Notes:

Statistical Process Control

Key Learning Points

1. Define statistical process control and how it impacts process performance.
2. Find sources of variation within a processes.
3. Differentiate between control limits and specification limits.

What is Statistical Process Control?

Statistical Process Control (SPC) is an approach to quality control involving the collection and plotting of data to determine if a process is in statistical control. Formally, SPC is the application of statistical techniques to measure and analyze process variation to detect special cause variation.

The goal of a process control system is to make economically sound decisions about actions affecting a process. This means balancing the consequences of taking action when action is not necessary (over-control or "tampering") or failing to take action when action is necessary (under-control). This is done in the context of the two sources of variation: special causes and common causes.

Definitions

Process

A set of interrelated activities that transform inputs into outputs.

Statistical Control

The state of Statistical Control—the state existing when variation in a set(s) of data can be attributed to a system of chance causes only.

In-Control Process

A process is in-control when quality measures are in a state of statistical control.

Common Cause Variation

Chronic, random variation due to expected process variation.

Special Cause Variation

This is variation because of an assignable cause.

Control Chart

This is a plot of a statistic over time—typically it has a calculated center line and control limits (upper and lower).

Defective Item

An item or article with one or more defects is a defective item. A defective item is sometimes called a nonconforming item.

Defect

A defect is a fault or nonconformity that causes an article or an item to fail to meet specification requirements. Each instance of an article's lack of conformity to specification is a defect. A defect is sometimes called a nonconformity.

Number of Defectives

In a sample of n items, d is the number of defective items in the sample. Also called the number nonconforming (np).

Number of Defects

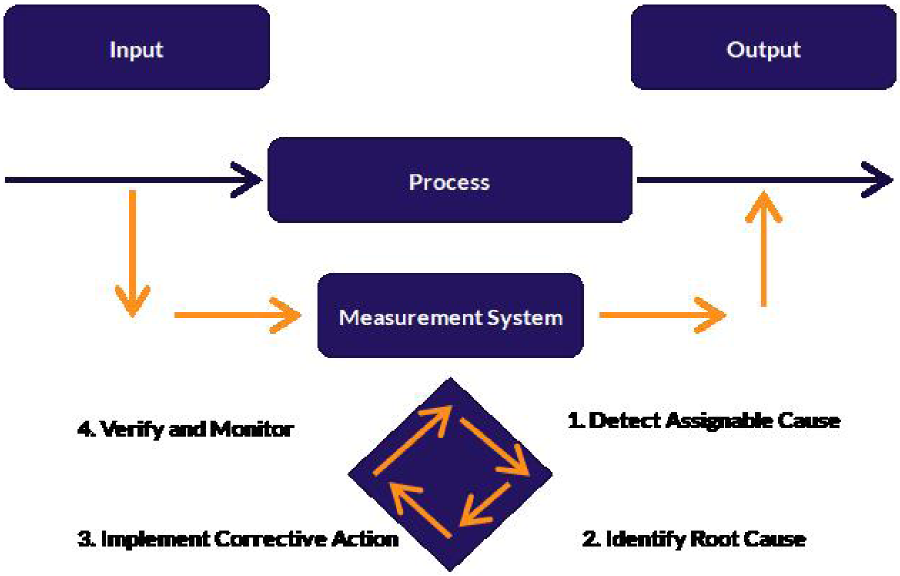
In a sample of n items, c is the number of defects in the sample. An item may be subject to many different types of defects. As an item is inspected, every instance of each type of defect is noted. The sum of all defects across the sample is c. Also called the number of non-conformities.

Fraction Defective

The ratio of the number of defective items in the sample, d, to the total number of items in the sample, n. The sample fraction defective p is therefore equal to d/n. Also called proportion nonconforming.

Notes:

The Goal of Statistical Process Control



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Sources of Variation

Common Causes of Variation (Random)

The many sources of variation within a process which occur when the process is stable and predictable over time. These occur when the process remains in a state of "statistical control."

Special Causes of Variation (Assignable)

The factors which cause variation unusual to the process. When they occur, they make the overall process distribution change. Unless all special causes of variation are identified and acted upon, they will continue to affect the process in unpredictable ways.

