Five Costly Mistakes Applying SPC
(and how to avoid them)

By Steve Daum

I have daily conversations with manufacturers who are using statistical process control (SPC). These conversations with plant managers, quality managers, engineers, supervisors, and production workers, reveal challenges when applying these quality methods. There are many mistakes made in the application of SPC; following are five that are prevalent and can be costly.

#1 - Capability before stability

Capability is a critical metric, and capability statistics are often an important part of a supply chain conversation. Customers want assurance that your processes are capable of meeting their requirements, and their requirements are communicated with tolerances or specifications.

Customers frequently specify a Cpk or Ppk value that you must meet, and because they put such importance on it, these capability statistics become your primary concern in quality improvement efforts.

A representative of a manufacturer of springs, a tier 3 supplier to the automotive industry, recently contacted me. They were puzzled because they had calculated an “acceptable” Cpk of 1.02 but had produced products that fell outside the customer specifications.

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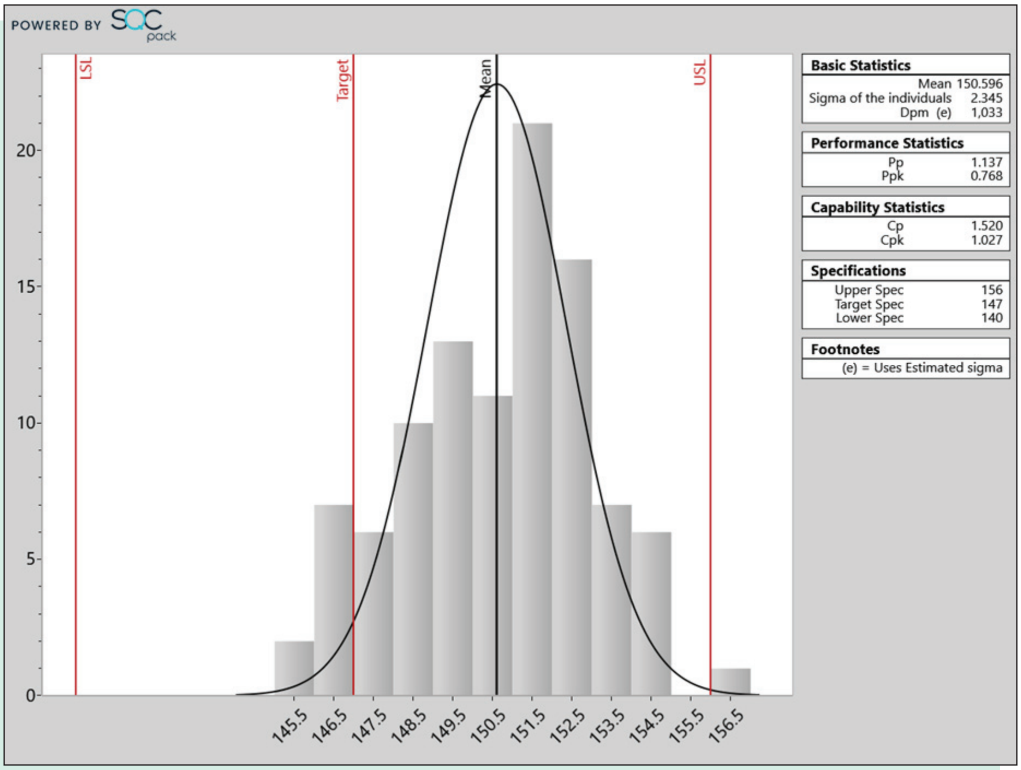

When a control chart of the process was produced, it became obvious that the manufacturer had not assessed process stability prior to calculating Cpk. In the control chart shown on the next page, you can see the process is not in control. Stability must be assessed before a capability study is done. Without this prerequisite, the Cpk statistics are not reliable.

