Process Capability: Minding Your Cpk's

by Mario Perez-Wilson

The process potential index, or Cp, measures a process's potential capability, which is defined as the allowable spread over the actual spread. The allowable spread is the difference between the upper specification limit and the lower specification limit. The actual spread is determined from the process data collected and is calculated by multiplying six times the standard deviation, s. The standard deviation quantifies a process's variability. As the standard deviation increases in a process, the Cp decreases in value. As the standard deviation decreases (i.e., as the process becomes less variable), the Cp increases in value.

By convention, when a process has a Cp value less than 1.0, it is considered potentially incapable of meeting specification requirements. Conversely, when a process Cp is greater than or equal to 1.0, the process has the potential of being capable.

Ideally, the Cp should be as high as possible. The higher the Cp, the lower the variability with respect to the specification limits. In a process qualified as a Six Sigma process (i.e., one that allows plus or minus six standard deviations within the specifications limits), the Cp is greater than or equal to 2.0.

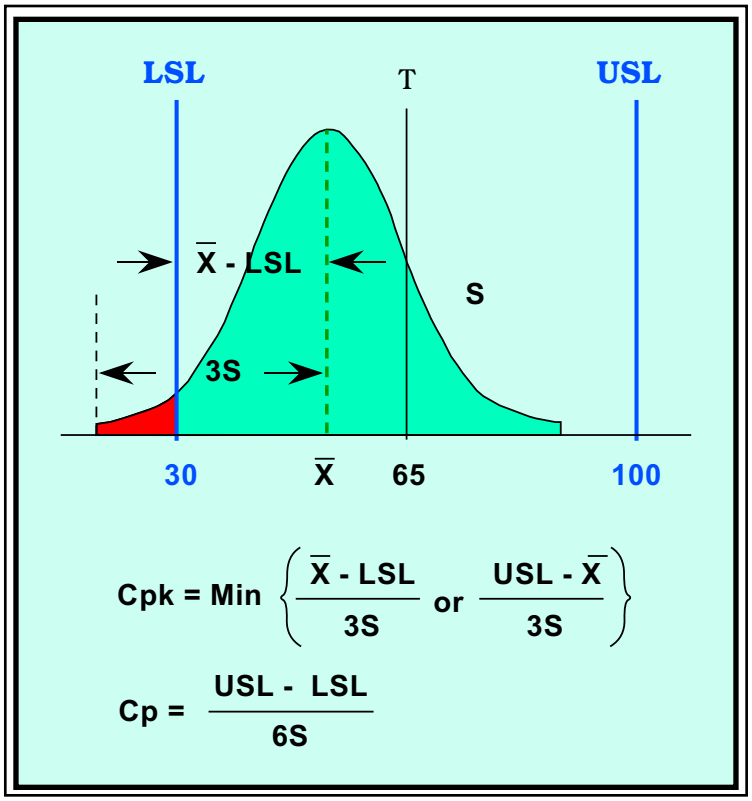
However, a high Cp value doesn't guarantee a production process falls within specification limits because the Cp value doesn't imply that the actual spread coincides with the allowable spread (i.e., the specification limits). This is why the Cp is called the process potential.

The process capability index, or Cpk, measures a process's ability to create product within specification limits. Cpk represents the difference between the actual process average and the closest specification limit over the standard deviation, times three.

By convention, when the Cpk is less than one, the process is referred to as incapable. When the Cpk is greater than or equal to one, the process is considered capable of producing a product within specification limits. In a Six Sigma process, the Cpk equals 2.0.

The Cpk is inversely proportional to the standard deviation, or variability, of a process. The higher the Cpk, the narrower the process distribution as compared with the specification limits, and the more uniform the product. As the standard deviation increases, the Cpk index decreases. At the same time, the potential to create product outside the specification limits increases.

Cpk can only have positive values. It will equal zero when the actual process average matches or falls outside one of the specification limits.



The Cpk index can never be greater than the Cp, only equal to it. This happens when the actual process average falls in the middle of the specification limits.

About the author

Mario Perez-Wilson is the founder and principal consultant of Advanced Systems Consultants based in Scottsdale, Arizona. He has over 23 years of industrial experience in engineering, quality and process improvement and has served at the executive level as Corporate Vice President of Quality for Flextronics International.

One of the original architects of Six Sigma, he served as a Division Statistical Methods Engineering Manager at Motorola. During his tenure, he institutionalised and standardised the application of statistical methods and Six Sigma in Motorola's worldwide manufacturing, production and engineering operations. His proprietary M/PCpS™ Methodology for characterizing processes has received global recognition as the first methodology to achieve and sustain Six Sigma.

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