirm that they are real causes.

How to Create a Cause-and-Effect Diagram

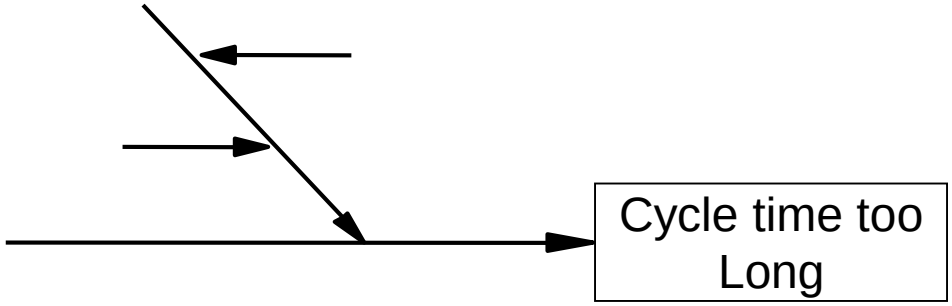
1. Review the Focused Problem Statement
2. Identify Possible Causes
3. Sort Possible Causes into Reasonable Clusters
4. Choose a Cluster and label a main Bone
5. Develop and Arrange Bones for that Cluster
6. Develop Other Main Bones

Avoid Common Mistakes

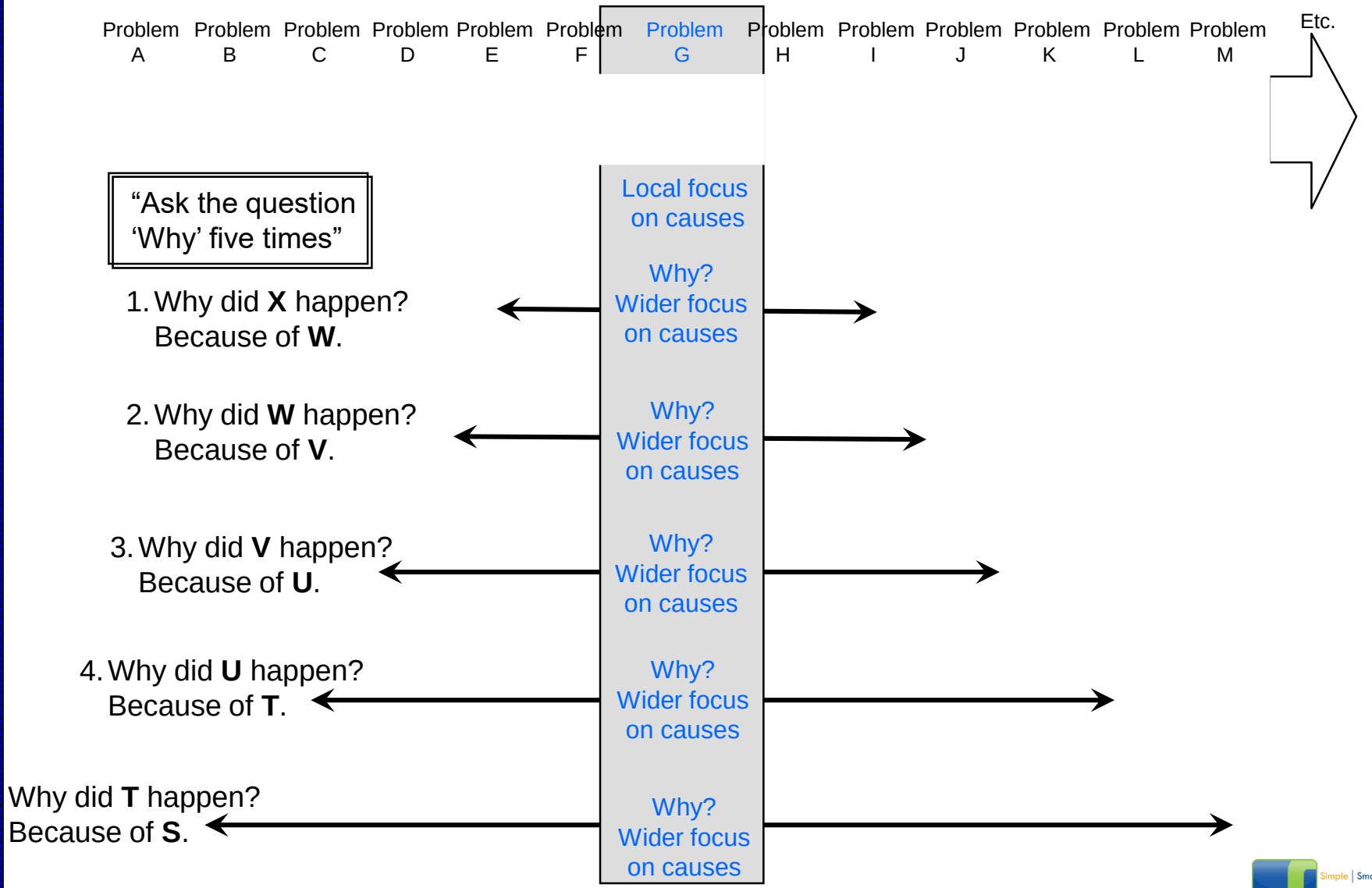
- Do not use this tool as an alternative form of outlining



- Do not use the tool to list potential solutions

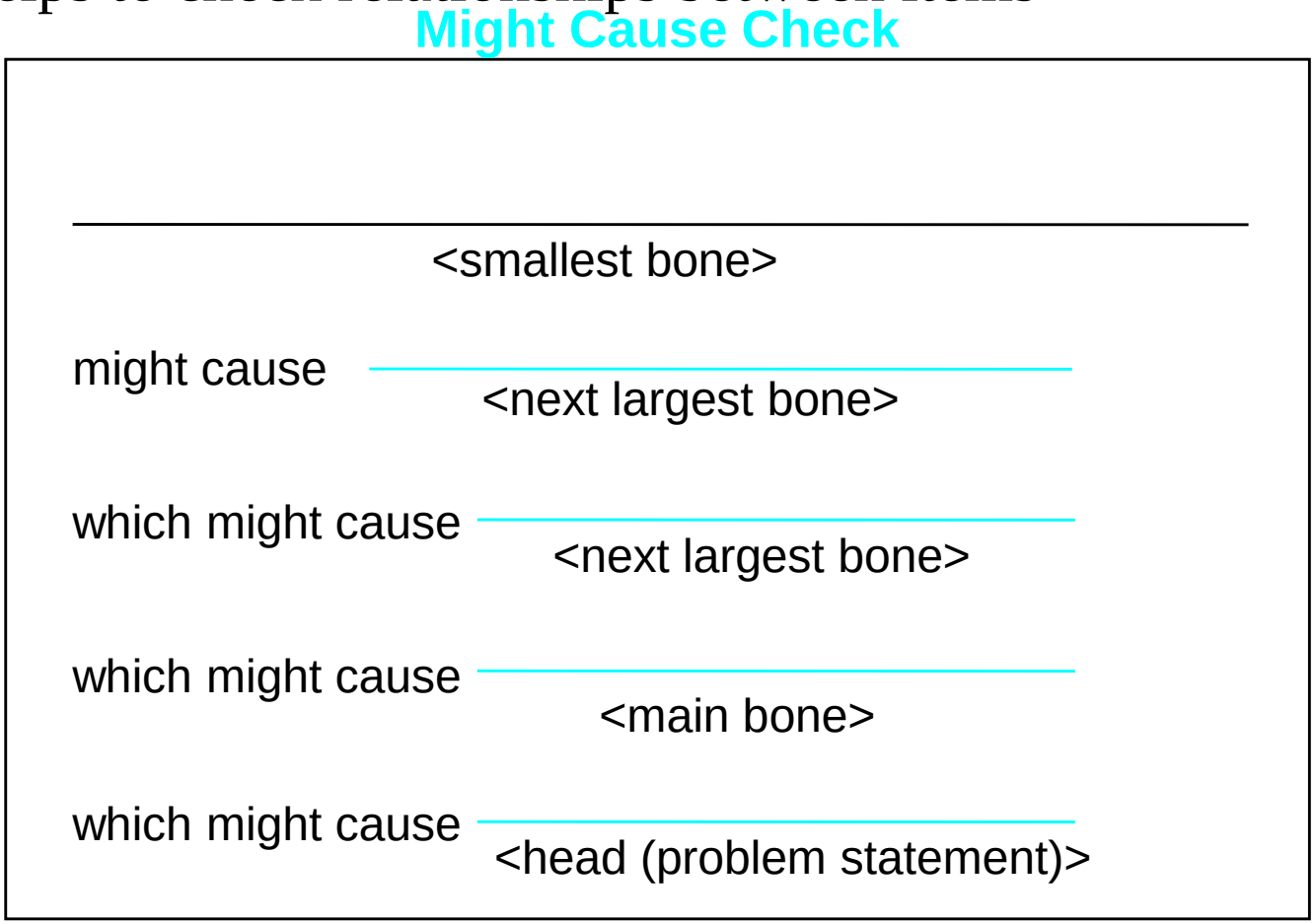


"The Five Whys" and Mile-Deep Thinking



The "Might Cause" Check

- Helps to confirm the items listed are potential causes
- Helps to check relationships between items



