Welcome to the Training Programme on Quality Circles & 7 QC TOOLS
QC - Team

Team size - 3 to 8 – preferably 6 (including the facilitator)

Composition:

Facilitator – 1no. - Can be any person Gradeless / Graded.
He / she can be facilitator of more than one QC.

Leader – 1no. – Only Graded employee
He / she can be a leader of only one QC

Members – Only Graded employees
Can be members of only one QC

The teams have to registered with the Business Excellence Divn. The QC facilitator will assign a serial no. to the Circle.
QC - Roles

Facilitator –

• To help the team with knowledge of job, data analysis, suggestions on approach to be taken and be the mentor of the team
• To help the team in taking the step-by-step structured approach of QC
• To ensure regular functioning of the team

Leader -

• To lead the team in taking up projects
• To assign responsibilities to team members
• To ensure regular functioning of the team
• To ensure timely completion of projects
• To prepare the document with the help of members for project closure
QC - Functioning

Meeting –

• Should meet at least once in a week. Preferably on a fixed day and time.
• Team should maintain a register and record attendance by having every member's signature. It should write briefly the proceedings of the meeting.
• Team should keep all its back-up records, sketches, drawings etc with the register.
Project selection

• The team should discuss various problems faced at their place of work, and prepare a list of these problems.
• The problems should relate to the objectives of their department – safety, cost reduction, reducing delays, improving quality, improving the method of working etc.
• The team should prioritize the problem based on criteria assigned by them. They can adopt the NGT (Nominal Group Technique)
## Project selection – NGT Voting & Ranking

### Round - 1

<table>
<thead>
<tr>
<th>Problem</th>
<th>Mr A</th>
<th>Mr B</th>
<th>Mr C</th>
<th>Mr D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem 1</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>Problem 2</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>8</td>
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<tr>
<td>Problem 3</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>Problem 4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Problem 5</td>
<td>5</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td>Problem 6</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>16</td>
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<tr>
<td>Problem 7</td>
<td>6</td>
<td>7</td>
<td>7</td>
<td>6</td>
<td>26</td>
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</table>
## Project selection – NGT Voting & Ranking

### Round - 2

<table>
<thead>
<tr>
<th>Problem</th>
<th>Mr A</th>
<th>Mr B</th>
<th>Mr C</th>
<th>Mr D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem 2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Problem 4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>7</td>
</tr>
</tbody>
</table>
SEVEN BASIC QUALITY TOOLS

- Cause and Effect Diagram
- Check Sheet
- Histogram
- Pareto Diagram
- Stratification
- Scatter Diagram
- Control Chart
Analysing a problem when the cause is not obvious

Cause & Effect Diagram
Or
Fish Bone Diagram
Cause & Effect Diagram: An Introduction

Graphical Technique that can be used in teams to identify and arrange all the possible causes of an event or problem or outcome

- Invented by Prof. Kaoru Ishikawa in 1943. He first used to explain at Kawasaki Steel Works “How a complex set of factors could affect the Problem”
- Designed for:
  - Stimulating thinking during a brainstorm of potential causes
  - Providing a structure to understand the relationships between many possible causes of a problem
  - Serving as a visual display of causes that have been studied

Special notes:
- Make the same number of cause & effect diagram as that of characteristics.
- Error in weight and length of the same product will have different cause & effect structures and these should be analyzed in two separate diagrams
- Write only the characteristic and the causal factors which are measurable.
- After completing a cause & effect diagram, it is necessary to grasp the strength of the cause & effect relationship objectively using data

Effect: The kid fell...
Cause: Because of the water.
Uses of The Cause and Effect Diagram

- Sorts and segregates the possible causes of a problem into a logical order
- Identifies areas for data gathering activity
- Educates participants in problem solving process
- Serves as a guide for discussions and serves to keep meetings on target
- Can be developed into a complete project management tool that displays actions taken and results achieved
Construction of a Cause and Effect Diagram

1. Define the characteristic to improve and control
   - Should be able to be quantified and measured
   - Quality characteristics = effect

2. Write the characteristic on the right side of the diagram

3. Draw a broad arrow pointing at the characteristic from the left side of the diagram

   - Slow Check - In
   - Effect
Construction of a Cause and Effect Diagram

4. Define the main factors which influence the characteristic to be improved
   ◆ Factors = causes
   ◆ Suggested main causal factors are as shown

5. Draw an arrow from each factor to the main central arrow

![Cause and Effect Diagram]

*Environment*  *People*  *Methods*  *Materials*  *Machines*

**Causes**

**Effect**

Slow Check - In
Construction of a Cause and Effect Diagram

6. Determine the detailed causes for each of the main factors and draw an arrow to the appropriate branch.
   - On to each of these, write in even more detailed causes and draw smaller arrows.