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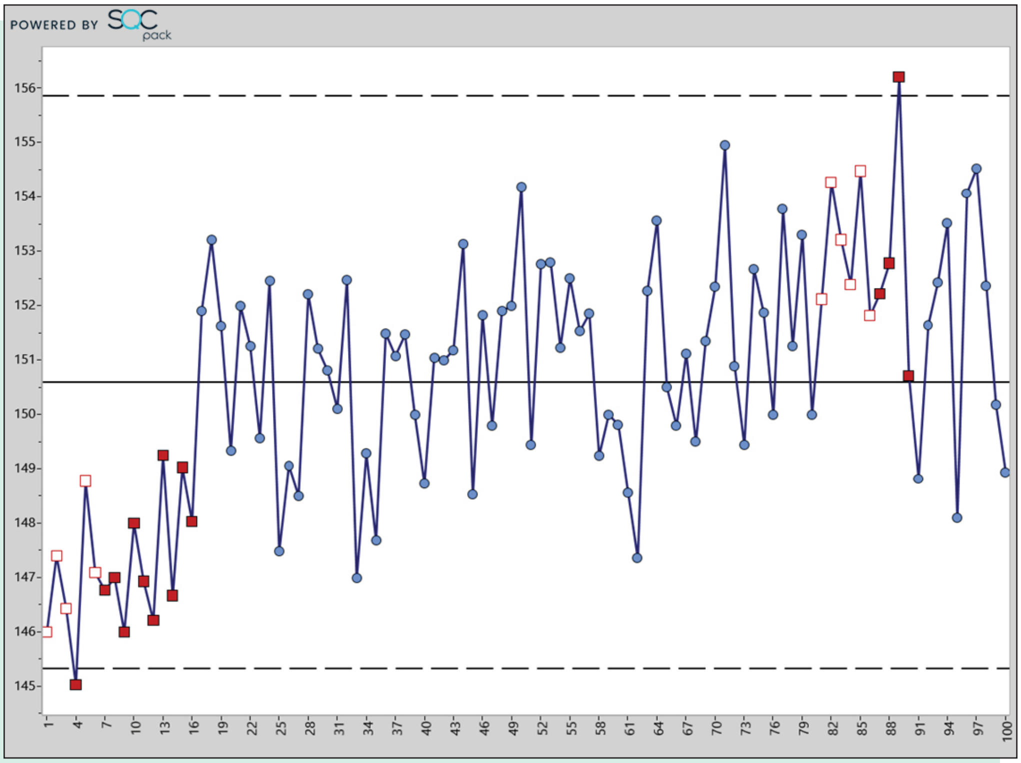

Without this determination of stability, any reliance on Cpk values is premature. The first issue to be addressed is getting to a stable, predictable process. Knowledge is power, but action gets things done. Building control charts into your analytical process on the front end can prevent costly mistakes such as scrap, rework, shipping unacceptable product, or even the dreaded recall.

When pressure is applied, perhaps prior to an audit or as part of contract negotiations, the need to calculate and present a Cpk value can be hard to resist. It is important to reinforce at every opportunity that stability (control) is required before capability is assessed. Require suppliers and staff to accompany capability statistics in any context with the relevant control chart showing that the process was in control (stable) prior to doing the capability analysis.

The Automotive Industry Action Group (AIAG) asserts that one of the three conditions that must be satisfied for capability analysis is process stability, specifically "the process from which the data come is statistically stable, that is, the normally accepted SPC rules must not be violated."[1]

#2 - Misuse of control limits

Producing control charts does not guarantee accurate process feedback. There are many subtleties in the application of control limits that are easy to get wrong. Here are a few common errors:

Computing wrong limit values with a home grown tool

Excel is a great software tool. It is so flexible that you can mimic almost any software application, including SPC software, using Excel. It's difficult to resist the temptation to use it exclusively because it is already on your computer. The calculations for control limits are not difficult, but they do have room for error. Questions such as How to calculate Sigma? Which sigma should be used? Does subgroup size affect Sigma? and How many values should be used for a Moving Range? must be addressed. The exact answers *can* be computed in a spreadsheet, but time and time again I have seen examples where the numbers are just plain wrong, often resulting in audit findings. If you use a home grown tool for SPC, proceed with caution. Validate the numbers for multiple use cases; these include large numbers, small numbers, negative numbers, samples with missing observations, samples with known assignable causes, etc.