Might Cause Example

Might Cause Check

High humidity
<smallest bone>

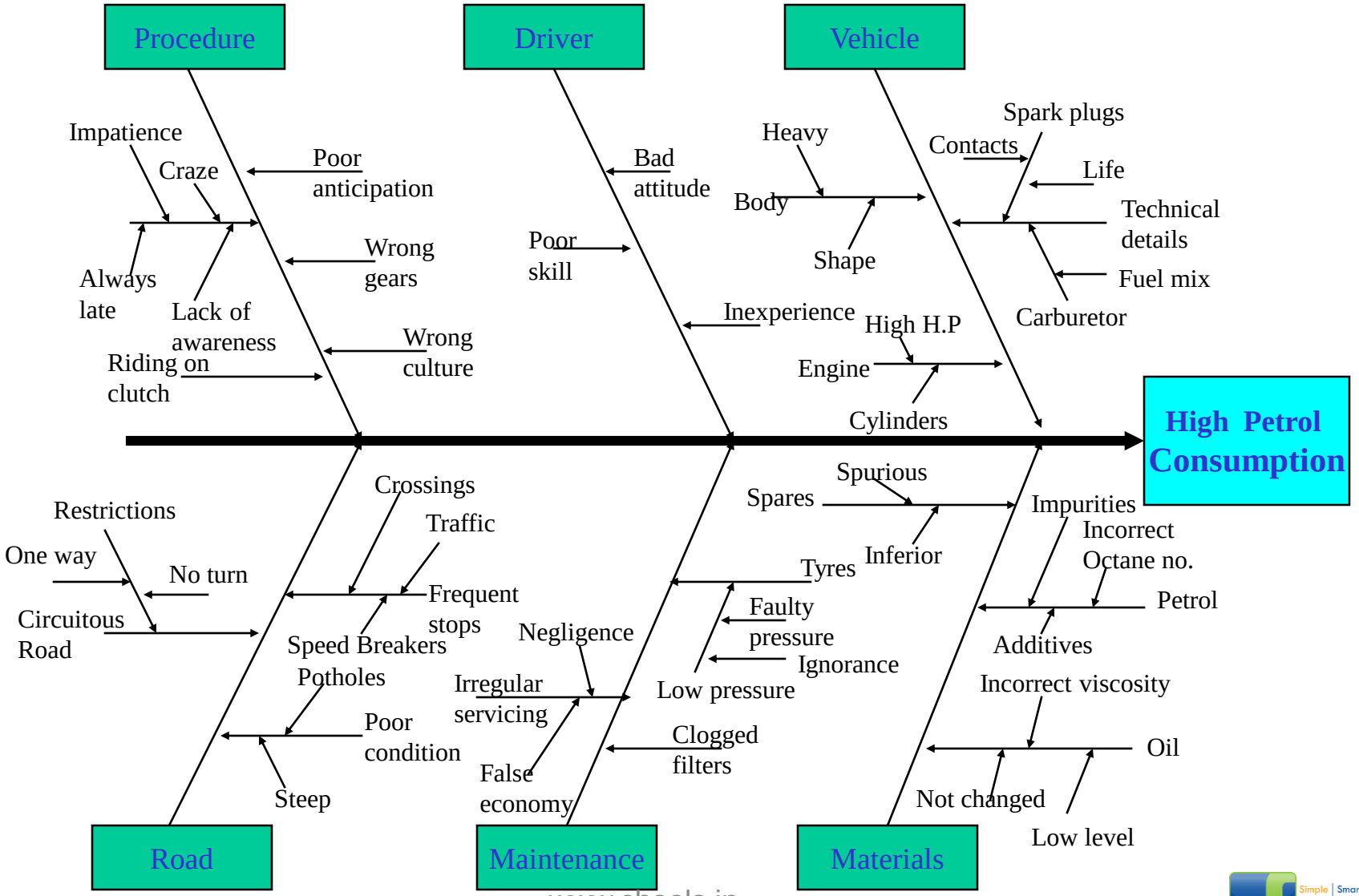
might cause *Corrosion*
<next largest bone>

which might cause
<next largest bone>

which might cause *No contact*
<main bone>

which might cause *Lamp does not turn on*
<head (problem statement)>

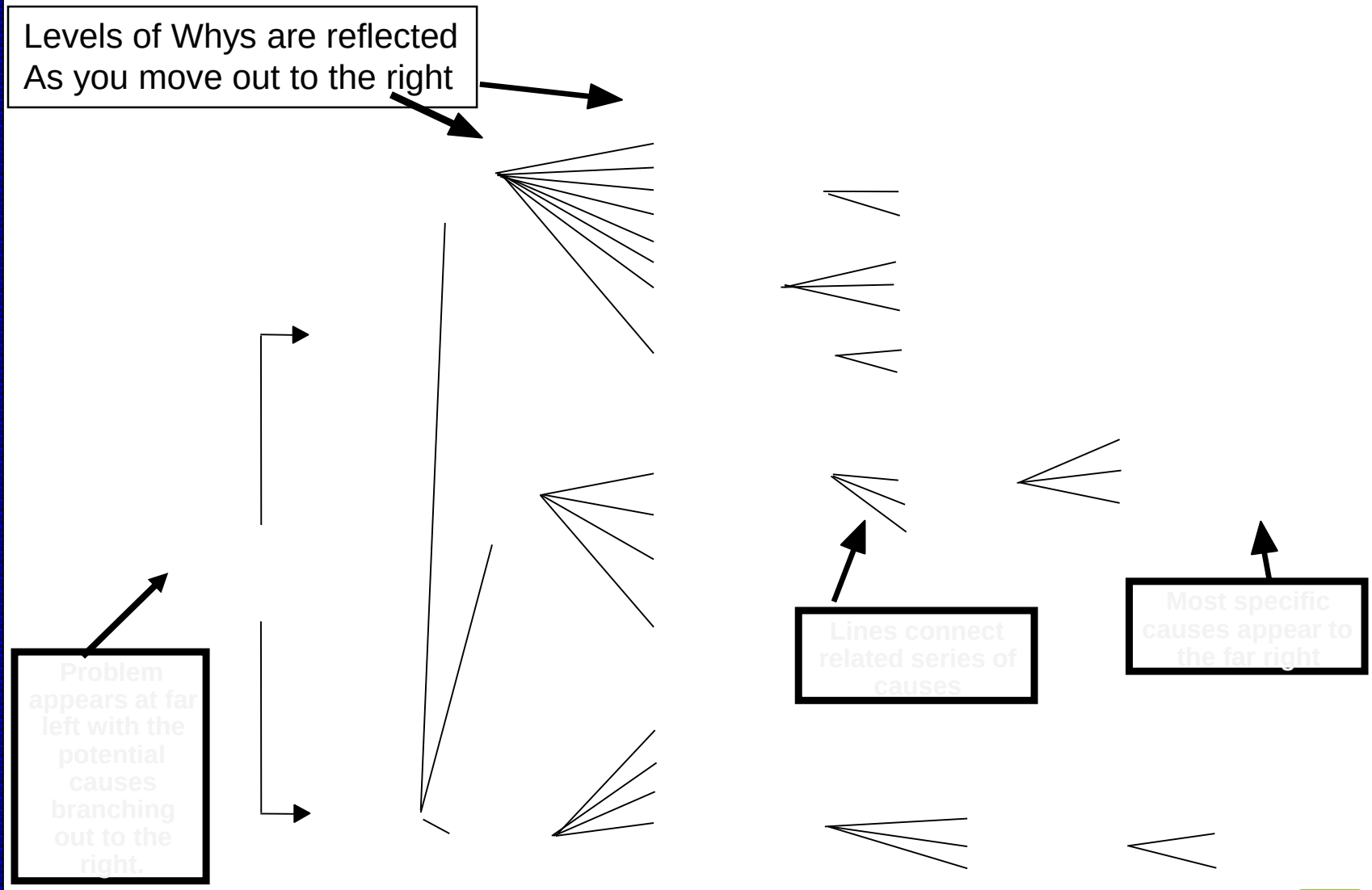
Cause and Effect Diagram for high petrol consumption



Tree Diagram Definition

Another way to find structure in potential causes is to use a tree diagram, which is a tool used to arrange related ideas in sequence from broad and general to narrow and specific.

