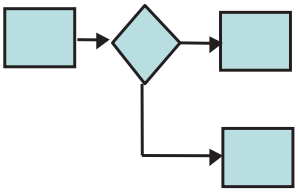
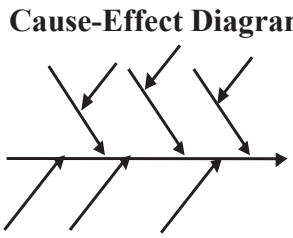
International Lean Six Sigma Institute

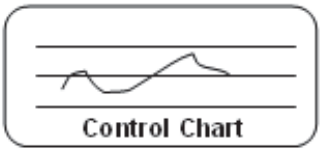
The 7 Basic Tools of Six Sigma

(7 Quality Tools)

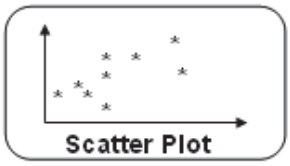


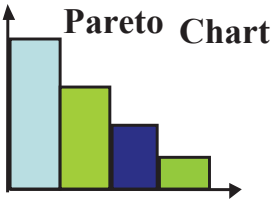
Flow Charts

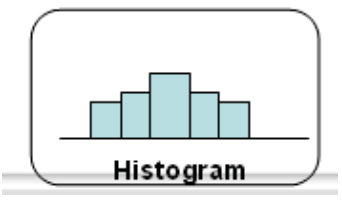




The 7 **Basic** Tools for Process Improvements







Where did the Basic Seven come from?

Kaoru Ishikawa (1915 - 1989)

- University of Tokoyo, Japan
- Translated and Integrated the teachings of w.Edwards Deming and Joseph Juran into the Japanese manufacturing culture.
- Known for “Democratizing Statistics”
- The Basic Seven Tools made statistical analysis less complicated for the average person[2]

What Is a Flowchart?

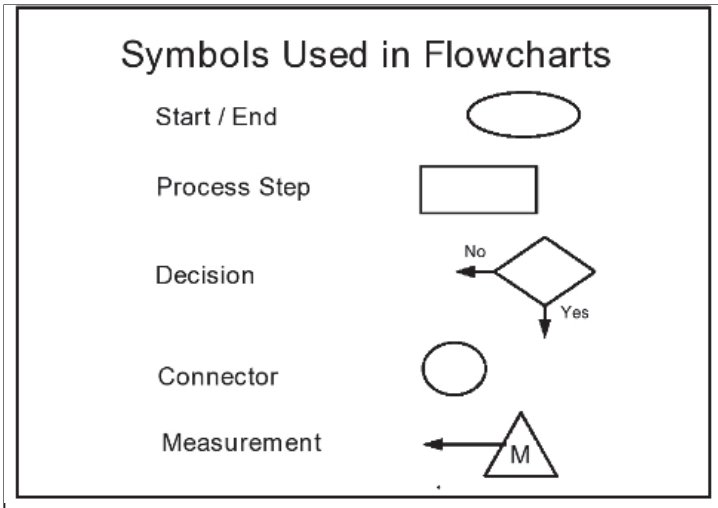
A diagram that uses *graphic symbols*
to depict the ***nature***
and ***flow*** of the steps in a process.

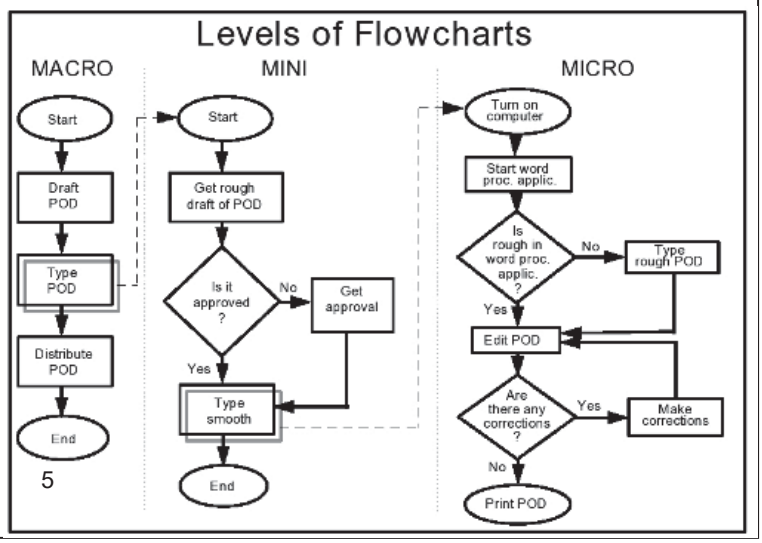
Benefits of Using Flowcharts

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

" Draw a flowchart for whatever you do. Until you do, you do not know what you are doing, you just have a job."

-- Dr. W. Edwards Deming.





Keys to Success

- Start with the big picture
- Observe the current process
- Record process steps
- Arrange the sequence of steps
- Draw the Flowchart

Interpreting Your Flowchart

- Determine who is involved
- Form theories about root causes
- Identify ways to simplify and refine
- Determine how to implement changes
- Locate cost-added-only steps
- Provide training

