Process Capability

Process capability compares the output of an in-control process to the specification limits by using capability indices. The comparison is made by forming the ratio of the spread between the process specifications (the specification "width") to the spread of the process values, as measured by 6 process standard deviation units (the process "width").

We are often required to compare the output of a stable process with the process specifications and make a statement about how well the process meets specification. To do this we compare the natural variability of a stable process with the process specification limits. A capable process is one where almost all the measurements fall inside the specification limits.

There are several statistics that can be used to measure the capability of a process: Cp, Cpk, Cpm. Most capability indices estimates are valid only if the sample size used is 'large enough'. Large enough is generally thought to be about 50 independent data values. The Cp, Cpk, and Cpm statistics assume that the population of data values is normally distributed. Assuming a two-sided specification, if μ and σ are the mean and standard deviation, respectively, of the normal data and USL, LSL, and T are the upper and lower specification limits and the target value, respectively, then the process capability indices are defined as follows.

$$Cp = \frac{USL - LSL}{6\sigma}$$

$$Cpk = \min\left[\frac{USL - \mu}{3\sigma}, \frac{\mu - LSL}{3\sigma}\right]$$

$$Cpm = \frac{USL - LSL}{6\sqrt{\sigma^2 + (\mu - T)^2}}$$

Example

For a certain process the USL = 20 and the LSL = 8. The observed process average is 16, and the standard deviation is 1.8. Compute the Cp and Cpk.

Solution

The estimated process capability indices are:

$$Cp = \frac{20 - 8}{6(1.8)} = 1.11$$

$$Cpk = \min\left[\frac{20 - 16}{3(1.8)}, \frac{16 - 8}{3(1.8)}\right] = \min[0.741, 1.48] = 0.741$$

Detailed calculations are available in the Microsoft Excel file "**Chapt-7 Process Capability.xlsx**".