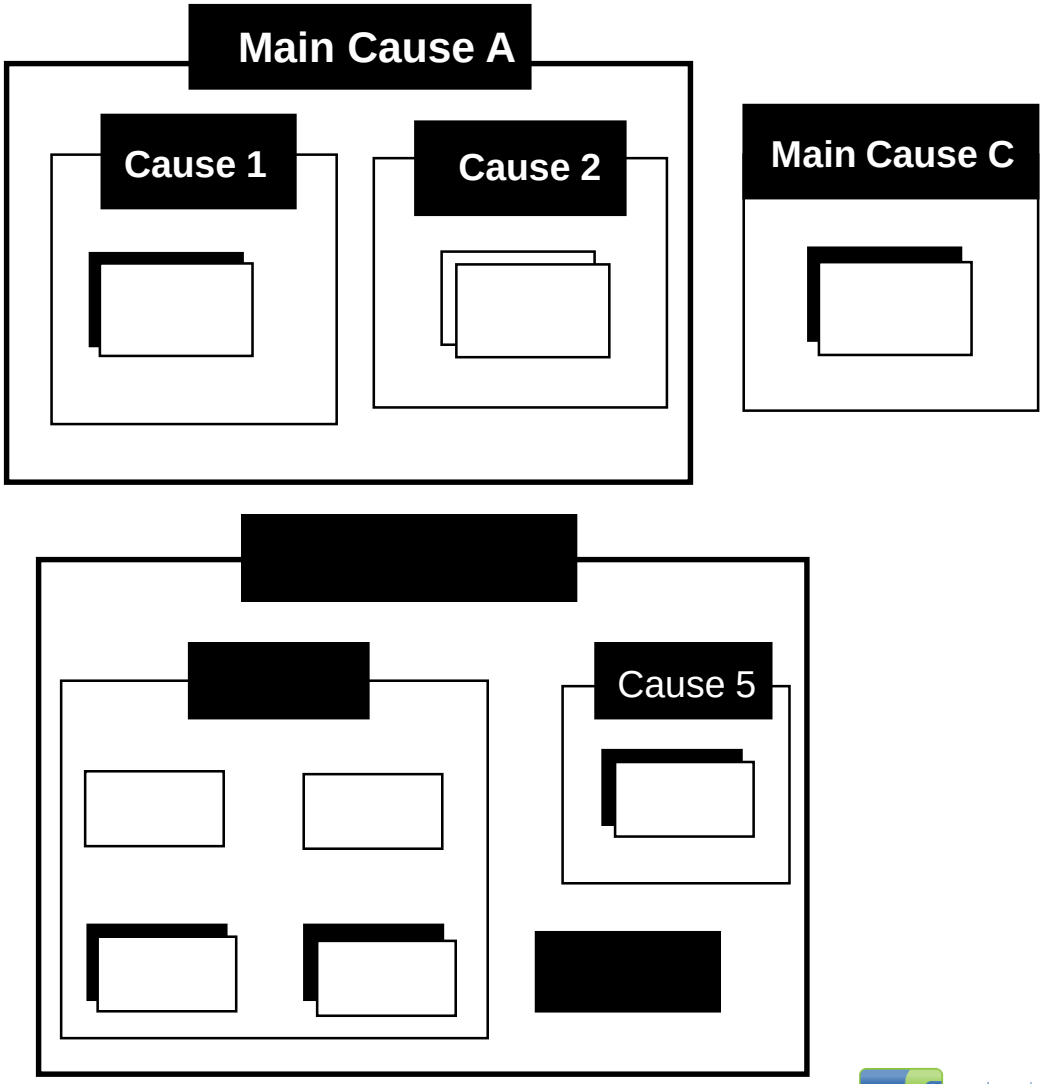
Causal Tree Diagram Features



Affinity Diagrams

Affinity diagrams were introduced in Module 1.3 as a tool for understanding customer needs.

The sketch shown here depicts how an affinity diagram can also be used to help understand the relationships between potential causes.



HISTOGRAM

Histogram is a graph that displays the distribution of data

Histogram is characterised by three constituents

- **A center (mean)**
- **A width (spread)**
- **An over all shape**

How to make a Histogram

Select a sample of size N.

Record the measurements.

Determine the range.

Decide the number of classes.

Determine the boundary or class limits.

Prepare frequency distribution.

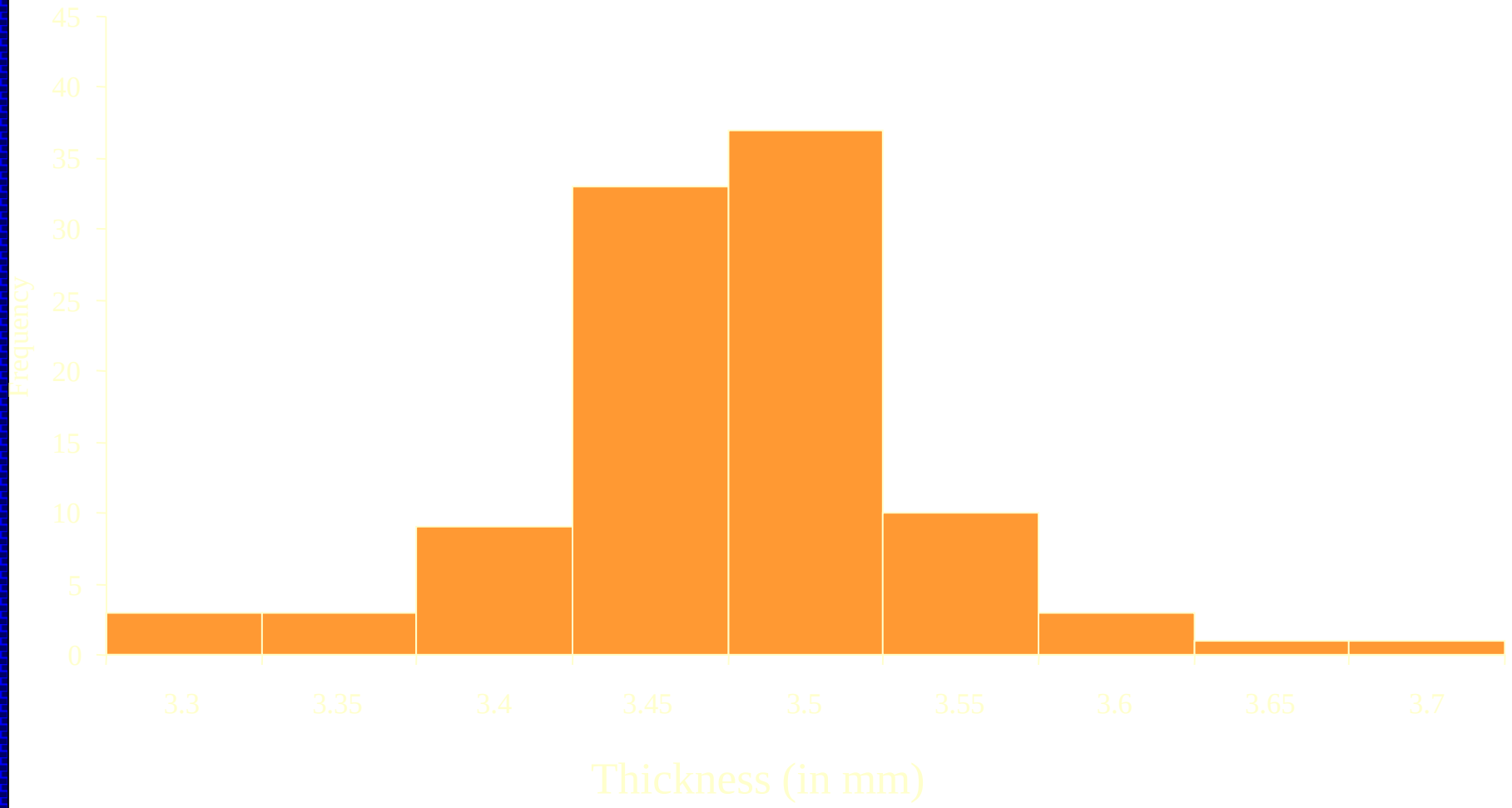
Construct histogram.