Interpretation Steps

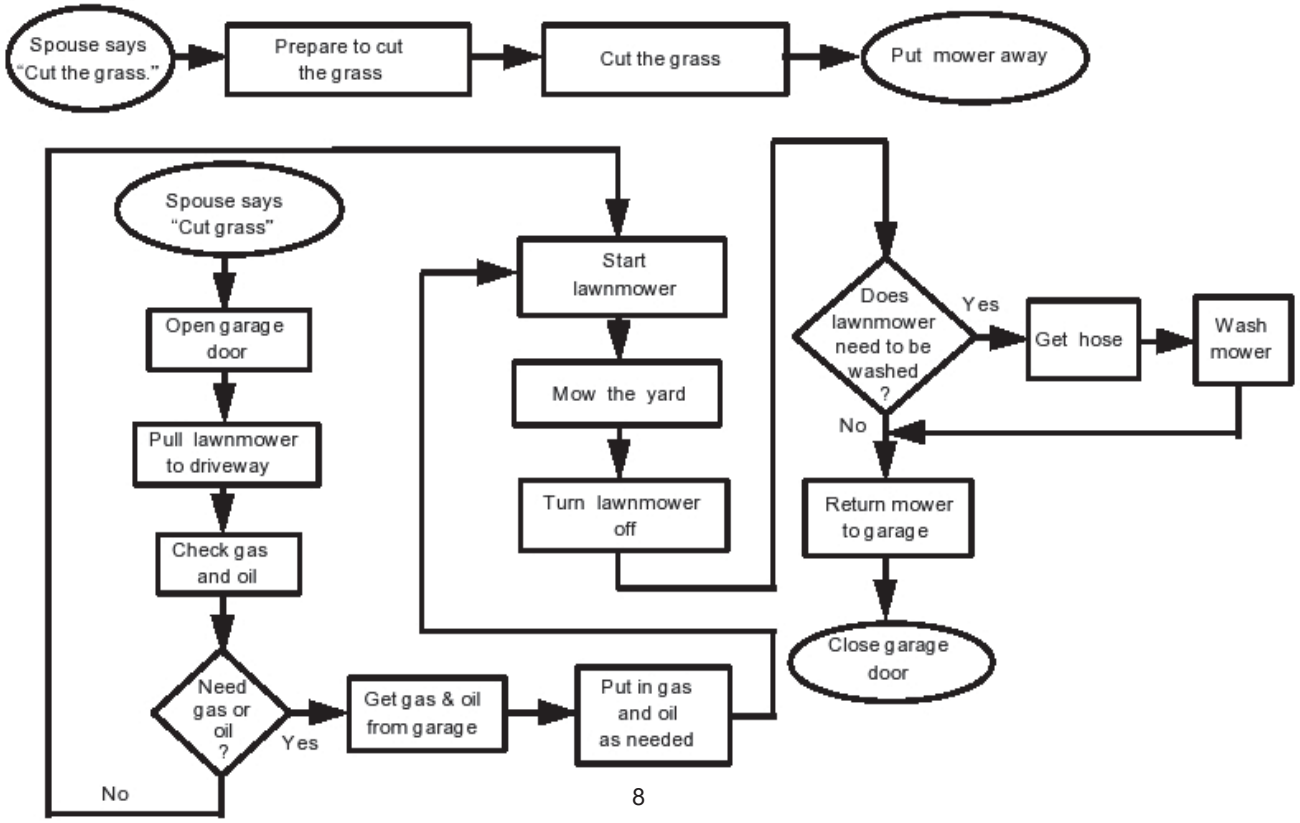
Step 1 - Examine each process step
Bottlenecks? Weak links? Poorly defined steps? Cost-added-only steps?

Step 2 - Examine each decision symbol
Can this step be eliminated?

Step 3 - Examine each rework loop
Can it be shortened or eliminated?

Step 4 - Examine each activity symbol
Does the step add value for the end-user?

EXERCISE 1
Flowchart for Cut Grass Process



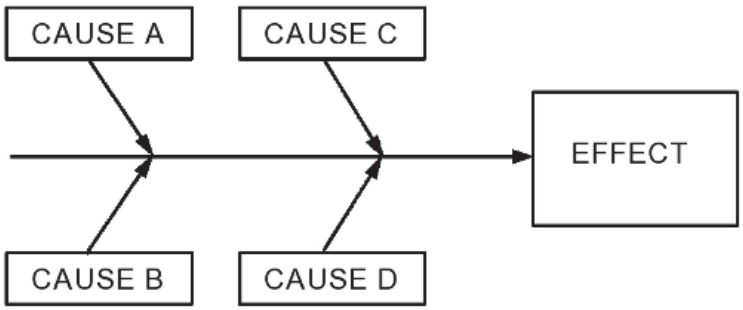
What Is a Cause and Effect Diagram?

A graphic tool that helps identify, sort, and display possible causes of a problem or quality characteristic.

Benefits of Using a Cause-and-Effect Diagram

- Helps determine root causes
- Encourages group participation
- Uses an orderly, easy-to-read format
- Indicates possible causes of variation
- Increases process knowledge
- Identifies areas for collecting data

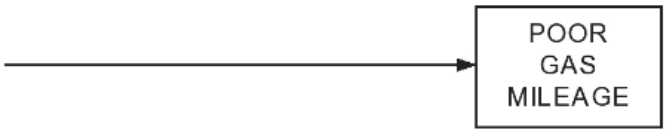
Basic Layout of
Cause-and-Effect Diagrams



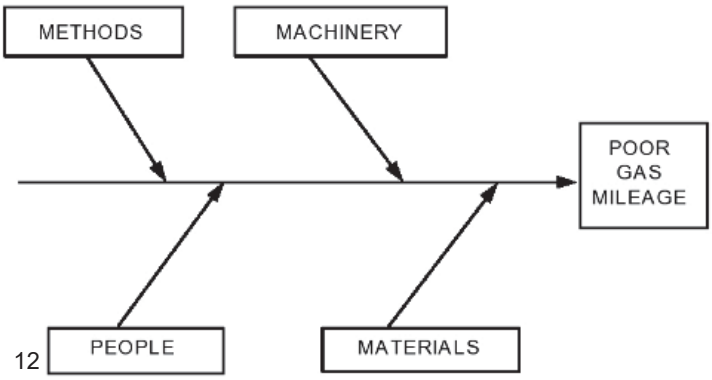
Step 1 - Identify and Define the Effect

- Decide on the effect to examine
- Use Operational Definitions
- Phrase effect as
  - > positive (an objective) or
  - > negative (a problem)