Control Limits vs. Specification Limits

Do not confuse control limits with specification limits. A process may be in control, but the product or service may still not meet customer needs. Being in control means only that the process is not displaying special cause variation.

Control limits reflect the expected variation in the data and are based on the distribution of the data points. Comparing the data to the control limits will give you information about the consistency of the process over time.

Comparing the process to the specification limits provides information on the adequacy of the process to produce good product, also known as process capability.

Control Limits

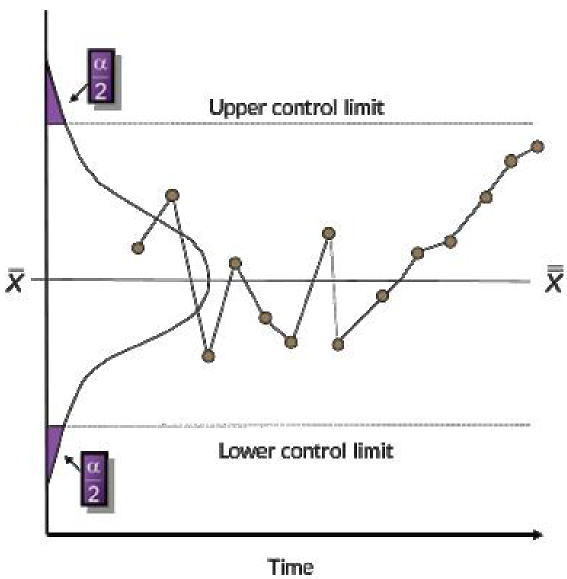
- Are derived from process data (± 3 estimated standard deviations of the statistic from the mean of the statistic).

- Are used to determine if your process is “in control” (without special cause variation).
- Are plotted on control charts.
- May be changed when there is a verified, significant change to your process.
- Represent the voice of the process.

Customer Specification Limits

- Are defined based on feedback/needs from the customer(s).
- Are typically used to determine if your process is producing defects.
- Are plotted on histograms (not control charts).
- Change when your customers say they do!
- Represent the voice of the customer.

The Shewhart Control Chart Model



Constructing Control Charts

Step 1: Select the appropriate characteristic to chart.

Step 2: Establish a rational subgroup and appropriate sample size.

Step 3: Select the appropriate control chart to use.

Step 4: Implement the data collection system and collect the data

Step 5: Calculate the center line and control limits.

Step 6: Plot the data.

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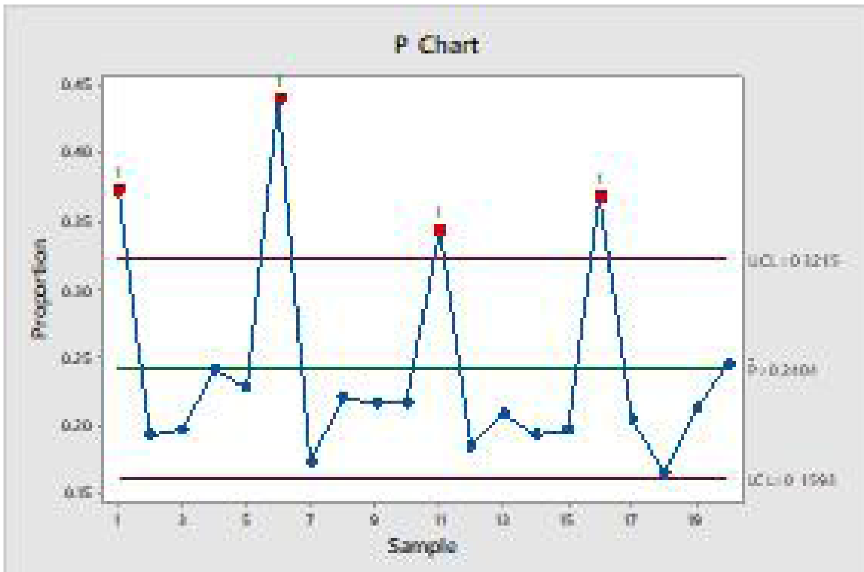
Step 7: Check for Out of Control (OOC) conditions.