Data on Metal Block thickness (in mm)

3.56	3.46	3.48	3.50	3.42	3.43	3.52	3.49	3.44	3.50
3.48	3.56	3.50	3.52	3.47	3.48	3.46	3.50	3.56	3.38
3.41	3.37	3.47	3.49	3.45	3.44	3.50	3.49	3.46	3.46
3.55	3.52	3.44	3.50	3.45	3.44	3.48	3.46	3.52	3.46
3.48	3.48	3.32	3.40	3.52	3.34	3.46	3.43	3.30	3.46
3.59	3.63	3.59	3.47	3.38	3.52	3.45	3.48	3.31	3.46
3.40	3.54	3.46	3.51	3.48	3.50	3.68	3.60	3.46	3.52
3.48	3.50	3.56	3.50	3.52	3.46	3.48	3.46	3.52	3.56
3.52	3.48	3.46	3.45	3.46	3.54	3.54	3.48	3.49	3.41
3.41	3.45	3.34	3.44	3.47	3.47	3.41	3.38	3.54	3.47

Frequency Table

Class no.	Class Boundaries	Mid-value	Frequency
1	3.275 – 3.325	3.30	3
2	3.325 – 3.375	3.35	3
3	3.375 – 3.425	3.40	9
4	3.425 – 3.475	3.45	33
5	3.475 – 3.525	3.50	37
6	3.525 – 3.575	3.55	10
7	3.575 – 3.625	3.60	3
8	3.625 – 3.675	3.65	1
9	3.675 – 3.725	3.70	1



Applications of Histograms

Shape and Smoothness

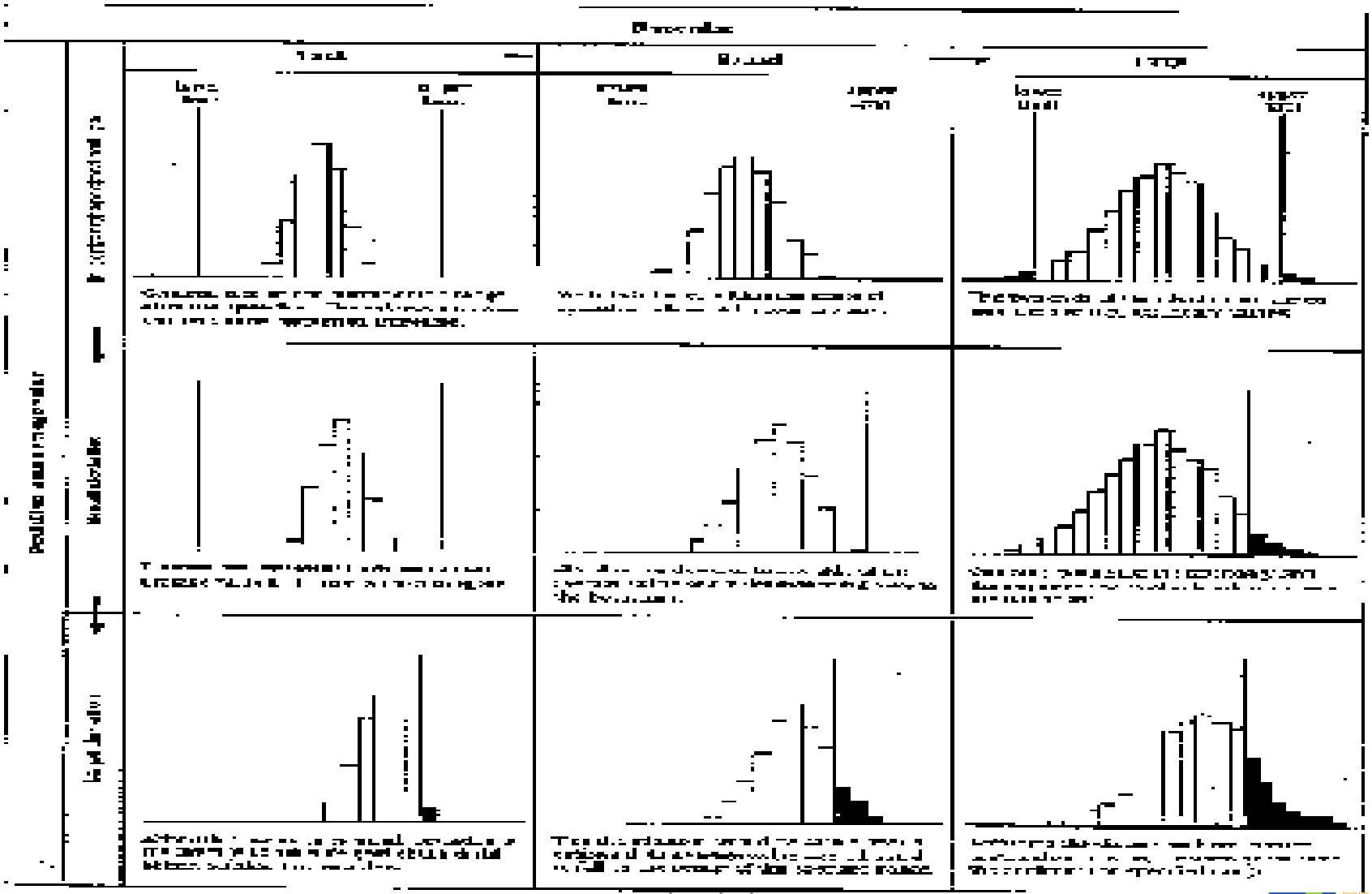
Comparison to Specification limits

Comparison to Sources of Variability

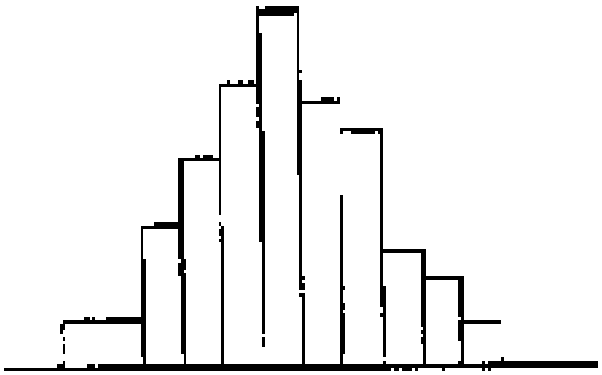
Outlier Detection

Before and After Comparison

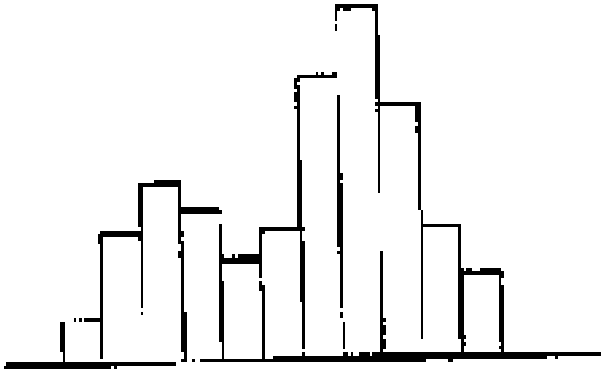
Comparison of Histogram with Specification Limits



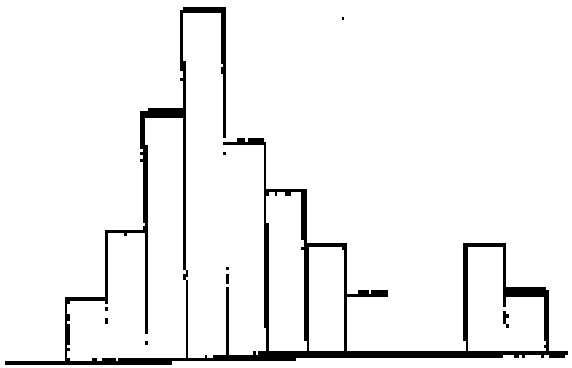
Types of Histograms



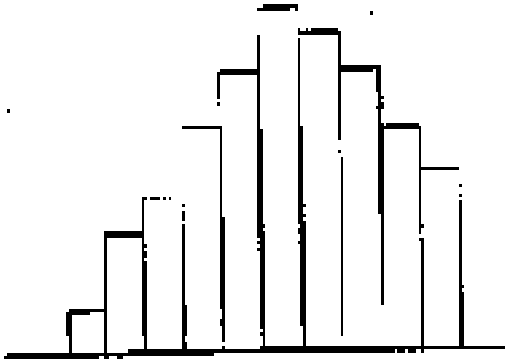
Normal Histogram



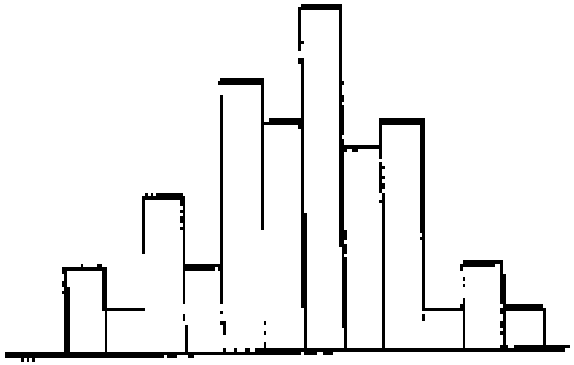
Double Peak Histogram



Isolated Island Histogram



Cliff Histogram



Edgetool Histogram

Types of Histograms

Bell shaped

Symmetrical shape with a peak in middle representing a normal histogram

Types of Histograms

Double peaked

Two normal distributions with two peaks in middle indicating more than one distribution at work

Types of Histograms

Plateau

More than one distribution at work

Types of Histograms

Comb

Alternative peaks showing possible errors in data collection and analysis

Types of Histograms

Skewed

An asymmetrical shape - positively or negatively skewed - usually reflecting limits in the specification on one side

Types of Histograms

Truncated

Usually being a part of a normal distribution with part of it having been removed.

Types of Histograms

Isolated peak

Two normal distributions suggesting two processes taking place at the same time.

Types of Histograms

Edged peaked

A normal distribution curve with a large peak at one end indicating errors in data recording.