Never computing control limits

The decision to compute control limits should be a deliberate one, even if your SPC software automatically computes limits for you. Someone with solid SPC training, knowledge of the process, and knowledge of the measurement being studied should decide when the limits will be computed and what data will be used. Once a *trial* set of control limits has been computed and it is clear that the process is stable (the control chart has no out-of-control conditions), this set of control limits can become the *official* set of control limits to be used on the chart.

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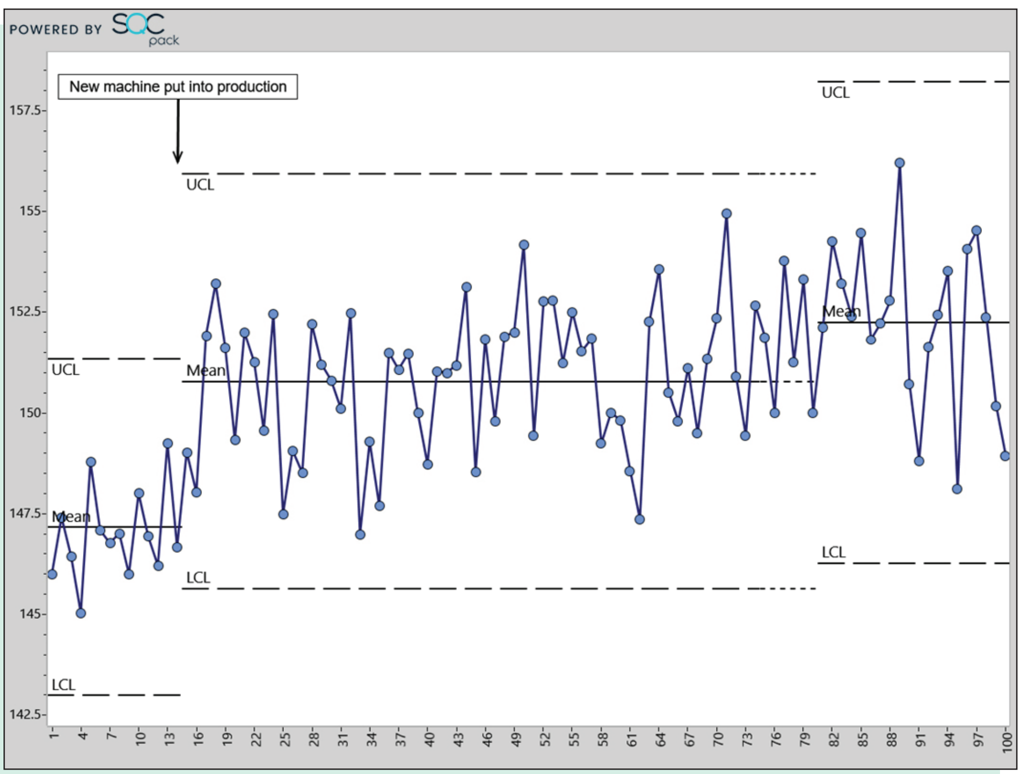
Never re-computing control limits

Once you have established a good official set of control limits for the control chart, the chart can be deployed and used as a process monitoring tool. However, this is not the end of the story. If you are focused on continuous improvement, you should strive to center the process on the target value, reduce variation, or both. For example, if you are successful in your improvement efforts over the course of the year, then the control limits you computed in January will not reflect how the process is running in September. A deliberate re-computing of the control limits to establish the new baseline is in order.

In the chart below, limits have been deliberately re-computed when known changes (improvements) were introduced in the process.



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Waiting to have enough data to compute control limits

Whether you have a small amount of data or a great deal of data, computing baseline control limits will almost always provide benefits. There are many guidelines, such as waiting until you have at least 25 subgroups gathered over a normal course of production. If you don't have much data yet, however, reasonable control limits can be computed even with small amounts of data. Control limits are sometimes called '*the voice of the process*.' Even with smaller amounts of data, this voice can shed light on the variation.

Confusing specification limits with control limits

Specifications, also known as tolerances, indicate what your customer requires. These are important numbers, but they are not control limits. Control limits are computed based on data from your process. Control limits reflect how your process behaves. I often see line charts with horizontal specification lines at the upper and lower specification values. This type of chart might provide value in some situations, but it should never be confused with a control chart.