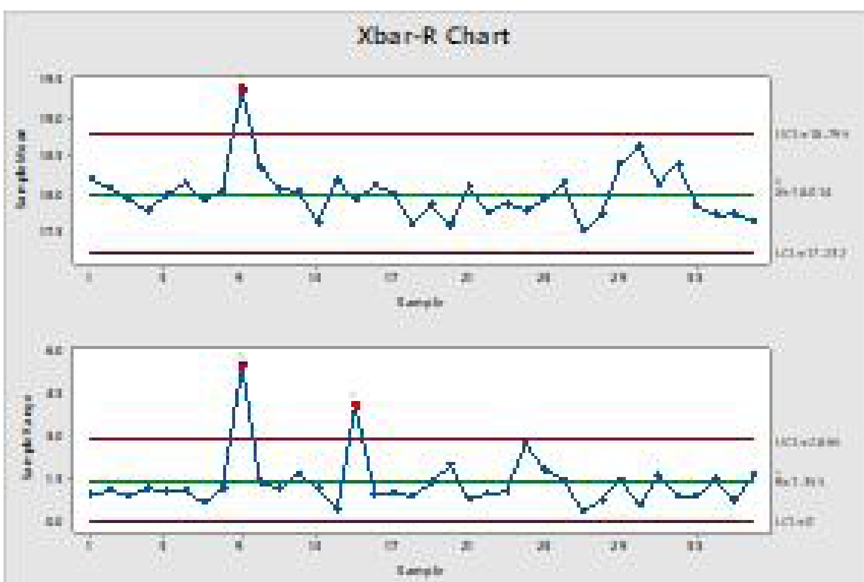
Step 8: Interpret findings, identify special cause variation, and remedy the cause(s).

Control Charts

P Chart



Xbar-R Chart



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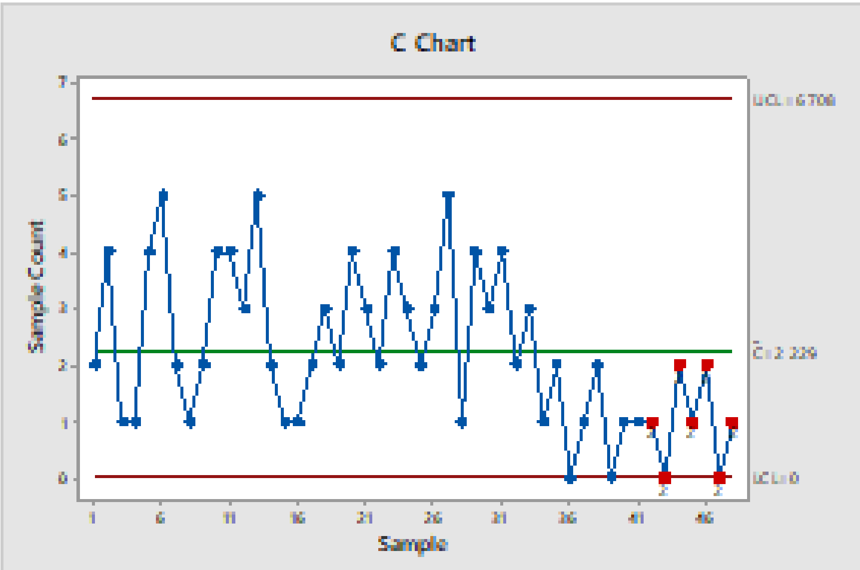
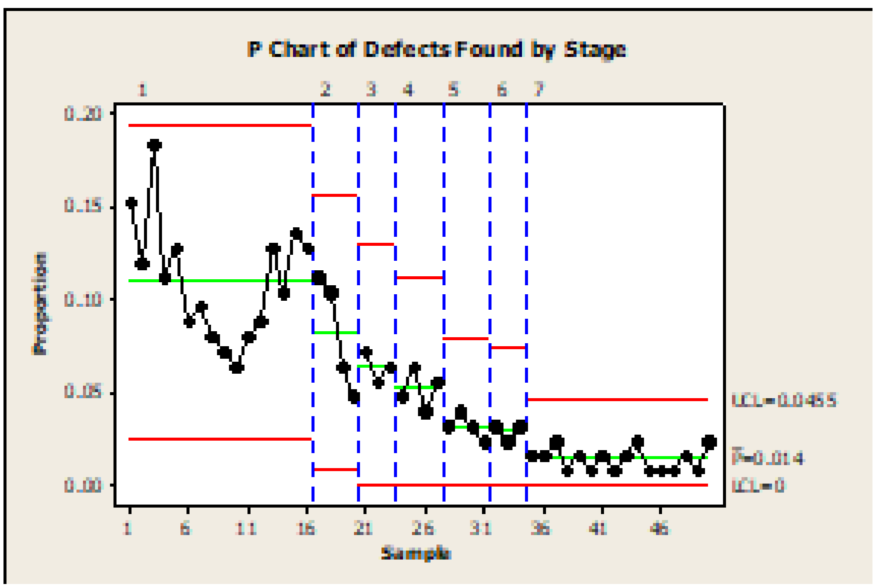
C Chart