5. Continue in this manner to examine and display all potential causes.
Causes and Effect Diagram

Environment
- Volume
- Temperature
- A/C

People
- Training
  - Content
  - Education

Methods
- Adequacy
  - Accuracy
  - Completeness

Materials
- Consistency
- Vendors

Machines
- Capability
  - Maintenance
  - Age

Front Desk Computer
- Self checks
- Precision

CAUSES
- Slow check - in

EFFECT

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Collecting data in a systematic way

Check Sheet
Check Sheet: Introduction

What is it?
- A tool for collecting data in a consistent form.
- Provides an easy, structured way of recording data as it is collected
- Assures data will be recorded in similar manner

What is Check sheet used for?
- Controlling and monitoring the production process
- Analysis of cause and effect properly
- Inspection for non-conformance
- To make data-gathering easy
- To arrange data automatically so that they can be used easily later on

Based on the purpose, customized check sheets are designed
## Check Sheet: An Example

Decide the purpose: In the example check sheet is being used for inspection.

Design the Format: Based on the requirement, the fields are customized.

<table>
<thead>
<tr>
<th>Product name</th>
<th>Lot number</th>
<th>Measuring method</th>
<th>Measuring instrument</th>
<th>Recorded by:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Monitoring Number of defects in a Day</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shift A</td>
<td>Shift B</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td>CHATTER</td>
<td>///</td>
</tr>
<tr>
<td>SPM ROLL MARKS</td>
<td>///</td>
</tr>
<tr>
<td>SPM PINCH MARKS</td>
<td>///</td>
</tr>
<tr>
<td>SPM SCRATCHES</td>
<td>///</td>
</tr>
<tr>
<td>SPM DENTS</td>
<td>///</td>
</tr>
<tr>
<td>RUBBING MARK - SPM</td>
<td>///</td>
</tr>
<tr>
<td>BLACK SPOTS NON REMOVABLE</td>
<td>///</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
</tr>
</tbody>
</table>

Number inspected: 2037

Percentage defects: 4.3%
Analyzing data

Histogram, Pareto Diagram, Stratification, Scatter Diagram
Histogram: An Introduction

**Purpose:**
Visual depiction of data, helps to infer about the population at a glance

- Plots the number of times an event has occurred within a range of value.
- Shows the distribution of occurrence of event

**Benefits:**
- The shape of the histogram shows process behavior
- The shape and size of the dispersion helps identify otherwise hidden sources of variation
- Presence of multi-modes may give a hint about mixed processes
- Used to determine the capability of a process
- Starting point for the improvement process
Histogram: Types & Information Provided

Normal distribution
The ideal case, if a point has a chance to assume any value around a target (in absence of special cause variation) it will take this shape. Most unlikely to exist in reality.

Skewed distribution
- May be because the specification limit is in only on one side or process is controlled on one side
- Value lower than a certain value does not occur. Most commonly found

Skewed distribution, no tail on one side
- May be because beyond some point the output is considered as defect.

Multiple processes
- Existence of more than one process, Can lead to wrong conclusion needs to be stratified

Comb shaped
- May be because of a particular tendency in the way data is rounded off.
What It is?

- Developed by Vilfredo Pareto (1897), an Italian economist
- He observed that 80% of Italy’s wealth lay in the hands of 20% of the population
- Used for prioritization by 80-20 rule.
- Differentiates ‘Vital Few’ from ‘Useful Many’ (Juran)
- Left vertical axis depicts the actual frequency of items while the right vertical axis denotes cumulative percentage

Benefits:
- Useful in establishing priorities
- Comparing Pareto charts of a given situation over time determines whether an implemented solution reduced the relative frequency or cost of that problem or cause

TRF Limited
Comparing Pareto Charts

While comparing Pareto Charts, the left vertical axis should have the same scaling.

Comparison of Pareto Diagrams Before and After Improvement
Scatter Diagram: An Introduction

A graphical representation of relationship between two variables. It can be between a cause and effect or between two causes. The better the correlation, the tighter the points will hug the line

When to use scatter diagram:
• Once the causal relationship between the two variables is established through cause and effect diagrams

Scatter Diagram Consideration:
• It is desirable to have at least 30 pairs of data
• Decide the horizontal & vertical scales so that the finished diagram is approximately square
• Scatter Diagram is used only when both, dependent & independent variables are continuous
• Scatter diagram should be jointly used with correlation coefficient, the value of correlation coefficient (depicted by r) varies from -1 to +1.
• Correlation implies a linear relationship between two variables. For non-linear relationships r may not give value close to 1 or -1 even if the relationship is evident

TRF Tempered A Tata Enterprise
Scatter Diagram: Some Examples

Look for the outlying points, points far from main group are assumed to be the result of errors in measurement. It is necessary to exclude such data for correlation.

(a) Strong Positive Correlation

(b) No Correlation

(C) Positive Correlation

(d) Negative Correlation

(e) Strong Negative Correlation

(f) Need Stratification

Example from “Statistical Methods for Quality Improvement” by Hitoshi Kume
When data from a variety of sources or categories have been lumped together, it becomes impossible to conclude meaning. Stratification is a technique that separates the data so that patterns can be seen.