The reason for doing a control chart (with control limits) is to reduce the chance of two types of errors:

1) Overcontrol, or adjusting the process when it should be left alone

2) Undercontrol, or not adjusting the process when it should be adjusted

The specification lines cannot give you this information. If your sample size is one, these lines can tell if one part is outside the customer specifications, but they do not relay any information about the variation in your process over time.

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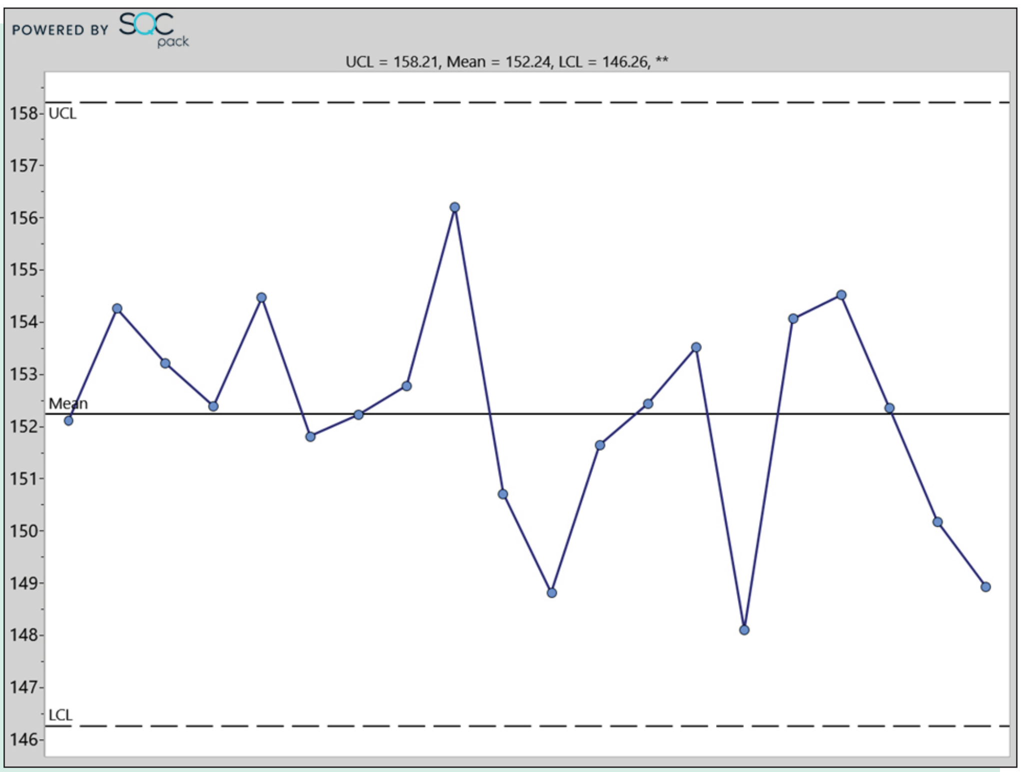
#3 - Measurement system issues

If you are applying SPC, you are likely measuring things. Do you know how well you are measuring? This critical area is easily overlooked when you are focused on SPC. Even the best application of SPC tools can be undermined when the ability to measure things is uncertain.

Your ability to measure accurately and consistently is critical. In the control chart shown below, everything is in control.



Next, look at the results of an R&R study done with a measurement device. By looking at the Total Variation (TV) for example, we know that the measured values could be significantly different from the actual values.

Measurement Unit Analysis

Repeatability - Equipment Variation (EV)	
EV = 0.2018	%EV = 17.61
Reproducibility - Appraiser Variation (AV)	
AV = 0.2298	%AV = 20.05
Repeatability & Reproducibility (R&R)	
R&R = 0.3058	%R&R = 26.68
Part Variation (PV)	
AV = 1.1044	%AV = 96.37
Total Variation (TV)	
TV = 1.1460	

We tend to think that points on a control chart are exact values. However, the R&R study above shows that there is a zone of uncertainty around each measured value.

