Understanding Process Capability

The Difference Between Capability and Control

BY DEAN V. NEUBAUER

Q: What do we mean by the capability of a process?

A. The *AT&T Statistical Quality Control Handbook* states, "The natural behavior of the process after unnatural disturbances are eliminated is called the process capability." The handbook emphasizes that a process capability study is a systematic investigation of a process by using control charts to determine its state of control, checking any lack of control for its cause and taking action to eliminate any nonrandom behavior when justified in terms of economics or quality.

Process capability can never be divorced from control charts or from the concepts of control that W.A. Shewhart envisaged. The capability of a process is independent of any specifications that may be applied to it. It is basic to the process and may be thought of as inherent process capability. This capability may be estimated from a range or standard deviation chart on past data, but it can be measured only when the process itself is in control.

A simple view of process control and process capability follows.

- Process control refers only to the "voice of the process," looking at the process using an agreed performance measure to see whether the process forms a stable distribution over time. In the context of this article, we will consider this to be statistical process control (as opposed to engineering process control).
- Process capability measures the "goodness of a process," comparing the voice of the process with the "voice of the customer." The voice of the customer here is the specification range (tolerance) and/or the nearest customer specification limit.

Process performance requires that the standard deviation estimate come from the overall dataset (single sample). This means that there is no time component involved in this long-term estimate of the standard deviation; hence, all of the sources of variation are combined. A histogram, stem-and-leaf plot, dot plot or similar graphic will show the shape of the overall data, whereas on a timeline there will be information on the assignable cause variation present.

Process capability requires that the standard deviation estimate come from subgroups of data (rational subgroups where the variation within them is considered homogeneous). This means that the variation over time will exist between subgroups but that the variation is homogeneous within the subgroup. A control chart will be used to show the assignable cause variation that is present in the process.

The objective is to get as close to the theoretical best variation (within subgroup variation) that your process can achieve by eliminating special causes of variation (between subgroup variation), so that only common (natural) causes are acting on the process, and then to reduce these to a minimum whenever possible, as shown in Figure 1.

The thrust of modern quality control is toward reduction of variation. This follows the Japanese emphasis on quality as product uniformity about a target rather than simple conformance to specifications. Thus, process capability becomes a key measure of quality and must be appropriately and correctly estimated.

While it is true that a product with less variation around nominal is, in a sense, better quality, specifications will probably never be eliminated, for specifications tell us how much variation can be tolerated. Specifications provide an upper limit on variation, which is important in the use of the product, but which should be only incidental to its manufacture. The objective of manufacturing should be to achieve the nominal, for the same product can be subjected to different specifications from various customers.

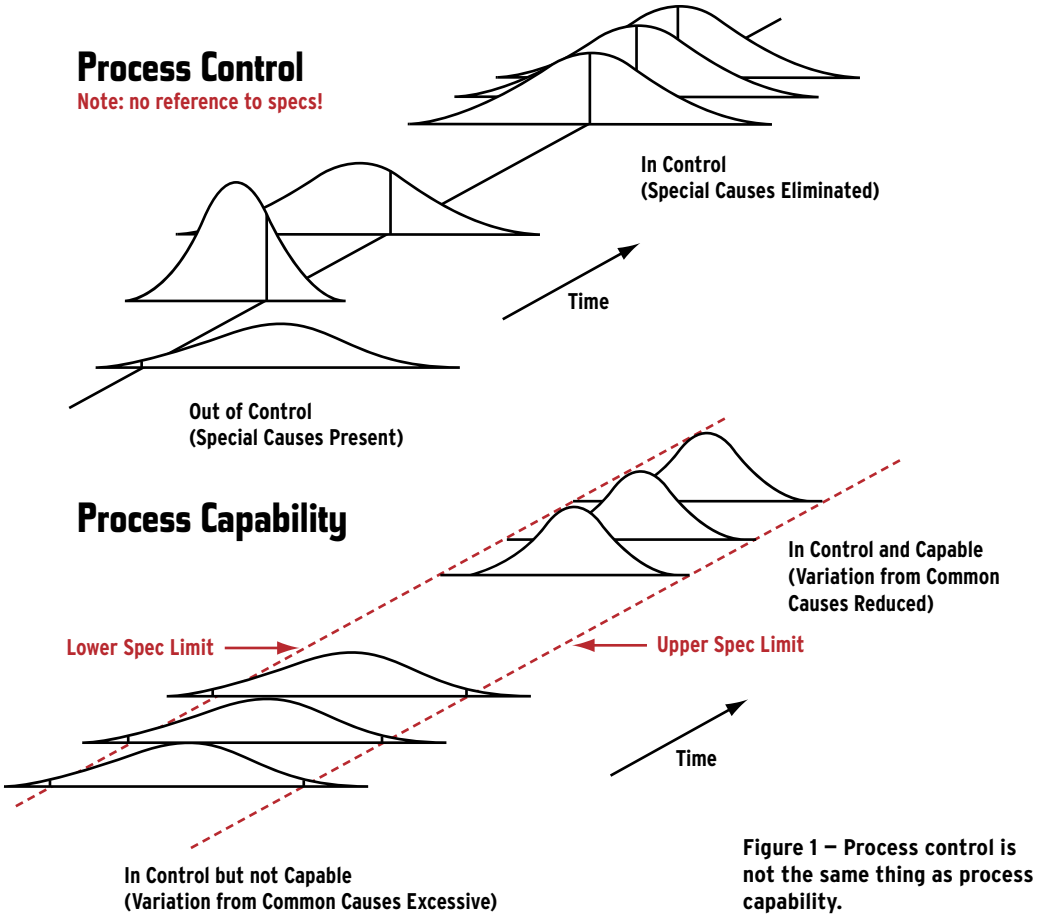

Figure 1 — Process control is not the same thing as process capability.

Also, specifications are not stable over time. They have a tendency to shrink. The only protection the manufacturer has against this phenomenon is to strive for product as close to nominal as possible in a constant effort toward improvement through reduction in variation. Otherwise, the best marketing plan can be defeated by a competitor who has discovered the secret of decreased variation.

It may be of interest to estimate the performance level of the process rather than its capability with respect to the specification. We can think of process performance as what the process *does make* with respect to the specifications. On the other hand, process capability tells us what the process *can make* when it is in control.

More information on the construction and use of control charts, and metrics associated with assessing process capability and performance, can be found in the ASTM *Manual 7, Presentation of Data and Control Chart Analysis, 8th ed.*, available through ASTM International. Another resource is ASTM standard E2281, Practice for Process and Measurement Capability Indices. Both of these resources are supported by ASTM Subcommittee E11.30 on Statistical Quality Control, part of Committee E11 on Quality and Statistics.

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