Step 2 - Fill in the Effect Box and Draw the Spine

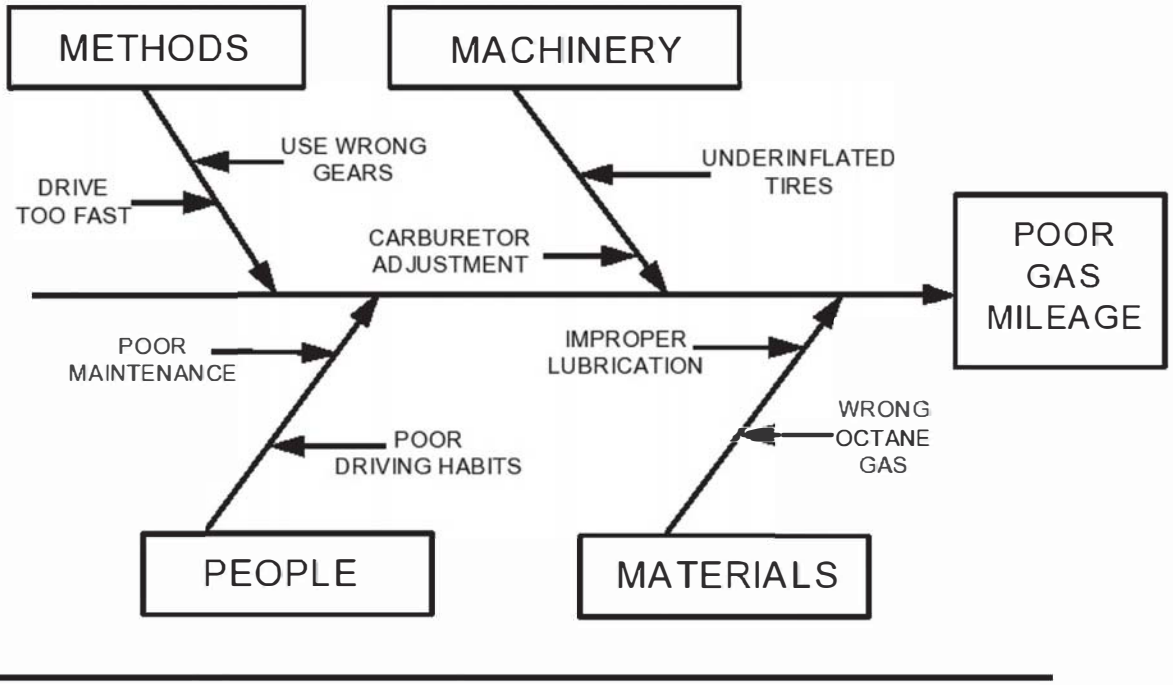


Step 3 - Identify Main Categories



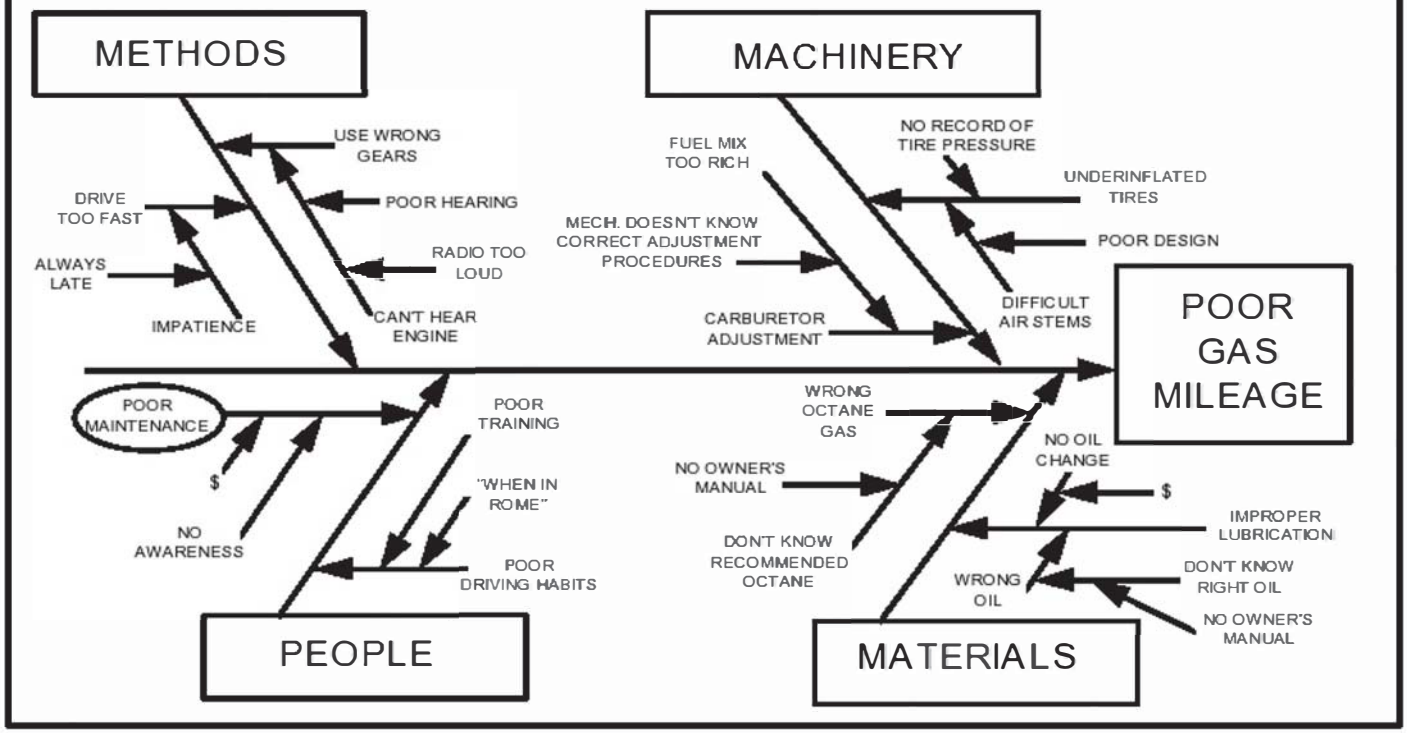
C&E Diagram

Step 4 - Identify Causes Influencing the Effect



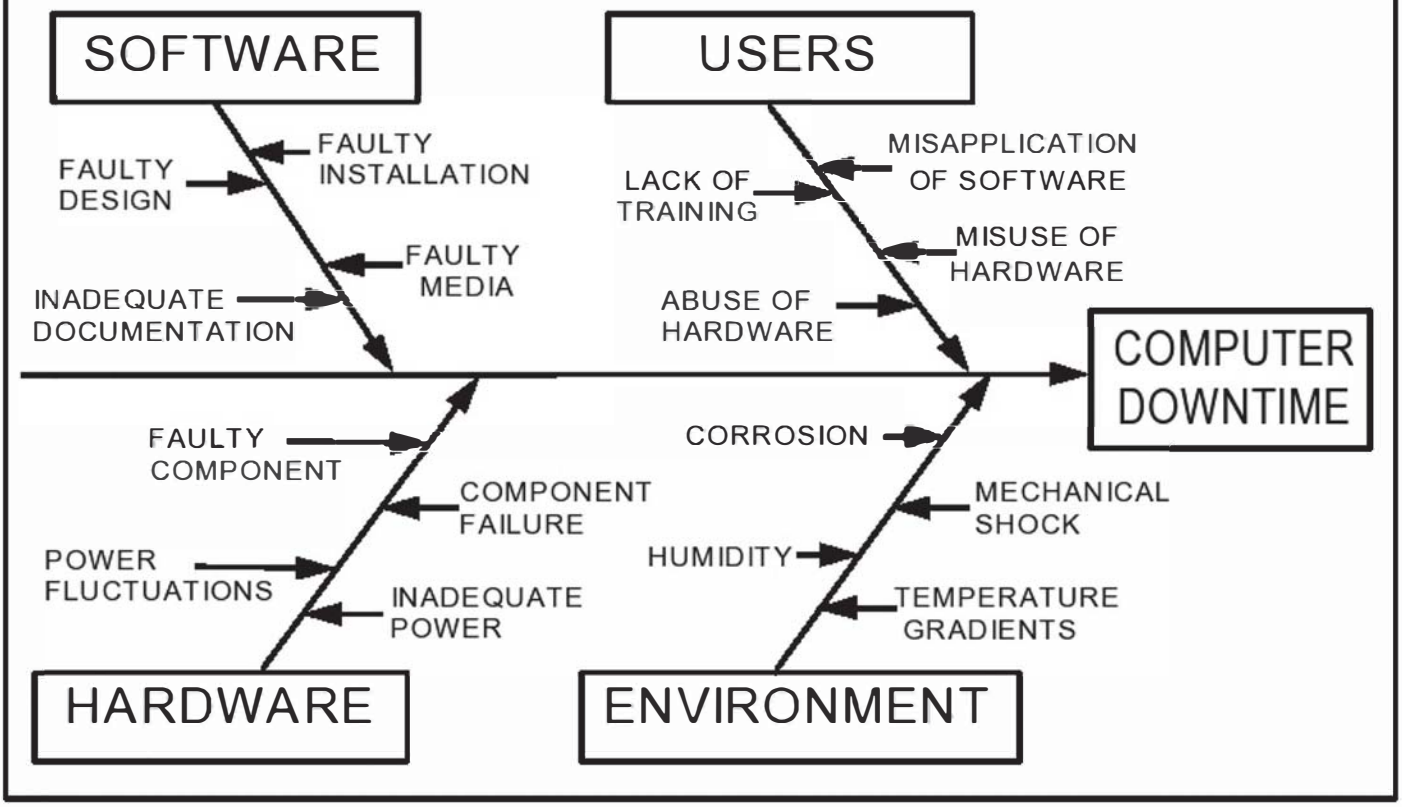
C&E Diagram

Step 5 - Add Detailed Levels
Step 6 - Analyze the Diagram



C&E Diagram

Example of How the Cause-and-Effect Diagram Could Be Constructed for the Detailed Exercise



C&E Diagram

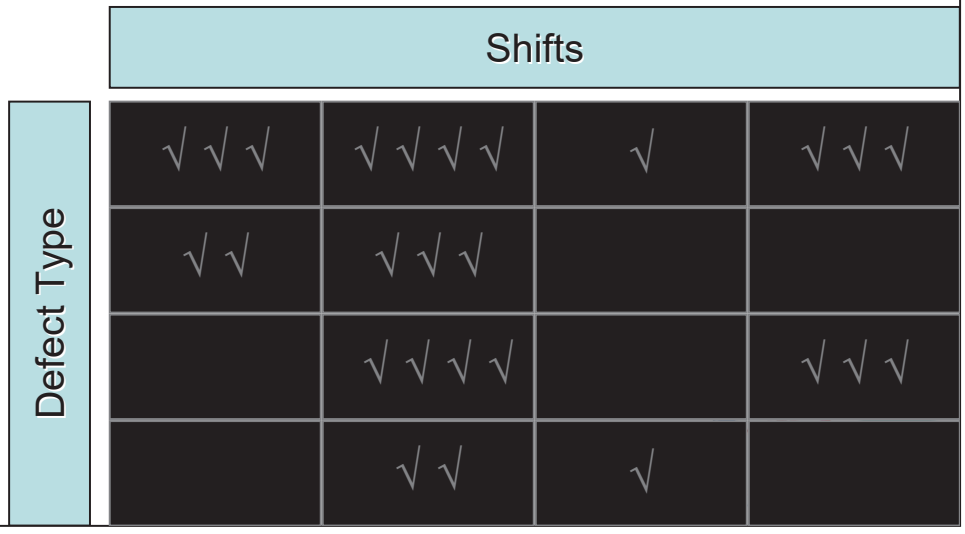
Data Collection

- Where
- What
- Who
- How

Check Sheet

Uses for Checksheets

