ORIGINAL RESEARCH PAPER

Mathematics

STATISTICAL PROCESS CONTROL

KEY WORDS: Statistical process control, control charts, design of experiments

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ABSTRACT

Statistical process control (SPC) is a method of quality control which employs statistical methods to monitor and control a process. This helps to ensure that the process operates efficiently, producing more specification-conforming products with less waste (rework or scrap). SPC can be applied to any process where the "conforming product" (product meeting specifications) output can be measured. Key tools used in SPC include run charts, control charts, a focus on continuous improvement, and the design of experiments. An example of a process where SPC is applied is manufacturing lines.

INTRODUCTION

Statistical Process Control (SPC) is not new to industry.

In 1924, a man at Bell Laboratories developed the control chart and the concept that a process could be in statistical control. His name was William A. Stewart.

He eventually published a book titled "Statistical Method from the Viewpoint of Quality Control" (1939). The SPC process gained wide usage during World War II by the military in the munitions and weapons facilities. The demand for product had forced them to look for a better and more efficient way to monitor product quality without compromising safety.

SPC filled that need.

The use of SPC techniques in America faded following the war.

It was then picked up by the Japanese manufacturing companies where it is still used today.

In the 1970s, SPC started to gain acceptance again due to American industry feeling pressure from high quality products being imported from Japan. Today, SPC is a widely used quality tool throughout many industries.

HOW TO USE STATISTICAL PROCESS CONTROL:

Before implementing SPC or any new quality system, the manufacturing process should be evaluated to determine the main areas of waste.

Some examples of manufacturing process waste are rework, scrap and excessive inspection time.

It would be most beneficial to apply the SPC tools to these areas first. During SPC, not all dimensions are monitored due to the expense, time and production delays that would incur.

Prior to SPC implementation the key or critical characteristics of the design or process should be identified by a Cross Functional Team (CFT) during a print review or Design Failure Mode and Effects Analysis (DFMEA) exercise.

Data would then be collected and monitored on these key or critical characteristics.

COLLECTING AND RECORDING DATA:

SPC data is collected in the form of measurements of a product dimension / feature or process instrumentation readings.

The data is then recorded and tracked on various types of control charts, based on the type of data being collected.

It is important that the correct type of chart is used gain value and obtain useful information.

The data can be in the form of continuous variable data or attribute data.

The data can also be collected and recorded as individual values or an average of a group of readings.

Some general guidelines and examples are listed below. This list is not all inclusive and supplied only as a reference.

VARIABLE DATA:

•Individual – Moving Range chart: to be used if our data is individual values
•X bar – R chart: to be used if we are recording data in sub-groups of 8 or less
•X bar – S chart: to be used if our sub-group size is greater than 8

ATTRIBUTE DATA:

•P chart – For recording the number of defective parts in a group of parts
•U chart – For recording the number of defects in each part

TOOLS FOR SPC

Seven basic tools for quality improvement are used for statistical process control as given below.

• Check sheet
• Run chart
• Histogram
• Pareto chart
• Scatter diagram/chart
• Cause and effect or fishbone diagram
• Control chart

CONTROL CHARTS:

Also called: Stewart chart, statistical process control chart.

The control chart is a graph used to study how a process changes over time.

Data are plotted in time order. A control chart always has a central line for the average, an upper line for the upper control limit, and a lower line for the lower control limit.

These lines are determined from historical data.

By comparing current data to these lines, you can draw conclusions about whether the process variation is consistent (in control) or is unpredictable (out of control, affected by special causes of variation).

This versatile data collection and analysis tool can be used by a variety of industries and is considered one of the seven basic quality tools.

WHEN TO USE A CONTROL CHART:

- When controlling ongoing processes by finding and correcting problems as they occur
- When predicting the expected range of outcomes from a process
- When determining whether a process is stable (in statistical control)
- When analyzing patterns of process variation from special causes (non-routine events) or common causes (built into the process)
- When determining whether your quality improvement project should aim to prevent specific problems or to make fundamental changes to the process

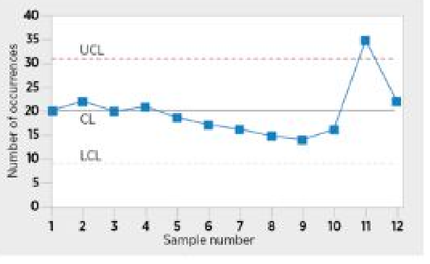

Figure 1. Control Chart Example

CONTROL CHART BASIC PROCEDURE-

1. Choose the appropriate control chart for the data.
2. Determine the appropriate time period for collecting and plotting data.
3. Collect data, construct the chart and analyze the data.
4. Look for "out-of-control signals" on the control chart. When one is identified, mark it on the chart and investigate the cause.