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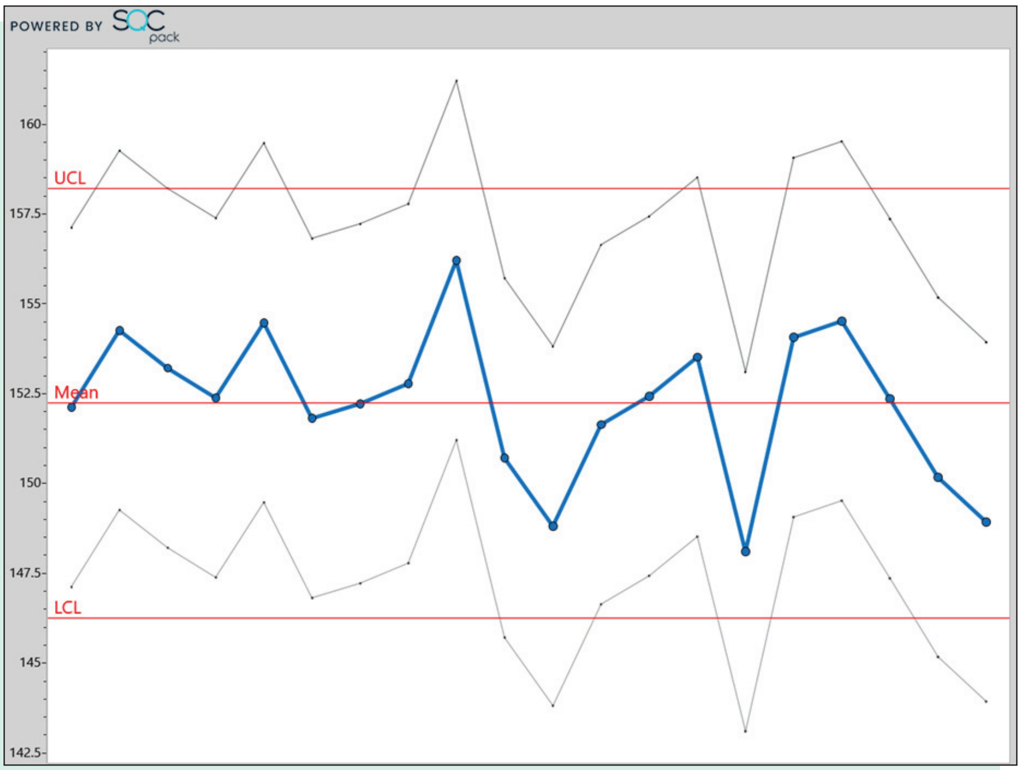
The next chart helps you visualize a zone of uncertainty around the control chart line. As you can see, if the measurements have too much variation, a process exhibiting complete stability could, given a better measurement system, have points beyond the control limits. This chart shows a large zone of uncertainty primarily for illustration.



If you don't assess your ability to make good measurements, the confidence in your SPC results is reduced. Simply put, garbage in, garbage out. Utilizing the set of tools known as Measurement Systems Analysis (MSA) can help ensure that quality measurements are fed to your SPC output.

Another measurement system issue is failure to manage the measurement devices. How well do you manage your measurement equipment? What is the calibration interval? What steps are checked during a calibration? What is the history of calibration for a given device? What master gages are used for the calibration, and have those devices been calibrated? Do you have systems in place to ensure that gages which are past due for calibration or preventative maintenance are not used?

In addition to performing measurement systems analysis, you need to properly manage your measuring devices. Software applications designed for this purpose, such as PQ Systems' GAGEpack®, can help you with assessing *and* managing your measurement system.

#4 - Delegating SPC work to one or a small group of employees

Some business processes have been formalized and internalized by most organizations. Think about accounting. All businesses do accounting. If one or more accounting staff members retire or leave the company, the accounting function will continue; it is a routine part of doing business. In many firms, SPC is not yet internalized and normalized as a part of doing business.

A common problem occurs when the *SPC person* leaves. The system for gathering and analyzing data put in place by the SPC person, gets less attention. Time may pass before a replacement is found. Charts on key quality metrics may not get refreshed.