SCATTER DIAGRAM

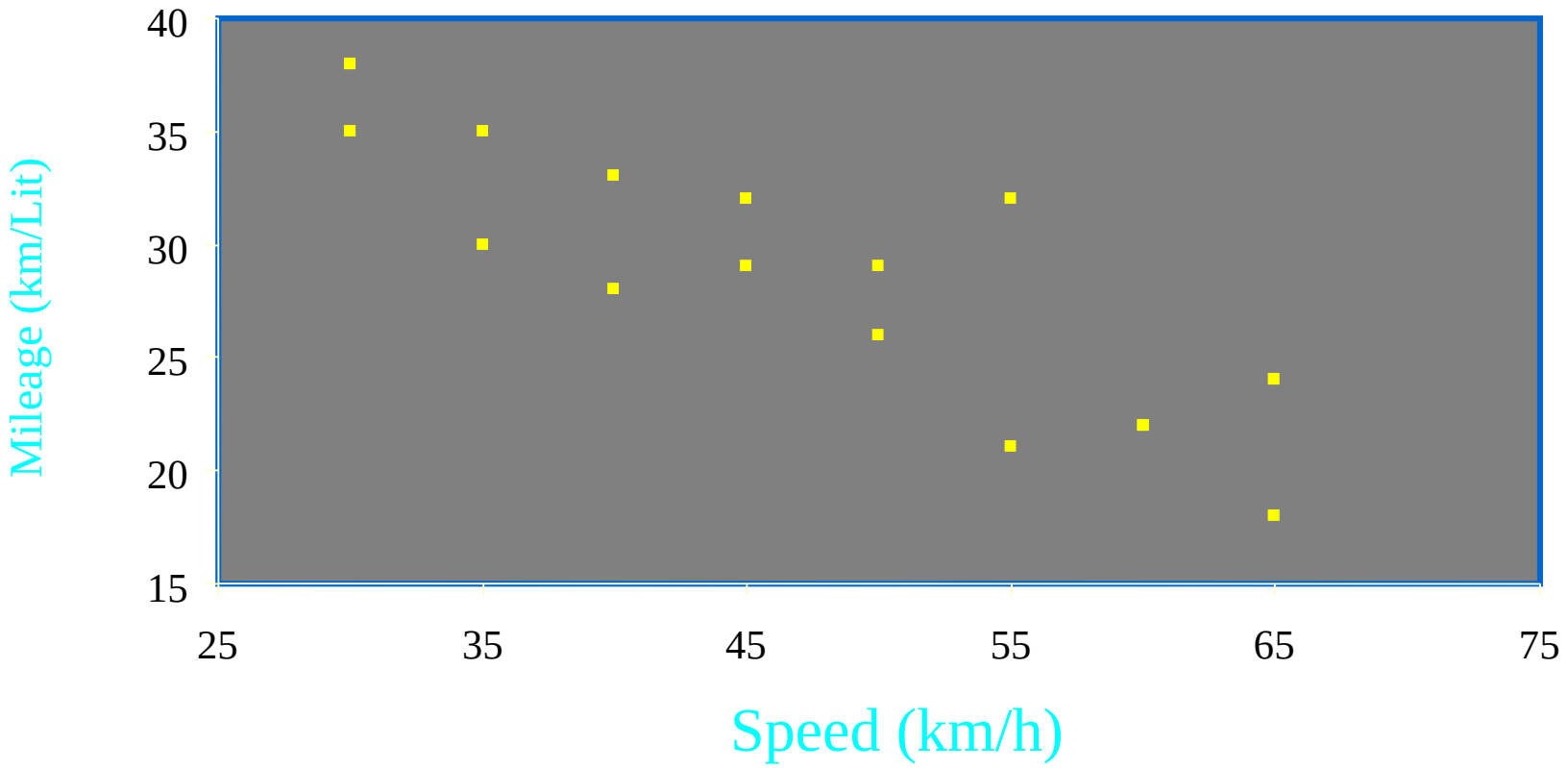
If two types of data, x and y, are related in that x increases or decreases with y, a correlation exists between them.

A scatter diagram is a chart that expresses the relationship between two such data types.

Some examples of relationship

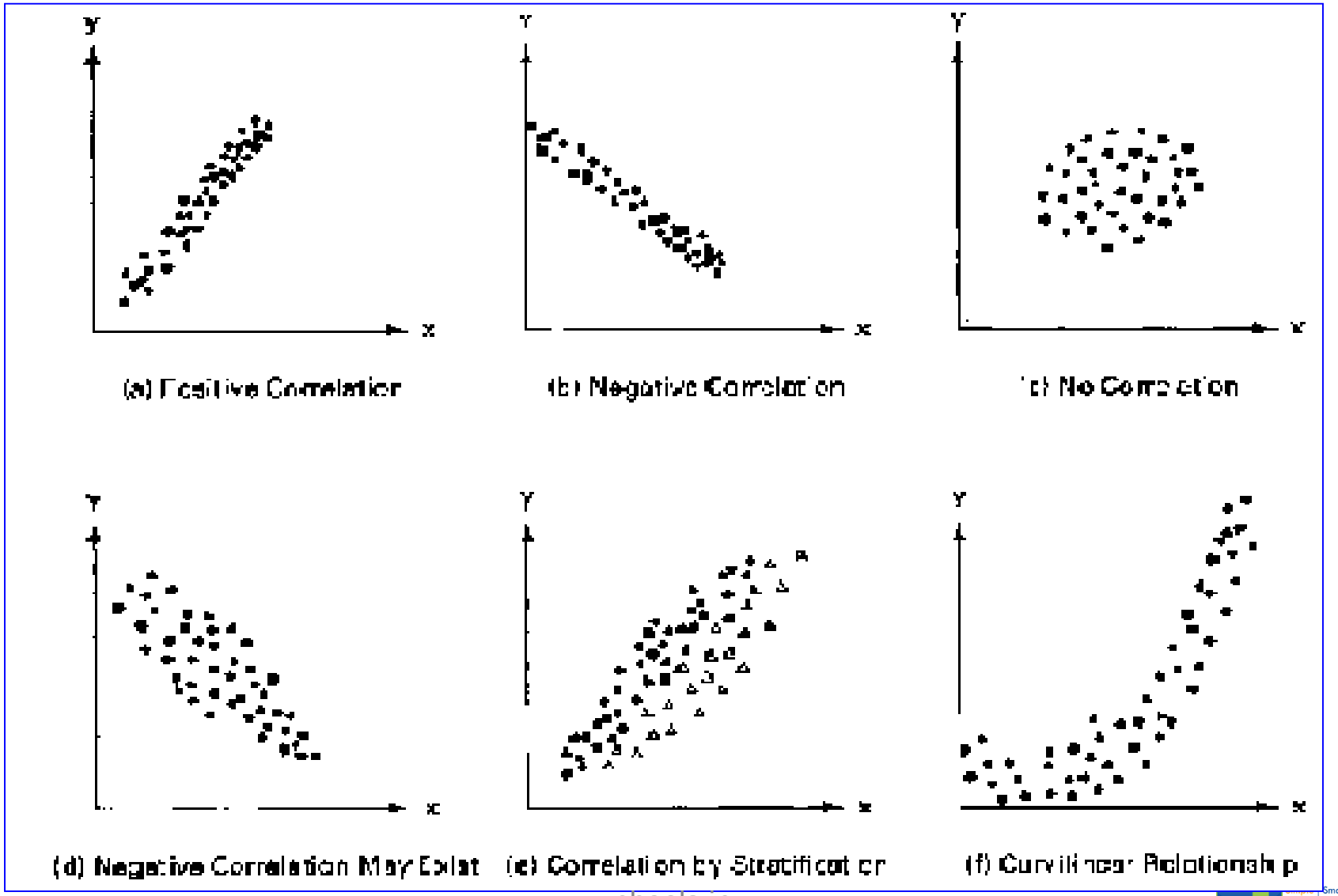
- Cutting speed and tool life
- Moisture content and thread elongation
- Breakdown and equipment age
- Temperature and lipstick hardness
- Striking pressure and electrical current
- Temperature and percent foam in soft drinks

Scatter diagram on Automotive Speed vs. Mileage



A scatter diagram depicts the relationship as a pattern that can be directly read.

Different Scatter diagram Patterns



If y increases with x, then x and y are positively correlated.

If y decreases as x increases, then the two types of data are negatively correlated.

If no significant relationship is apparent between x and y, then the two data types are not correlated.