- Record data for further analysis
- Provide historical record
- Introduce Data Collection methods



Check Sheet

Types of Checksheets

Tabular Format

JULY 94								
DEFECT	12	13	14	15	16	17	18	TOTAL
WRONG NSN	II	I	II	I	I	I		8
FAULTY MATERIAL	I	II		I		I		5
PMS NOT DONE	II	III	II	III	I	III	II	16
INSTALL PROBLEMS				I		I		2

Types of Checksheets

Graphic Format

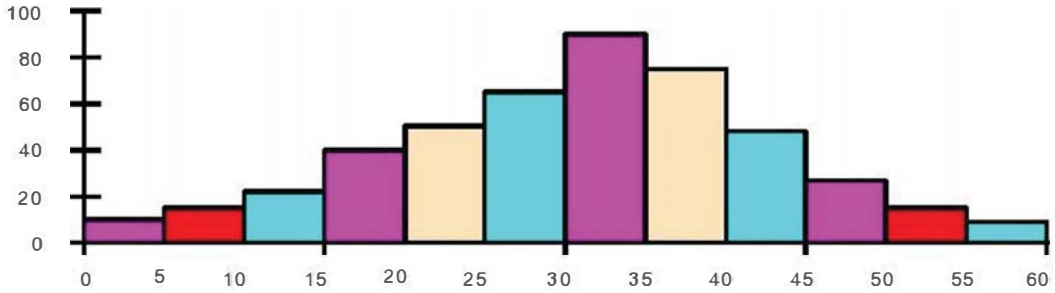
Check Sheet

Making a Useful Checksheet

- Tailored for specific purpose
- Workers help develop form
- Columns labeled clearly
- User-friendly format

Check Sheet

What Is a Histogram?