Phased P Chart



Rational Subgroups

- Each point on a control chart (except a chart of individuals) represents a subgroup.
- Subgroups for variables charts should be chosen so as to be most representative of both short-term (within) and long-term (between) variability.
- The rational subgroup for attribute charts should:
  - Encompass a convenient time period or
  - Encompass a convenient material quantity

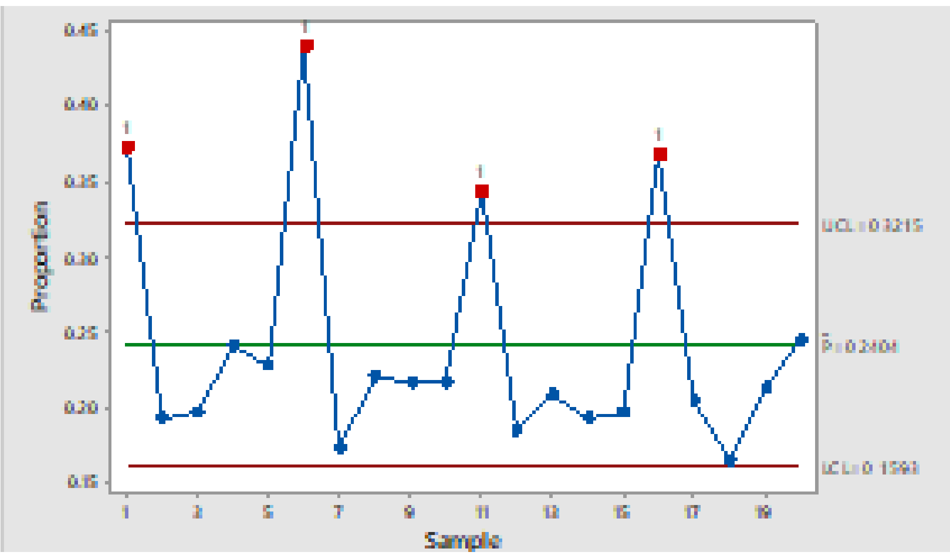
Notes:

- Be representative of the short-term variation in the population

Interpreting Control Charts

Look for:

- Sudden Shifts in Average Level
- Trends in Level
- Wide, Alternating Swings



Misleading Control Charts

- The chart is in-control, but the process is out of control.
- The chart is out of control, but the process is stable.

Corrective Action

- Type 1 Corrective Action = Countermeasure (Best)
- Type 2 Corrective Action = Flag
- SPC on input variables or response variables with fully trained associates and staff who respect the rules
- Type 3 Corrective Action = Inspection
- SPC on input variables or response variables with fully trained associates
- Standard Operating Procedure (S.O.P.)
- Warning Signal
- SPC on input variables or response variables without proper training: = WALLPAPER (Worst)

Notes:

When Should Statistical Process Control Be Used?

Notes:

Control Charts:

- Are a proven technique for improving productivity
- Are effective in defect prevention
- Prevent unnecessary process adjustments
- Provide diagnostic information
- Provide information about process capability
- Can be used for both attribute and variable data types

Pitfalls to Avoid

- Everyone must be WELL trained and periodically retrained
- Data must be gathered correctly
- Mean and Range/Standard Deviation must be calculated correctly
- Data must be charted correctly
- Charts must be analyzed correctly
- Reactions to patterns and charts must be appropriate-Every time