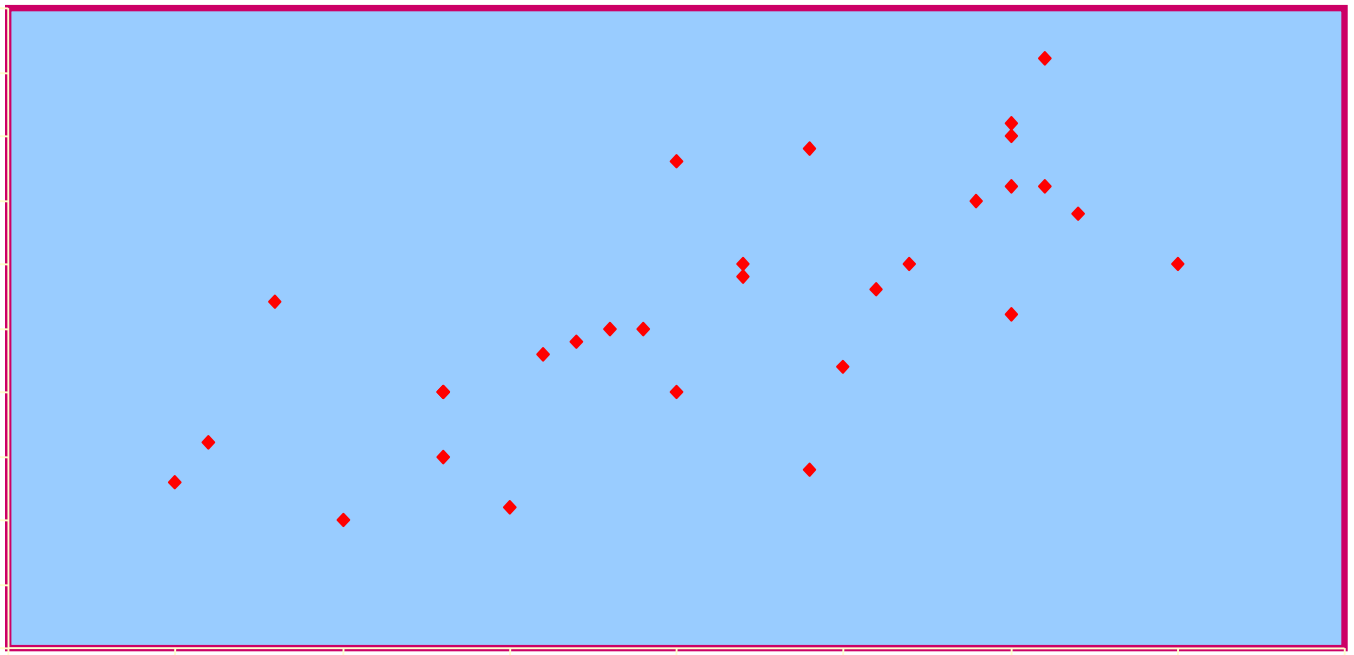
How to make a Scatter diagram

- **Collect 30 to 50 pairs of quantitative data (x and y).**
- **Choosing units that express the range of the x and y values, draw an x scale along the horizontal axis and a y scale along the vertical axis.**
- **Plot the data pairs (x, y) as points on a scatter diagram.**

Data on Conveyor Speed and Severed Length

Sl. No.	Conveyor Speed (cm/sec)	Severed Length (mm)	Sl. No.	Conveyor Speed (cm/sec)	Severed Length (mm)

Scatter Diagram on Conveyor Speed vs. Severed Length



Uses of Scatter Diagram

If an increase in y depends on increase in x, then, if x is controlled y will be naturally controlled.

If x is increased, y will increase somewhat. Then y seems to have causes other than x.

GRAPHS and CHARTS

Graphs and charts are pictorial representation of the data, making it easy to spot trends, ratios and comparisons among different groups of data.

The more common types of graphs and charts are Line graphs, Bar charts and Pie charts.

Purpose of Graphs and Charts

To present the numerical data in an easy-to-plot visual form.

Purpose of Graphs and Charts

Line graphs are used to depict change or variation over time.

Purpose of Graphs and Charts

Bar charts are used for comparing quantities between persons, regions, time intervals etc.

Purpose of Graphs and Charts

Pie charts are used to show percentages or proportions of different components of a specific item.

Procedure for making Graphs and Charts

Select the type of chart or graph most suitable for the type of data.

Decide the units and scale of items to be shown on X-axis and Y-axis

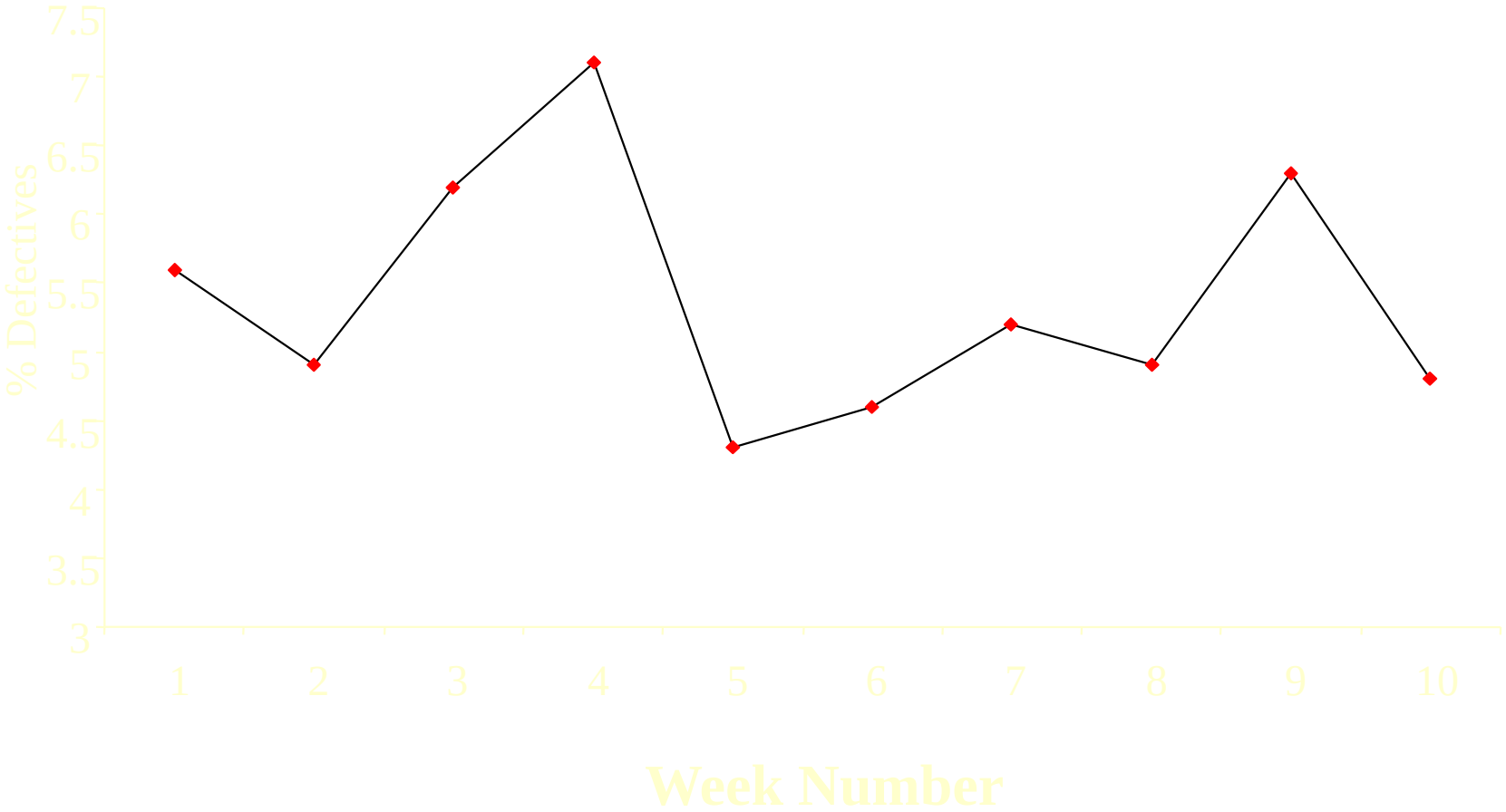
Fill the information on the graph sheet.

Join the required points to complete lines or bars.