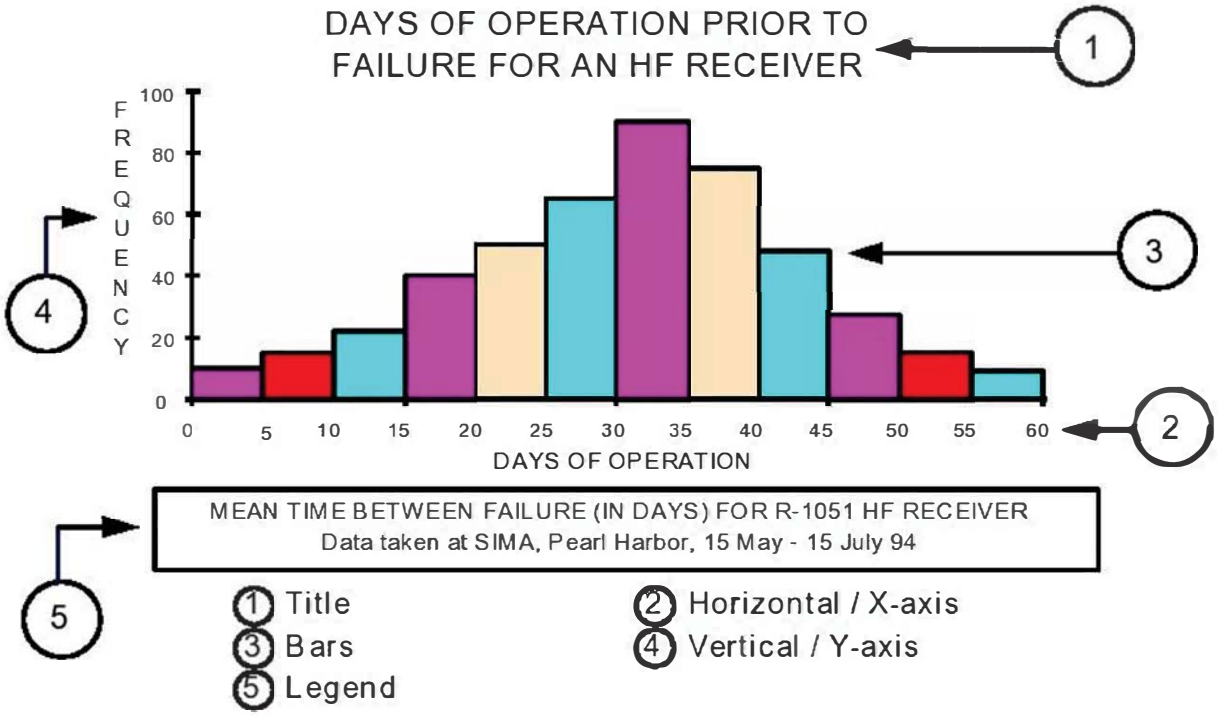


- A bar graph that shows the distribution of data
- A snapshot of data taken from a process

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



Constructing a Histogram

Step 1 - Count number of data points

Step 2 - Summarize on a tally sheet

Step 3 - Compute the range

Step 4 - Determine number of intervals

Step 5 - Compute interval width

Constructing a Histogram

Step 6 - Determine interval starting points

Step 7 - Count number of points in each interval

Step 8 - Plot the data

Step 9 - Add title and legend

How to Construct a Histogram

Step 1 - Count the total number of data points

Number of yards long (+ data) and yards short (- data) that a gun crew missed its target.

-180	30	190	380	330	140	160	270	10	- 90
- 10	30	60	230	90	120	10	50	250	180
-130	220	170	130	- 50	- 80	180	100	110	200
260	190	-100	150	210	140	-130	130	150	370
160	180	240	260	- 20	- 80	30	80	240	130
210	40	70	- 70	250	360	120	- 60	- 30	200
50	20	30	280	410	70	- 10	20	130	170
140	220	- 40	290	90	100	- 30	340	20	80
210	130	350	250	- 20	230	180	130	- 30	210
-30	80	270	320	30	240	120	100	20	70
300	260	20	40	- 20	250	310	40	200	190
110	-30	50	240	180	50	130	200	280	60
260	70	100	140	80	190	100	270	140	80
110	130	120	30	70					

TOTAL = 135

Histogram

How to Construct a Histogram

Step 2 - Summarize the data on a tally sheet

DATA	TALLY	DATA	TALLY	DATA	TALLY	DATA	TALLY	DATA	TALLY
- 180	1	- 20	3	90	2	190	4	290	1
- 130	2	- 10	2	100	5	200	4	300	1
- 100	1	10	2	110	3	210	4	310	1
- 90	1	20	5	120	4	220	2	320	1
- 80	2	30	6	130	8	230	2	330	1
- 70	1	40	3	140	5	240	4	340	1
- 60	1	50	4	150	2	250	4	350	1
- 50	1	60	2	160	2	260	4	360	1
- 40	1	70	5	170	2	270	3	370	1
- 30	5	80	5	180	5	280	2	380	1
								410	1

How to Construct a Histogram

Step 3 - Compute the range for the data set

Largest value = + 410 yards past target

Smallest value = - 180 yards short of target

Range of values = 590 yards

Calculation: + 410 - (- 180) = 410 + 180 = 590

How to Construct a Histogram

Step 4 - Determine the number of intervals required

IF YOU HAVE THIS MANY DATA POINTS	USE THIS NUMBER OF INTERVALS:
Less than 50	5 to 7 intervals
50 to 99	6 to 10 intervals
100 to 250	7 to 12 intervals
More than 250	10 to 20 intervals

Histogram

How to Construct a Histogram

Step 5 - Compute the interval width

$$\text{Interval Width} = \frac{\text{Range}}{\text{Number of Intervals}} = \frac{590}{10} = 59$$

Use 10 for the number of intervals

Round up to 60

How to Construct a Histogram

Step 6 - Determine the starting point of each interval

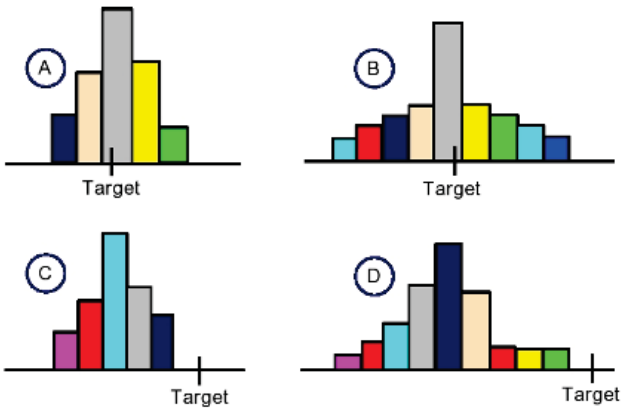
Step 7 - Count the number of points in each interval

INTERVAL NUMBER	STARTING VALUE	INTERVAL WIDTH	ENDING VALUE	NUMBER OF COUNTS
1	-180	60	-120	3
2	-120	60	-060	5
3	-060	60	000	13
4	000	60	060	20
5	060	60	120	22
6	120	60	180	24
7	180	60	240	20
8	240	60	300	18
9	300	60	360	6
10	360	60	420	4

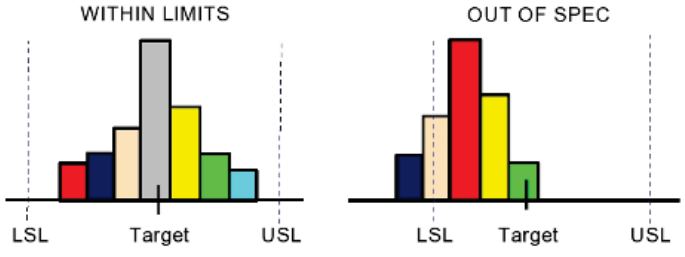
Equal to or greater than the STARTING VALUE

But less than the ENDING VALUE

Interpreting Histograms
Location and Spread of Data



Interpreting Histograms
Is Process Within Specification Limits?