The guidance here is to not tie your SPC system to a single employee. It should be documented and systematized so that the work continues beyond the tenure of any given employee. It may be unrealistic for all employees to be trained in SPC. However, SPC is an important way of thinking and this way of thinking should become part of your organization's culture.

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#5 - Not leveraging technology to scale your SPC efforts

Technology has made it easier to create and deploy SPC charts on anything and everything. While advantages to this development abound, the amount of time spent by valuable workers doing repetitive, non-value-added, SPC-related work can be costly.

If you need to monitor dozens or even hundreds of SPC charts, you need to seek methods of scaling your SPC application. Consider the time it might take to do these steps:

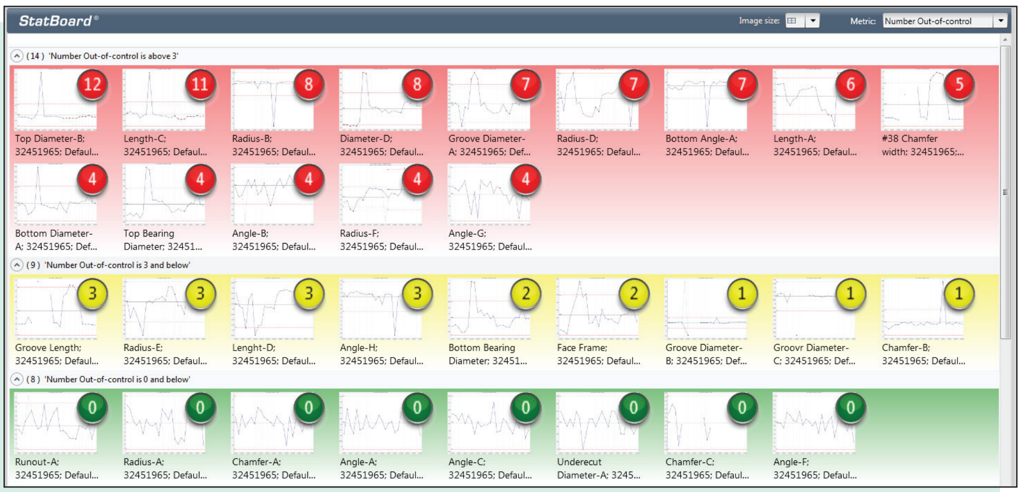
1. Find the chart of interest
2. Display the chart
3. Analyze the chart
4. Decide if action is needed or not

One large textile manufacturer's business goals justified monitoring 300 SPC charts. They needed a method of scaling their global SPC application efficiently. Even their most efficient, well-trained worker who was able to complete the four steps in just one minute was spending five hours of work simply monitoring charts!

Rather than invest their analysts' time and attention viewing hundreds of charts—most of which reflect processes that are operating in control—they implemented software that uses scanning techniques to surface only the charts that need attention.

Utilizing an automated approach to process monitoring can amplify your ability to pay attention to key metrics without dragging quality workers away from more important activities.

In the example below, 31 charts have been created and put into an SQCpack StatBoard®. The StatBoard has scanned each chart for out-of-control conditions and ranked the charts based on the number of conditions found. The analyst can focus on the red and perhaps yellow charts and ignore the remaining ones. The interval at which the StatBoard runs is set by the user. In the case of the textile manufacturer, it is running every two hours.



Dr. Donald Wheeler describes SPC as “a way of thinking with some tools attached.” Often, when I see these mistakes being made, the root cause is too much focus on the tools of SPC and not enough focus on the SPC way of thinking. The common thread among the five mistakes is an underlying need for more education. Through continuing education, this SPC way of thinking can become embedded in the manufacturing culture.

ABOUT THE AUTHOR

Steve Daum is Director of Software Engineering for PQ Systems. He has more than 30 years of experience with statistical process control, control charts, and control charting software. Steve has published papers in a variety of professional journals and has led multiple seminars and presented on statistical process control and issues related to quality to a variety of audiences in the U.S., England, and South Africa. To learn more about PQ Systems' software applications SQCpack and GAGEpack, visit www.pqsystems.com.

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