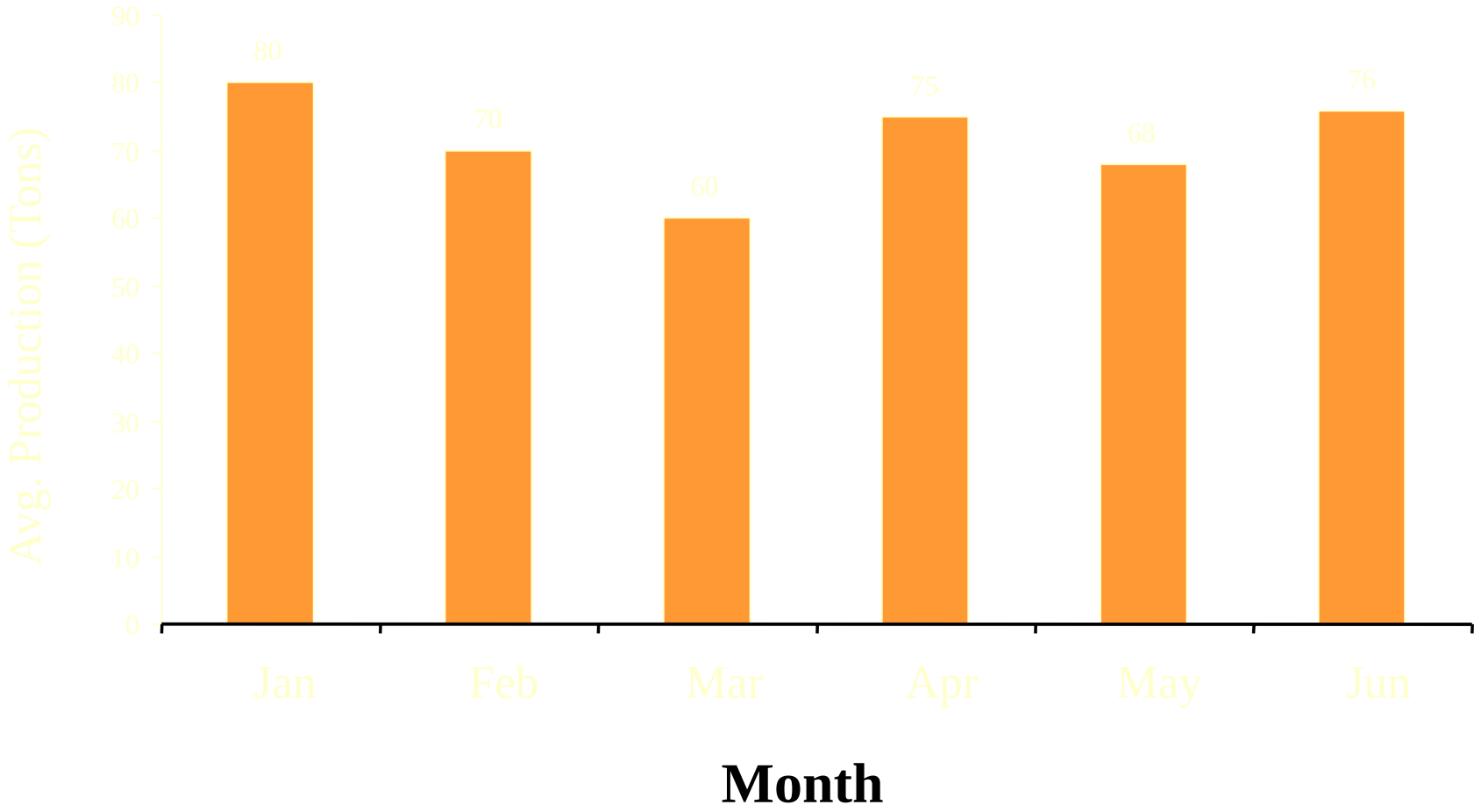
Colour or shade the lines or bars to distinguish between different groups or classes.

Provide appropriate title.

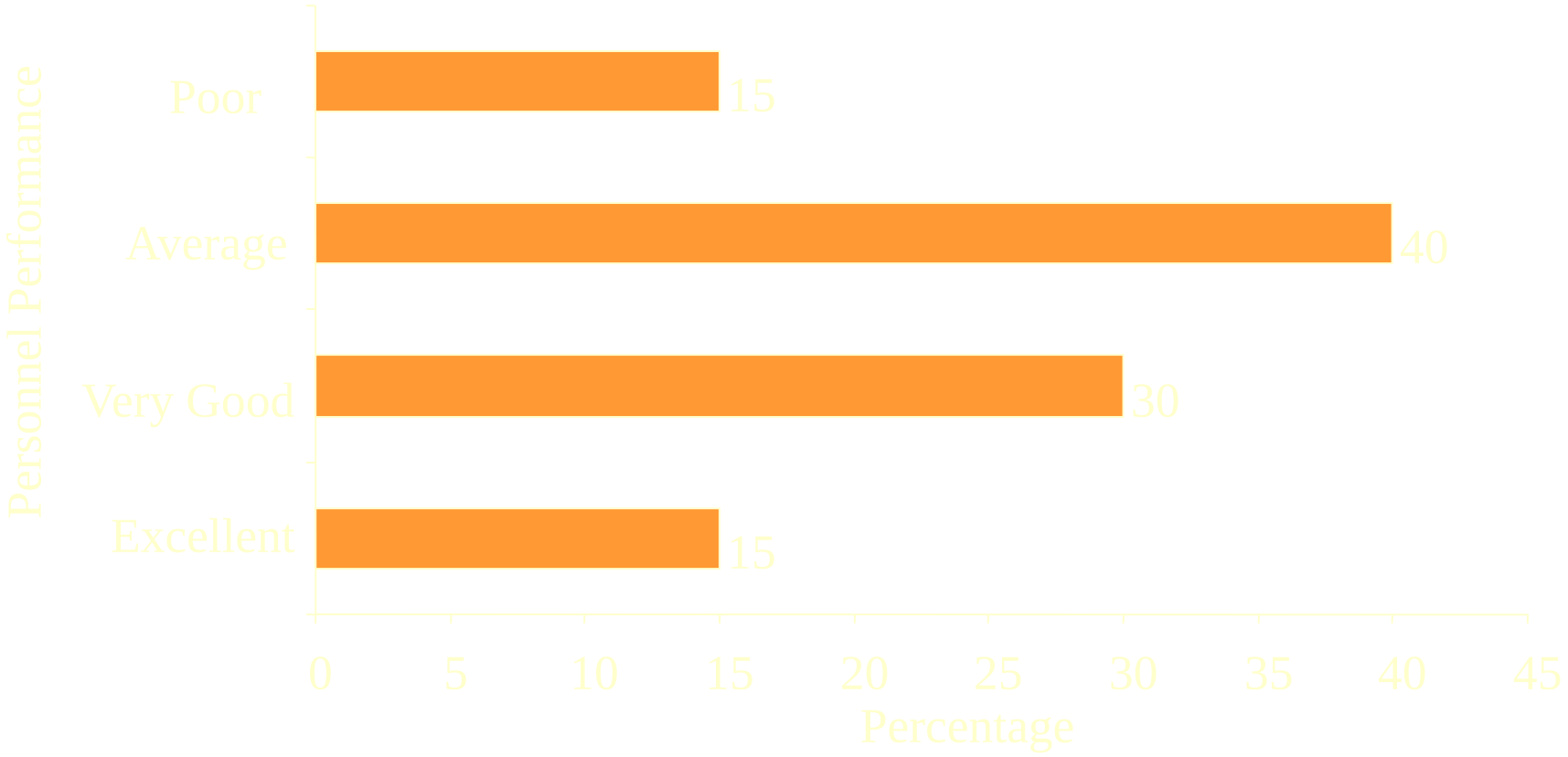
% Defectives for different Weeks for product XYZ