LSL = Lower specification limit
USL = Upper specification limit

What Is a Pareto Chart?

- Bar chart arranged in descending order of height from left to right
- Bars on left relatively more important than those on right
- Separates the "vital few" from the "trivial many" (Pareto Principle)

Why Use a Pareto Chart?

- Breaks big problem into smaller pieces
- Identifies most significant factors
- Shows where to focus efforts
- Allows better use of limited resources

Pareto Principle

- Vilfredo Pareto (1848-1923) Italian economist
  - 20% of the population has 80% of the wealth

- adapted by Joseph Juran.
  - Remember the 80/20 rule states that approximately 80% of the problems are created by approximately 20% of the causes.

Constructing a Pareto Chart

Step 1 - Record the data

Step 2 - Order the data

Step 3 - Label the vertical axis

Step 4 - Label the horizontal axis

Step 5 - Plot the bars

Constructing a Pareto Chart

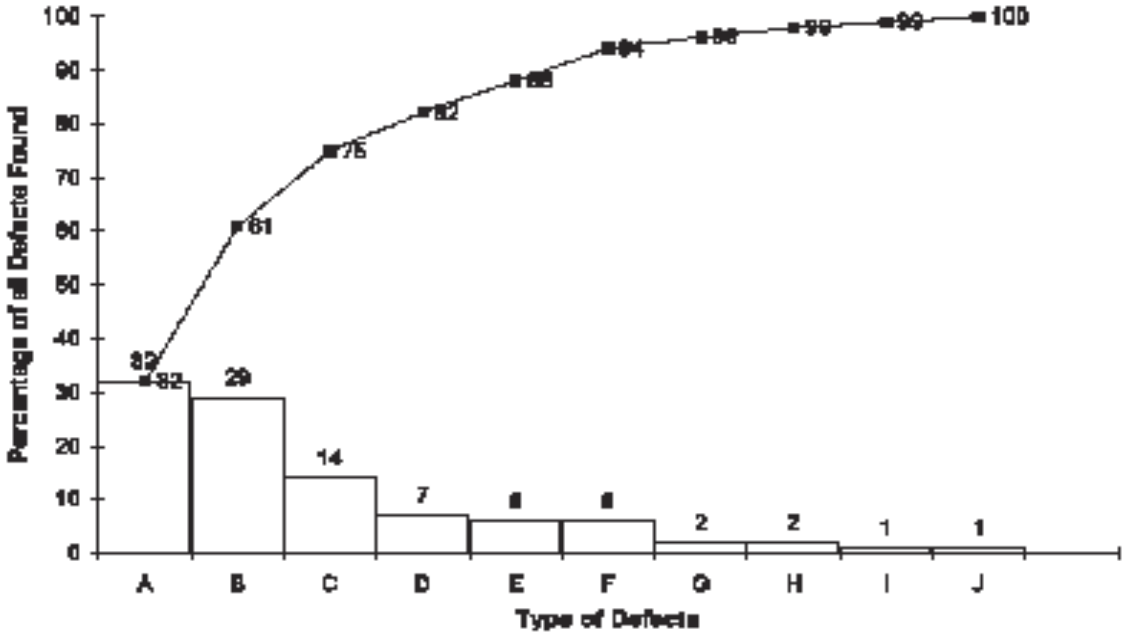
Step 6 - Add up the counts

Step 7 - Add a cumulative line

Step 8 - Add title, legend, and date

Step 9 - Analyze the diagram

Pareto Charts



Pareto Chart

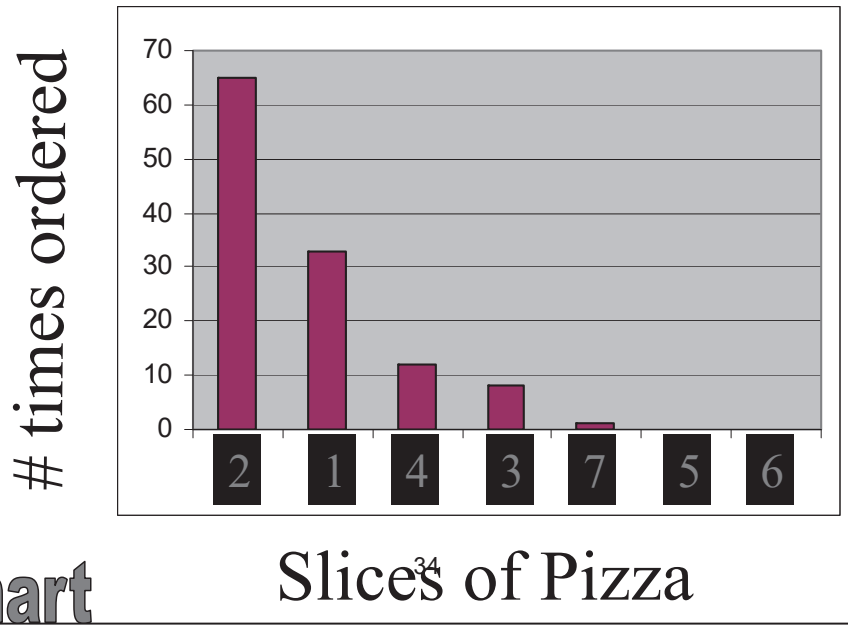
Acme Pizza

Slices	Frequency	%
0	1	0.3
1	33	13.09
2	65	25.79
3	8	3.17
4	12	4.76
5	0	0
6	0	0
7	1	0.3

Pareto Chart

Acme Pizza

- The completed Pareto Analysis results in the following:

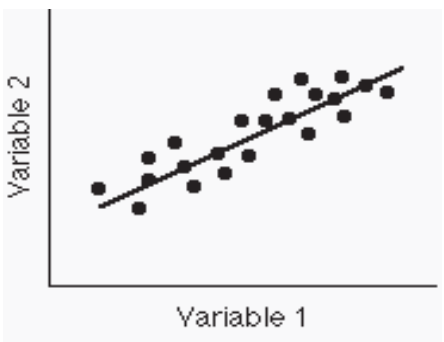


Pareto Chart

Scatter Diagrams

Slide 1 of 4

- Scatter Diagrams Defined
  - Scatter Diagrams are used to study and identify the possible relationship between the changes observed in two different sets of variables.

