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Analyzing the MSA

In the previous videos, you learned how to visualize the results of an MSA. You can use a variety of statistical methods to formally analyze and quantify measurement system variation.

One popular method is a variance components analysis. As the name implies, variance components are estimates of the variation attributed to each component, or source, of measurement system variation. The Variance Components table reports estimates of the variances and standard deviations from each source of measurement system variation. Here, we see the Variance Components table for the Micrometer MSA. For our study, the total variability in the measurements can be attributed to Inspector, Part, the Inspector*Part interaction, and Within, which represents the repeatability variation. Let's look at the % of Total column.

A large percent of the total variation, 65.9%, is due to Part. We selected a random sampling of 10 parts for this study, spanning the range of target values (4.0 to 5.5 cm), and we hope that most of the variation is due to Part. However, 5.1% is due to the Inspector*Part interaction and 29% of the variation is Within, or repeatability variation. The variation due to the measurement system can be broken down into these components: Inspector, the Inspector*Part interaction, and Within. The standard deviations are also reported. It's important to know that you can add variances, but you can't add standard deviations. Think of the Pythagorean Theorem: The square of the hypotenuse is equal to the sum of the squares of the other two sides. But the hypotenuse is not equal to the sum of the other two sides.

To compute the standard deviation for the measurement system, we take the square root of the variance for the measurement system. So the standard deviation is 0.223 cm. To put this value into perspective, remember that we define the process width as 6 standard deviations. Our measurement system is also a process, with numerous sources of variation. If our measurement system is unbiased, then approximately 99.73% of our measurements will be within plus or minus 3 standard deviations of the true value. This is an interval of 1.33 cm. This means that, for the same part, the measurement system can produce values that are up to 1.33 cm apart. Let's say that the width of our spec limits is 3 cm. This means that you can easily measure good parts as being out of specification, and parts that are out of the spec limits can be measured as being within the spec limits.

For example, this curve represents the possible measurements for a particular part. The actual value for this part is within specs, but because of measurement system variation, you might have a measurement that is out of spec. And this part is out of spec, but the measurement might be in spec. Another way of looking at the variance components is to combine the terms attributed to repeatability and reproducibility. This is reported as Gauge R&R, or, Gauge Repeatability and Reproducibility.

For this MSA, the Gauge R&R is 29% of the total variation. This is all due to repeatability (Within) variation. The variation due to the interaction, 5.1%, is reported separately. Note that Gauge R&R is a stand-alone method for analyzing the repeatability and reproducibility in a measurement system that was developed by the AIAG the Automobile Industry Action Group. You learn how to conduct a traditional Gauge R&R analysis in a JMP demo. For details on performing a traditional Gauge R&R analysis, see the Read About It for this module.