Understanding Capability for Process Improvement

You've learned how to compute capability indices and how to interpret their values. In this video you learn how capability indices can be used for process improvement.

Let's consider an example. You work for a company that makes printed circuit boards. These boards are used in a variety of applications. It is critical to achieve the specified thickness of the finished board for your customer's applications. If the board is too thick or too thin, it won't work.

The target value for thickness of the board is 2.3 mm. The characteristic, thickness, is normally distributed.

You have collected production data over time and have used control charts to verify that the process is stable.

Let's say the thickness specifications are 2.0 to 2.6 mm.

If you have a circuit board that measures at 2.59 mm, it is within specification and is acceptable.

But if you have a board that is 2.61 mm thick, it is outside of specification and is unacceptable.

Both of these measurements are relatively far away from the target value of 2.3.

Product can fall outside the specifications because there is too much process variability, or because the process is off target, or both. The capability indices help you understand these issues.

If C_p is low, the process has too much variation.

If C_p is high but C_{pk} is low, the process is off target, but the variability might be acceptable.

If both C_p and C_{pk} are low, the process is both off target and has too much variability.

Because these indices are based on knowledge of the normal distribution, a capability study also enables you to estimate how much of your product will be out of spec, or nonconforming.

Let's examine some scenarios.

We know that, if the process characteristic is normally distributed, approximately 99.73% of all observations will fall within plus or minus 3 standard deviations of the mean.

If your process is exactly centered on target and each spec limit is 3 standard deviations from the target, then both C_{pk} and C_p will be 1.0. The probability that an observation is nonconforming, or falls beyond either spec limit, is 0.0027, or 0.27%.

In our example, the lower spec limit is 2.0 mm, the target is 2.3 mm, and the upper spec limit is 2.6 mm.

The process is on target, with a mean of 2.3, and the standard deviation is 0.1. The C_{pk} is 1, and approximately 0.27% of the observations will be nonconforming.

With the same process mean, what if the standard deviation is increased by 50%, from 0.1 to 0.15 mm?

The C_{pk} will drop to 0.667, and the estimated nonconforming rate will increase to 4.55%.

What if our standard deviation is the original value, 0.1 mm, but the process mean shifts off target to 2.45 mm?

The C_{pk} drops to 0.5, and the nonconforming rate increases, to approximately 6.7%.

To put this in perspective, this means that nearly 7 circuit boards out of 100 will be out of spec.

However, what if the process is off target, with a mean of 2.45 mm, but we cut the variability in half (from 0.1 to 0.05 mm)?

Even if the process remains off target, the nonconformance rate will be extremely low: approximately 0.135% of the circuit boards will fall beyond the upper spec.

As this simple example illustrates, capability indices give us insights into potential paths for process improvement.

Does your process have too much variation? Is your process shifted off target? Is the process both too variable and off target? Your answers to these questions can guide your improvement efforts.

For example, if your process has too much variability, you need to identify and control the sources of variation in the process.

If your process is off target, you need to identify settings of important parameters that will bring the process on target.

In this video, you learned how to interpret capability indices using some simple scenarios.

In the next video, you see how to conduct a capability analysis for the Metal Parts example.

Close