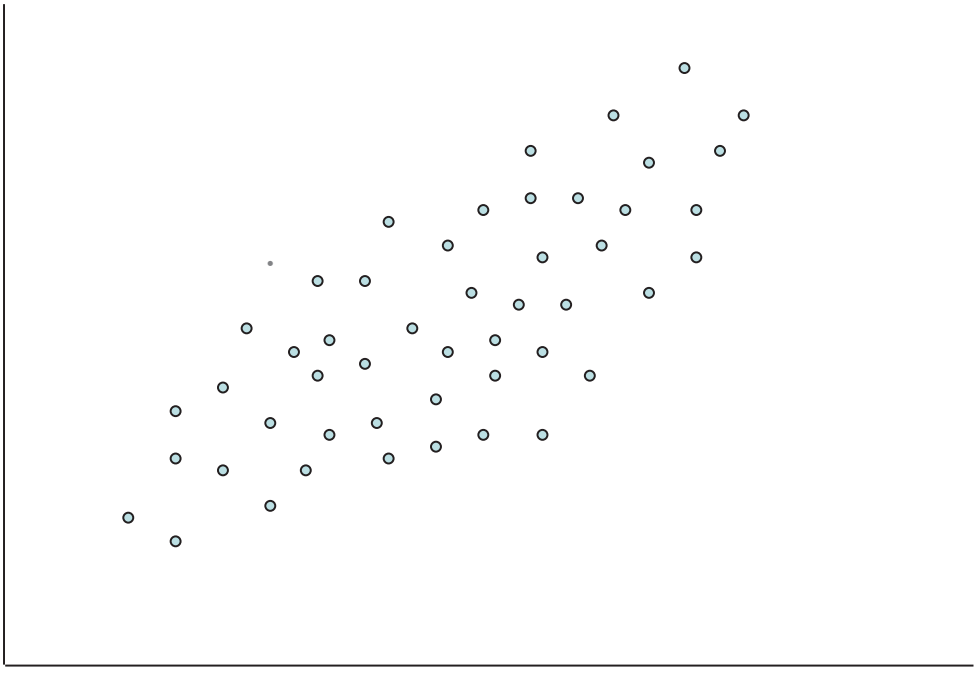


Scatter Plot

Constructing a Scatter Diagram

- 1. collect two pieces of data and create a summary table of the data.
- 2. Draw a diagram labeling the horizontal and vertical axes.
  - 3. It is common that the “cause” variable be labeled on the X axis and the “effect” variable be labeled on the Y axis.
- 4. Plot the data pairs on the diagram.
- 5. Interpret the scatter diagram for direction and strength.

Scatter Diagram



What Is a Control Chart?

A statistical tool used to distinguish between process variation resulting from common causes and variation resulting from special causes.

Why Use Control Charts?

- Monitor process variation over time
- Differentiate between special cause and common cause variation
- Assess effectiveness of changes
- Communicate process performance

What Are the Control Chart Types?

Chart types studied in this module:

