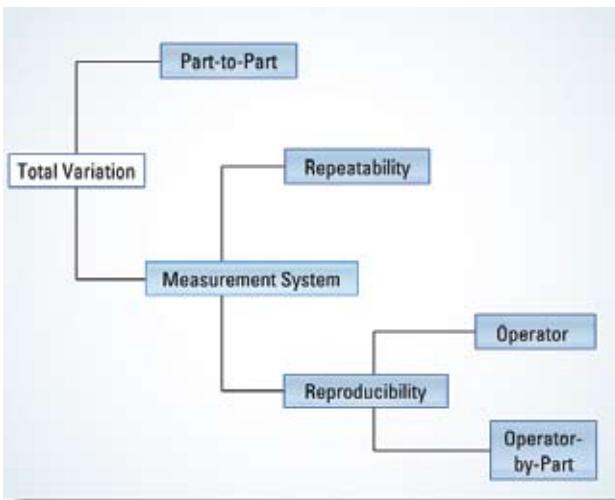


# How To Determine if Your Measurement System is Adequate

Have you ever stepped on a scale to weigh yourself, stepped off the scale, and then stepped back on to measure your weight a second time? Have you ever gotten two different readings? Whether you are monitoring your weight or trying to improve a process vital to your company's success, it is imperative that the measurement system you use is adequate.

Most measurement systems contain some variation, and we can use a Gage Repeatability and Reproducibility Study (Gage R&R) to quantify that variation and assess a measurement system.

Measurement system variation can be split into two components: repeatability and reproducibility. Repeatability is the variation observed when the same operator measures the same part multiple times with the same device, while reproducibility is the variation observed when different operators measure the same part with the same device. In a Gage R&R Study, the measurement system variation is compared to the part-to-part variation, which will be the largest component of variation if the measurement system is sufficient.



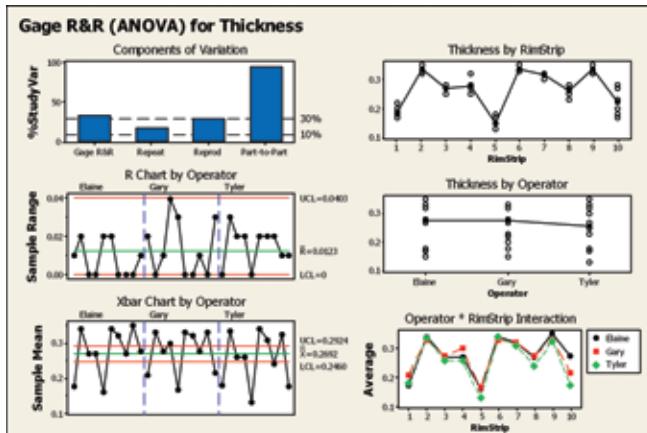
## TO CONDUCT A GAGE R&R STUDY, FOLLOW THESE STEPS:

1. Take a random, representative sample of parts to measure.
2. Randomly select qualified operators to take the measurements. You need at least two operators to estimate reproducibility.
3. Decide how many measurements each operator should take.
4. Create the measurement plan and take the measurements.

+	C1	C2-T	C3
	RimStrip	Operator	Thickness
1	10	Gary	0.20
2	9	Gary	0.33
3	1	Gary	0.22
4	7	Gary	0.32
5	4	Gary	0.28
6	5	Gary	0.18
7	6	Gary	0.33
8	3	Gary	0.28
9	2	Gary	0.33
10	8	Gary	0.28
11	9	Tyler	0.33
12	4	Tyler	0.27

5. Run the analysis. In this example, three operators have measured the thickness of ten bicycle tire rim strips two times each. Note that each operator measured the parts in random order to minimize external factors.

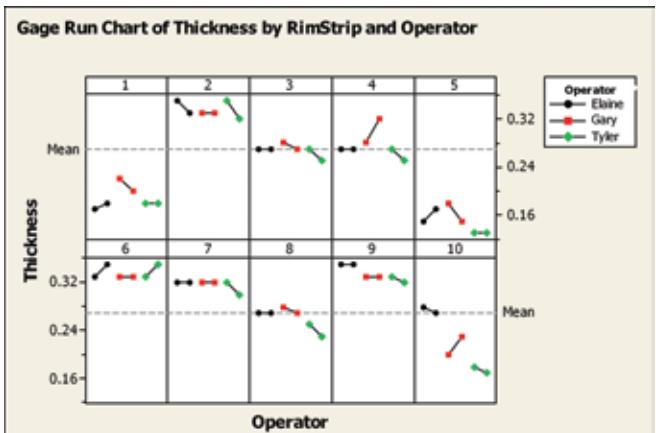
We can use the Gage R&R results to assess the measurement system. The *Components of Variation* graph



shows the amount of variation contributed by the Gage R&R combined, repeatability, reproducibility, and the part-to-part. Typically, a Gage R&R %Study Variation less than 30% is acceptable, while less than 10% is ideal. In this analysis, the %StudyVar for Gage R&R is greater than 30%, with reproducibility being the largest contributor. Therefore, the measurement system needs improvement and the system may not be able to distinguish between parts.

We can use the other graphs to figure out why the Gage R&R %StudyVar is larger than desired. For example, the *Thickness by RimStrip* and *Operator\* RimStrip Interaction* plots show a greater amount of variation between the operators' measurements for the tenth rim strip, which contributes to the poor reproducibility results. However, the R Chart, which can be used to identify repeatability issues, is in control. In addition, the Xbar Chart is out of control, which is also favorable. This indicates that there is more variation between the parts than when the same operator measured the same part repeatedly.

The Gage Run Chart is another tool that can be used to identify measurement system issues. This chart again shows that part 10 was particularly difficult to



measure. The Gage Run Chart will also reveal patterns in the data. In this analysis, we can see that Tyler almost always measures the rim strips smaller the second time, which would have gone undetected if we relied solely on the Gage R&R results.

The Gage R&R Study shows that the measurement system used to measure rim strip thickness needs improvement. Perhaps there were certain attributes of part 10 that made it difficult to measure, and the Gage Run Chart indicates that Tyler may have used a different procedure when measuring the rim strips a second time. There are many causes for inadequate measurement systems, including issues with the measurement device itself, an operator who was not properly trained, or a measurement tool that exhibits wear out after repeated use. Whatever the case may be, evaluating your measurement system is crucial; only then can you uncover measurement system issues and build confidence in your data.

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