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Designing and Conducting an MSA

In the Area MSA practice, you were presented with 12 objects in random order. Did you realize that some of the objects were the same? In fact, there were only six objects, and you measured each object twice. Why did we randomize the presentation of the parts? If you measure an object, and then immediately measure it again, you probably remember the last measurement. However, if the objects are presented to you in random order, you might not know that you are measuring the same object twice. And you might not get the same measurement when you measure the same object a second time. This blind, random presentation of the parts to the measurer is a critical component of conducting a measurement system study.

Why did we ask you to measure the same object twice? Measuring the same object more than once gives you the ability to estimate the repeatability variation in the measurement system. Later, you'll see how well you did. For now, let's talk about the study design.

The design for this study was simple. We had one operator, measuring six objects with two measurements per object. The study design might have looked something like this, where your measurements are entered into the last column. We call this a gauge study worksheet. During the measurement study, you use gauge study worksheets to organize the presentation of objects to inspectors (or operators), and to enter the measured values.

Let's consider the hand micrometer example. The accuracy of the micrometer has been confirmed, but you want to study repeatability and reproducibility variation. You design an MSA that includes multiple parts, multiple inspectors, and multiple measurements on each part. You have decided to include three inspectors and 10 parts. You randomly select the 10 parts to span the range of operating conditions and target values (4.0 cm to 5.5 cm). Each inspector measures each part twice with the micrometer, and the parts are randomly presented to the inspectors. How many total measurements will you have?

If every inspector measures every part twice, you will have a total of 60 measurements. The first 20 rows of your gauge study worksheet might look something like this. Here, there are two repeats, or sets of readings. The parts are randomized within inspector, and the inspectors are also randomized.

When you conduct the MSA, you do this in two parts. For the first set of readings, Inspector 2 measures the 10 parts in random order. Then Inspector 3 measures the parts, in a different random order, followed by Inspector 1. As each inspector measures the parts, the measurements are recorded in the worksheet. After you finish the first set of measurements, you cycle through the second set of measurements. Because all inspectors measure each part twice, this is referred to as a crossed design. In the next video, you see how to create this worksheet in JMP.

Let's think a little more about how you would conduct this MSA. Should you have all inspectors in the same room, each watching the other take the measurements? Or should you rotate the inspectors through the measurements, without the inspectors observing the other inspectors?

In general, it is recommended that you conduct the MSA in a blind fashion. This means that you have the inspectors measure each part without the other inspectors observing the process or hearing the measurements. This reduces the chance that an inspector is influenced or biased by other inspectors. Depending on how long the measurements take, all of the measurements for the first set will be taken within a day, or within a few days. Then the inspectors return later for the second set of measurements. How much later depends on factors like how long the measurements take, the availability of the calibrated gauges, and the chance that the inspectors might remember their measurements from the first round.

As you conduct the MSA, you might observe differences between inspectors as they are taking the measurements. For example, there might be differences in how the inspectors use the gauge, how the inspectors position the parts in the gauge, or the unit of measure recorded. You might want to take notes during the MSA and record these observations. The differences you note might be causes of variation in the measurements, and these insights can lead to improving the performance of the measurement system.

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