Out-of-control signals:

1. A single point outside the control limits. In Figure 2, point sixteen is above the UCL (upper control limit).
2. Two out of three successive points are on the same side of the centerline and farther than 2 from it. In Figure 2, point 4 sends that signal.
3. Four out of five successive points are on the same side of the centerline and farther than 1 from it. In Figure 2, point 11 sends that signal.
4. A run of eight in a row are on the same side of the centerline. Or 10 out of 11, 12 out of 14, or 16 out of 20. In Figure 2, point 21 is eighth in a row above the centerline.
5. Obvious consistent or persistent patterns that suggest something unusual about our data and our process.

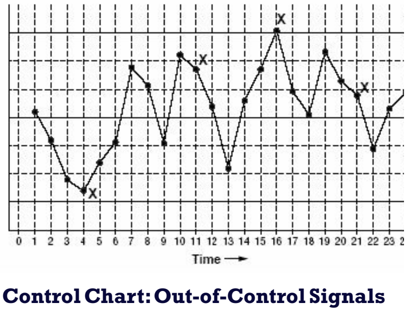

Figure 2. Control Chart: Out-of-Control Signals

6. Continue to plot data as they are generated. As each new data point is plotted, check for new out-of-control signals.
7. When we start a new control chart, the process may be out of control. If so, the control limits calculated from the first 20 points are conditional limits. When we have at least 20 sequential points from a period when the process is operating in control, recalculate control limits.

BENEFITS OF STATISTICAL PROCESS CONTROL:

Statistical process control (SPC) is commonly used in manufacturing or production process to measure how consistently a product performs according to its design specifications. By achieving consistent quality and performance, some of the benefits manufacturers can realize are:

- Reduced scrap, rework, and warranty claims
- Maximized productivity
- Improved resource utilization
- Increased operational efficiency
- Decreased manual inspections
- Improved client satisfaction
- Reduced Costs
- Extensive Analytics and Reporting

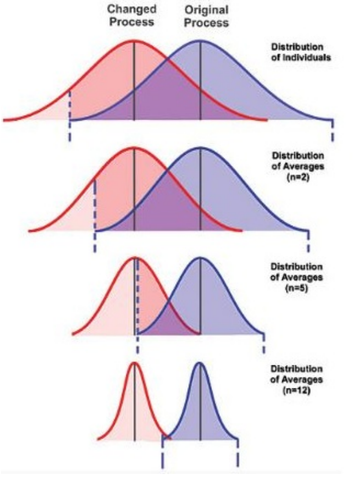

Figure 3. Statistical process control

DISADVANTAGE OF SPC IMPLEMENTATION-

SPC can take time to apply rigorously but applications do show that there are few, if any, disadvantages to SPC. Its application must remain relevant and useful, rather than becoming a system 'for its own sake'. Problems can occur in introducing it to avowed innumerate.

APPLICATIONS OF SPC-

The application of SPC involves three main sets of activities:

1. The first is to understand the process. This is achieved by business process mapping.
2. The second is measuring the sources of variation assisted by the use of control charts.
3. The third is eliminating assignable (special) sources of variation.

It can be used in various industries for improving the quality of the product and helps in lowering the product costs as it provides a better product and/or service.

CONCLUSION-

SPC is important because it gives the customers good quality products and services.

Inspection cannot build Quality into a product or a service. The process producing it needs to be capable to deliver good quality.

Quality is thus built into a product or a service through Process Assurance. Statistical Process Control (SPC) brings us a well defined method of assuring Quality of a Process and monitoring the stability of a good process over a period of time.

SPC helps us bring about Process Assurance and in turn a good Quality in what we do.

With the advent of industrial revolution, there came the era of mass produced items.

This posed a challenge: how to maintain quality of products which were being churned out in hundreds or thousands per hour.

It wasn't possible to check each and every item. There was no scientific method of sampling either.

QC inspectors continued to discharge their primary responsibility of rejecting bad items which in any case wasn't the solution to solve quality problems.

It was under these compulsions that statistics came to help quality control and tools and techniques of statistical process control developed.

The objective of SPC is simple: to control the process, not the product.

If the process is in control, it will automatically deliver good products.

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