X-Bar and R Chart

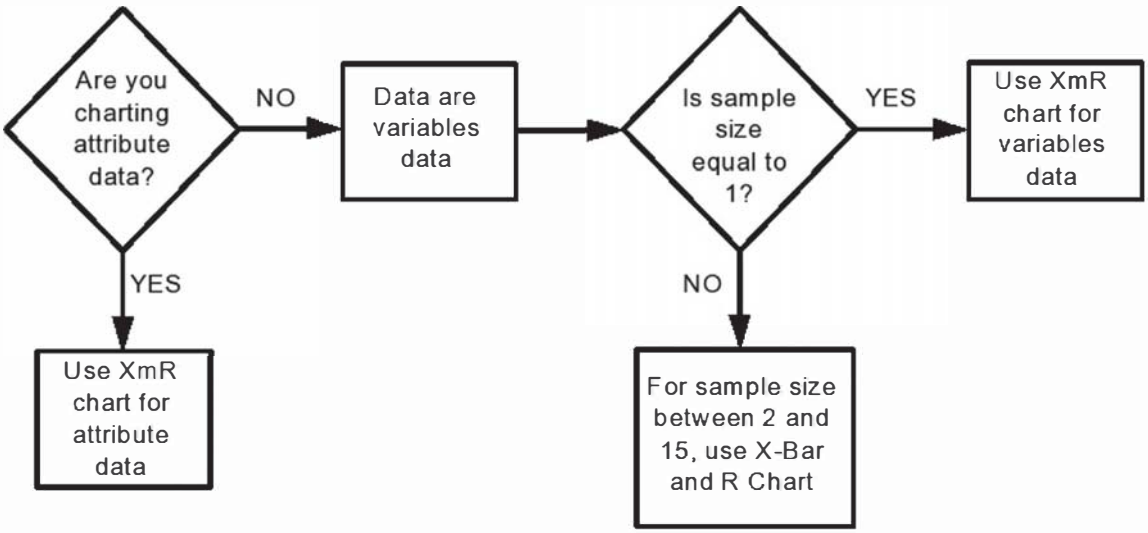
Individual X and Moving Range Chart

- For Variables Data
- For Attribute Data

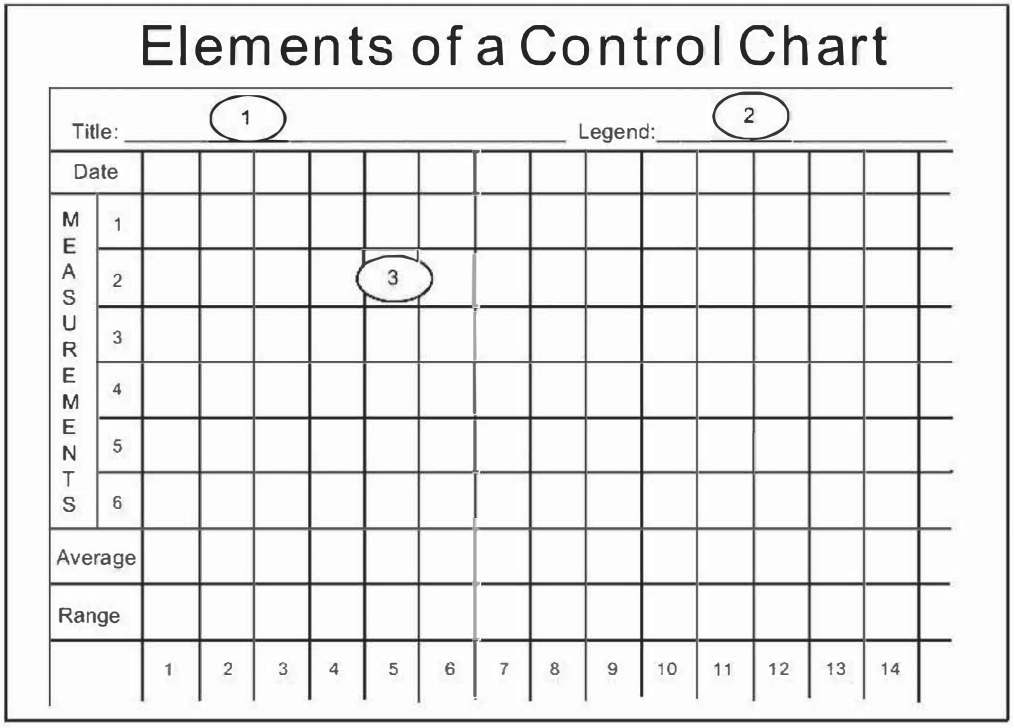
Other Control Chart types:

X-Bar and S Chart	u Chart
Median X and R Chart	p Chart
c Chart	np Chart

Control Chart Decision Tree



Elements of a Control Chart



CONTROL CHART VIEWGRAPH 5

Step 12b - Constructing an XmR Chart

Upper Plot

$UCL_X = \bar{X} + (3.144)$ (Median Moving Range)

$LCL_X = \bar{X} - (3.144)$ (Median Moving Range)

$Centerline_X = \bar{X}$

Lower Plot

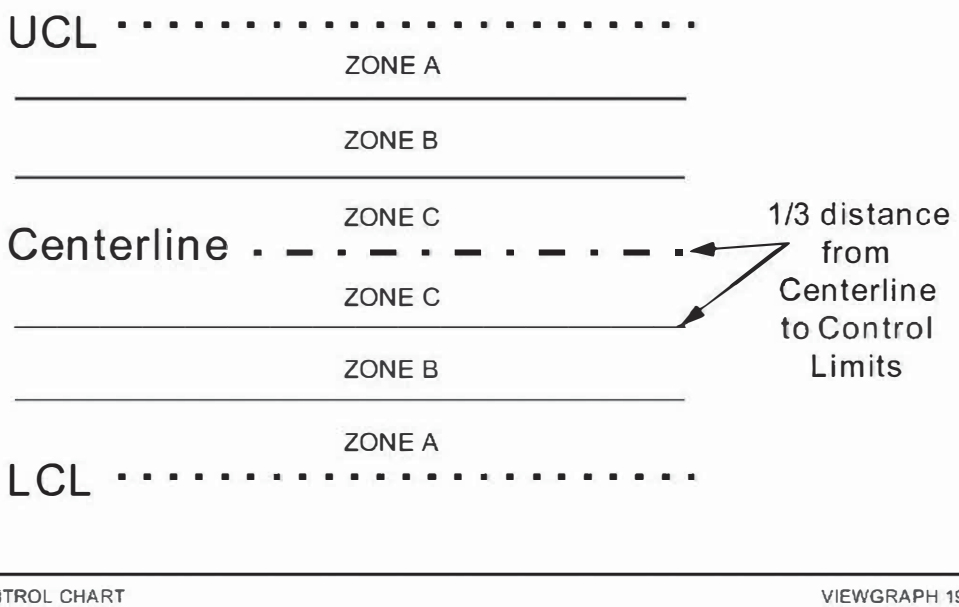
$UCL_{mR} = (3.865)$ (Median Moving Range)

LCL_{mR} = None

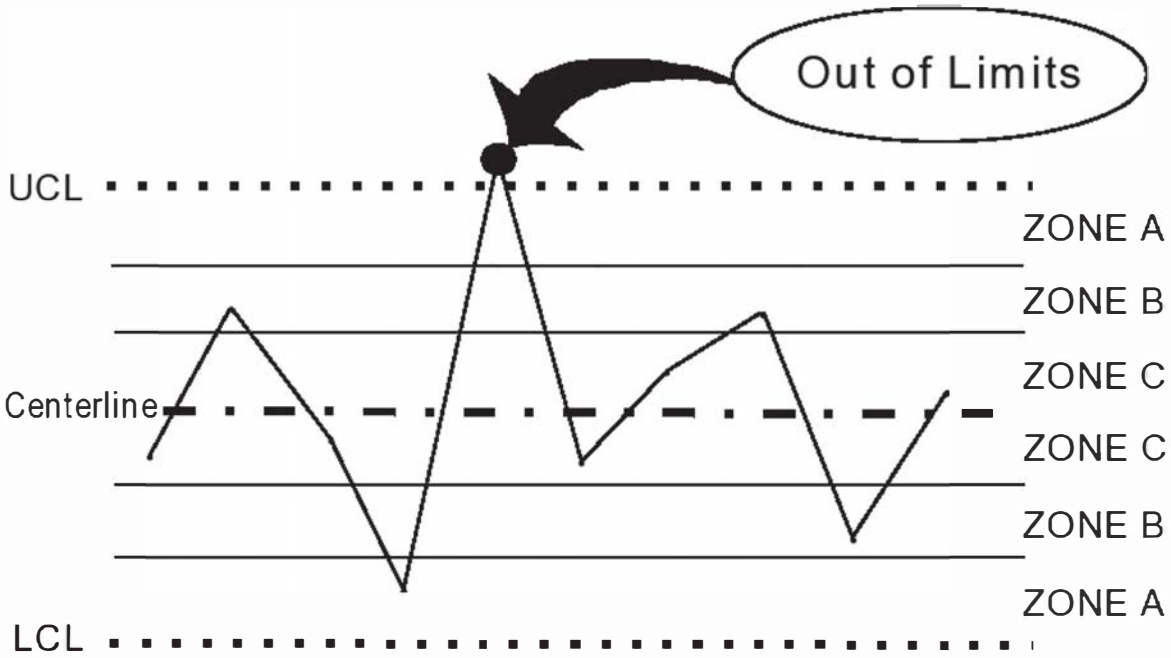
$Centerline_{mR}$ = Median Moving Range

CONTROL CHART VIEWGRAPH 18

Control Chart Zones



CONTROL CHART VIEWGRAPH 19



Control Chart