Statistical Process Control (SPC)

Statistical process control (or SPC) is the application of scientific principles to analyze data that are collected from a process for purposes of characterize, control, and improve its performance. One of the fundamentals of quality management is that decisions are based on facts, not on opinions. Facts come from data. Wherever there is data, statistical procedures should be used to help with the interpretation and presentation of the data. This approach requires that objective measurements be made, recorded, plotted, and actually used to improve the process. Computers and SPC software programs are frequently used to perform number crunching and graphical presentation of data.

There are many SPC tools which can be used to determine where resources should be spent to yield their return on quality improvement. Some of the more widely used SPC tools and how they can be used in print production processes are explained below:

a. Pareto analysis  Pareto analysis is a data collection and analysis method of separating the vital few problems from the trivial many where the vital few quality characteristics tend to contribute to a high percentage of the quality loss. By focusing on the vital few, the rest are not tackled since the cure may cost more than the disease. This concept is also known as the 20/80 rule since approximately 80% of the quality loss can usually be attributed to 20% of the problems. The construction of a Pareto diagram involves the following steps: (1)
a definition of the process or product to be studied, (2) tallying of defects that occur over a given period of time, (3) ranking the defects in order of frequency of occurrence, and (4) identifying the top two or three culprits. For example, if we collect data on defect types in presswork and percent of their occurrences, then rank the % occurrence from high to low, we will see that the top few defect types do make up most of the non-conformance problems (Figure 1a). The Pareto diagram shows the same message in a graphical manner. The use of the cumulative frequency line gives clue about the majority of the quality defects.

When there are quality problems in production, some quality problems are much more costly than others. If quality improvement is to occur, these key problems, or defects, must be identified and corrected. And the use of the Pareto analysis has proven most useful.

b. Flow diagram The flow diagram shows a series of events which outline major components of a manufacturing process using symbols, pointers, and words. It offers a big picture of what takes place during the process. For example, when planning for product inspection (Figure 1b), it reveals places where inspection points may be placed.

c. Cause and effect diagram The cause and effect diagram is a useful tool for determining what variable or factors are influencing a given situation. This diagram, as shown in Figure 1c, puts the outcome or "effect" on the right and the factors or "causes" influencing the outcome on the left. Usually, the
causes are grouped into the five basic sources of variation: materials, machines, manpower, methods, and measurement. These are often referred to as the 5Ms. It helps people organize their thoughts, aid in brainstorming, and identify where data must be collected.

**d. Histogram** Variation exists in all manufacturing processes. The most common method for learning about the pattern of variation is the frequency histogram, or simply histogram. The histogram is a graphical display of the number of times of each piece of data. The basic steps in constructing a histogram are: (1) determine the number of intervals or classes to be counted, (2) tally the data into these classes, and (3) count the number of tallies in each class. A more visually pleasing picture is obtained when the tally marks are replaced with bars where the heights of each correspond to the count for each class (Figure 1d). Histogram is a useful tool to describe the process capability because it provides quick estimates of both the central tendency (or average) of a data set as well as the amount of variation (range).

**e. Control chart** A control chart is a time chart (also known as a run chart) with the process average and the upper control limit and the lower control limit, indicated (Figure 1e). In this example, solid ink densities of a printing unit was measured. Other measurement units may be % film dot area, pH of the fountain solution, or % dot gain of a press run, etc.
A process is said to be in a state of control when special causes of variation have been eliminated to the extent that the points plotted on a control chart remain within the control limits, and only common causes exist. When the data from the process exceeds these limits or when the pattern becomes non-random, it is taken as evidence of assignable cause variation. Thus, the control chart signals when to look for a problem.

**Implementing SPC** Notice that the use of computer, at the individual level, as a supportive tool for data collection and analysis has proven to be necessary. While SPC is becoming a very useful tool for process control and defect prevention, it represents an essential part of the total quality management (TQM) practices.

When it is necessary to mass produce a product, there is a need to know as much as possible about the quality requirements, the cost of producing it, and how to improve it. SPC has been used in all types of printing operations in the United States—whether it’s a quick print shop or a multi-million dollar publication printing plant. SPC can also be used to reduce scrap, rework, and wasted efforts. In other words, SPC is not just for companies who is in trouble of losing their market shares. It is for anyone who is interested in understanding, controlling, and improving their processes for satisfied customers and profitability.
Figure 1. Illustration of SPC tools.

(a) Pareto diagram.

(b) Flow chart.

(c) Cause-and-effect diagram.

(d) Histogram.

(e) Control chart.
Bibliography