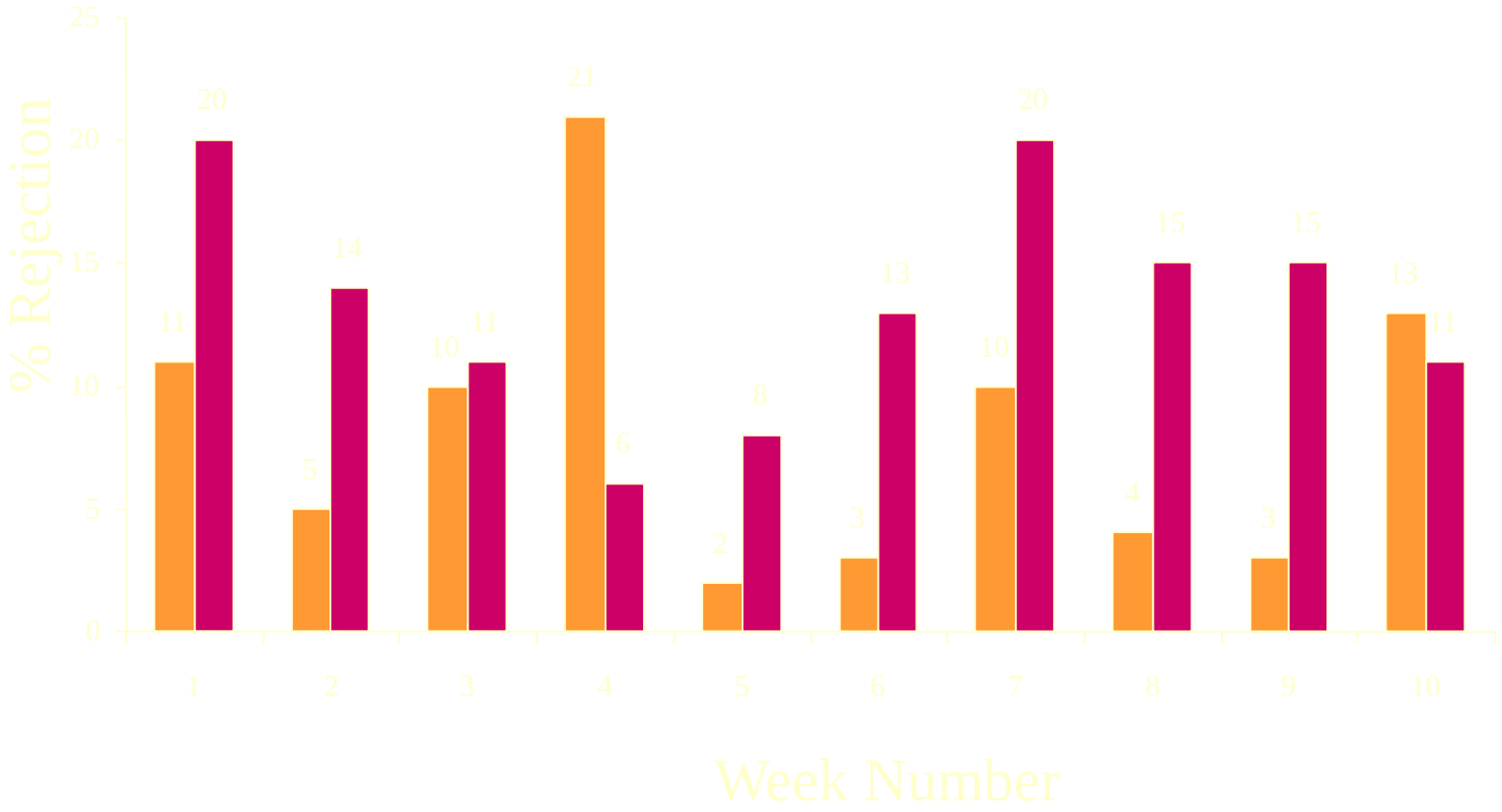
Average Production in different months



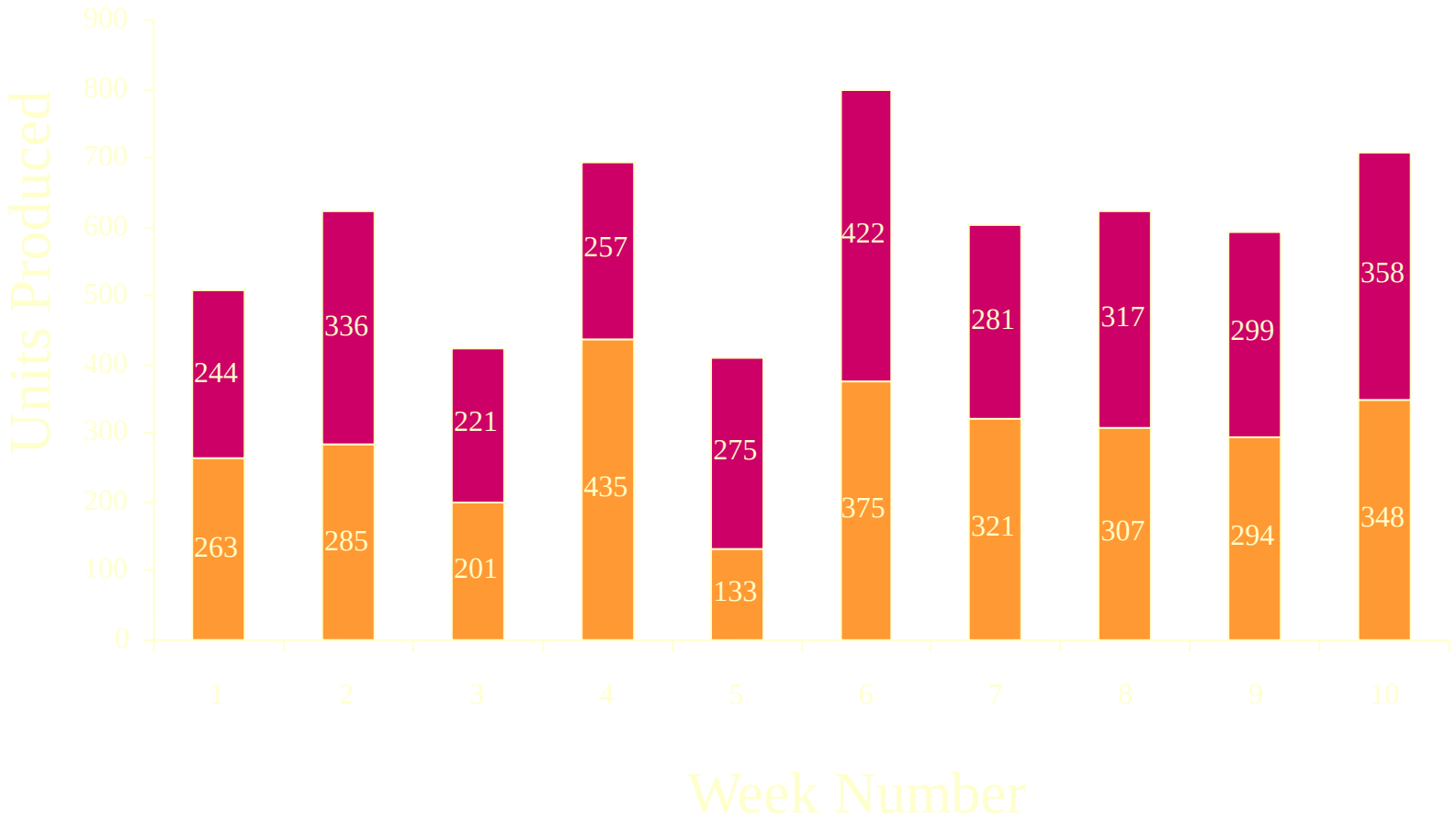
Horizontal Bar Graph



Comparison of Machines A & B for weekly Rejection



Comparison of Machines A & B for Units Produced



Pie Chart for Customer returned watches

A - Glass Broken

B - Stop

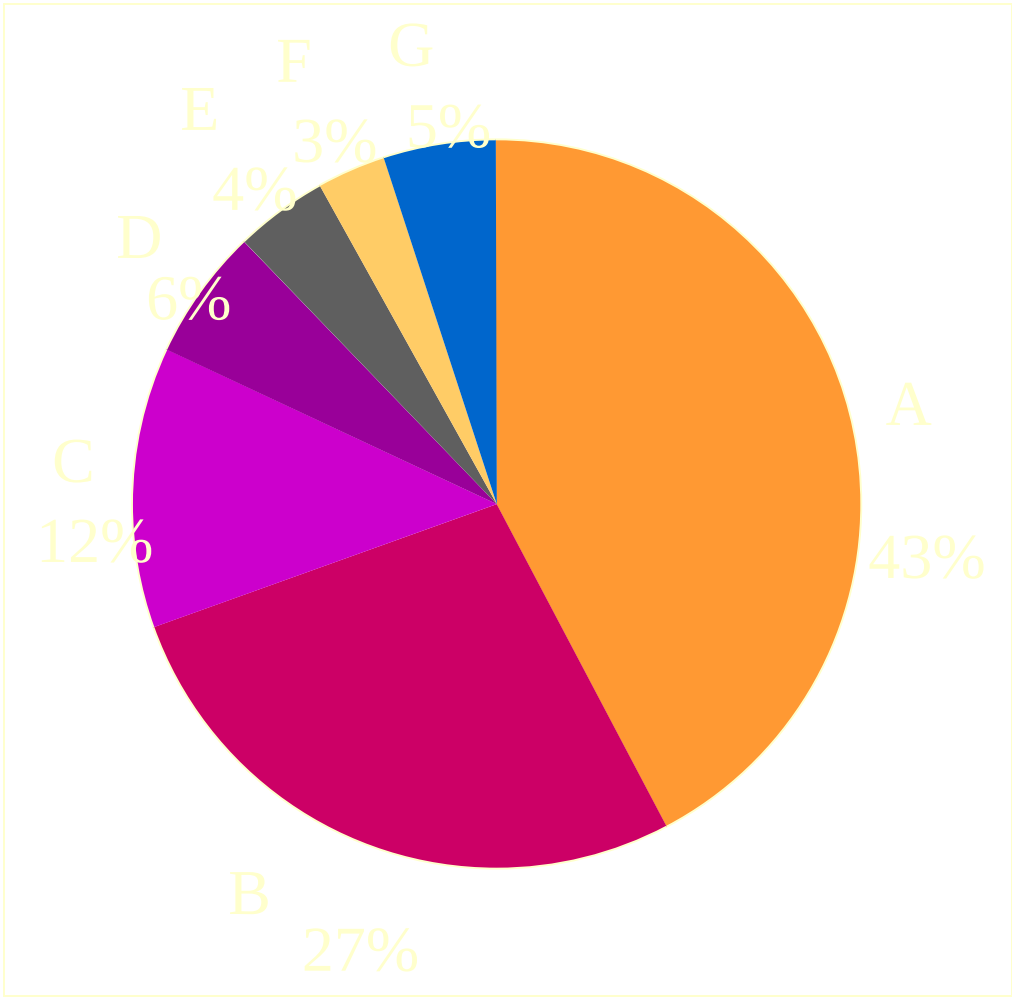
C - Matt. Trouble

D - Defective Dial

E - Regulation

F - Stem Loose

G - Others



BASIC SEVEN TOOLS