When the observed values represent two or more sub-populations according to the conditions which existed at the time of data collection, such sub populations are called strata, and dividing data into strata is called stratification.

When to use stratification:

- When data comes from several sources or conditions
- When data analysis may require separating different sources or conditions for detailed study of the problem.

Stratification Consideration:

- Examples of different sources that might require data to be stratified:
  - By time: month, week, day, shift etc.
  - By work force: operator, section etc.
  - By Machinery and Equipment, BY Raw Materials: Supplier, previous process, lot, place of manufacture etc.
  - By Product: Product category, destination, special order etc.
  - By Measurement / Inspection.

- Always consider before collecting the data whether stratification might be needed during analysis. Plan to collect stratification information. After the data is collected it might be too late.

Number of rejections stratified based on Supplier (A&B), Operator (1,2,3,4)
Stratification: An Example

Combined data from a chemical reaction process in two vessels, A and B

No. of data points = 100
Mean = 85.05
Stdev = 1.35
Max : 87.9
Min : 82.7

After Stratification: Two vessels, A and B

Now it is telling a different story.
Vessel A and vessel B are behaving differently, therefore to be dealt with differently.
Understanding the current problem.
Monitoring Improvements

Graphs, Run Charts, Control Charts
RUN CHART

Measurement

Time

Average

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RUN CHART BENEFITS

◆ Simplest display of trends over time
◆ Data plotted in time order
◆ An aid to understanding basic characteristics of a process
Run Chart Example
Customer Inquiries

Week

Number of Inquiries
Control Chart

Measurement

Upper Control Limit

Average

Lower Control Limit

Time

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CONTROL CHART BENEFITS

- Displays the expected range of variation in a stable process
- Display relative stability of a process
- Assists in process analysis. Can indicate when something out-of-the-ordinary happens
- Assesses effects of process control and process improvement
Process In Control

UCL

Measure

X

LCL

Time

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Process In Control

Out of Control

Measure

\( \bar{X} \)

UCL

LCL

Time

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<table>
<thead>
<tr>
<th>Chart</th>
<th>Description</th>
<th>Example # 1</th>
<th>Example # 2</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process In Control</td>
<td>Chart points do not form a particular pattern and lie within the upper and lower chart limits</td>
<td><img src="chart1.png" alt="Chart 1" /></td>
<td><img src="chart2.png" alt="Chart 2" /></td>
<td>The process is stable, not changing. Doesn't necessarily mean to leave the process alone. May be opportunities to improve the process and enjoy substantial benefits.</td>
</tr>
<tr>
<td>Process Out of Control</td>
<td>Chart points form a particular pattern OR one or more points lie beyond the upper or lower chart limits</td>
<td><img src="chart3.png" alt="Chart 3" /></td>
<td><img src="chart4.png" alt="Chart 4" /></td>
<td>Alerts us that the process is changing. Doesn't mean you need to take a corrective action. May be relate to a change you have made. Be sure to identify the reason(s) before taking any constructive actions(w).</td>
</tr>
<tr>
<td>Run</td>
<td>Chart points are on one side of the center line. The number of points in a run is called the “length of the run”</td>
<td><img src="chart5.png" alt="Chart 5" /></td>
<td><img src="chart6.png" alt="Chart 6" /></td>
<td>Suggest the process has undergone a permanent change (positive or negative) and is now becoming stable. Often requires that you recompute the control lines for future interpretation efforts.</td>
</tr>
</tbody>
</table>
## Interpreting Control Charts

<table>
<thead>
<tr>
<th>Chart</th>
<th>Description</th>
<th>Example # 1</th>
<th>Example # 2</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trend</strong></td>
<td>A continued rise or fall in a series of points (7 or more consecutive points direction)</td>
<td><img src="image1.png" alt="Trend Chart" /></td>
<td><img src="image2.png" alt="Trend Chart" /></td>
<td>Often seen after some change has been made. Helps tell you if the change(s) had a positive or negative effect. May also be part of a learning curve associated with some form of training.</td>
</tr>
<tr>
<td><strong>Cycle</strong></td>
<td>Chart points show the same pattern changes (e.g. rise or fall) over equal periods of time</td>
<td><img src="image3.png" alt="Cycle Chart" /></td>
<td><img src="image4.png" alt="Cycle Chart" /></td>
<td>Often relates to factors that influence the process in a predictable manner. Factors occur over a set time period and a positive/negative effect. Helps determine future work load and staffing levels.</td>
</tr>
<tr>
<td><strong>Hugging</strong></td>
<td>Chart points are close to the center line or to a control limit line (2 out of 3, 3 out of 4, or 4 out of 10.)</td>
<td><img src="image5.png" alt="Hugging Chart" /></td>
<td><img src="image6.png" alt="Hugging Chart" /></td>
<td>Suggests a different type of data has been mixed into the sub-group being sampled. Often need to change the sub-group, reassemble the data, redraw the control chart.</td>
</tr>
</tbody>
</table>
Thank you!