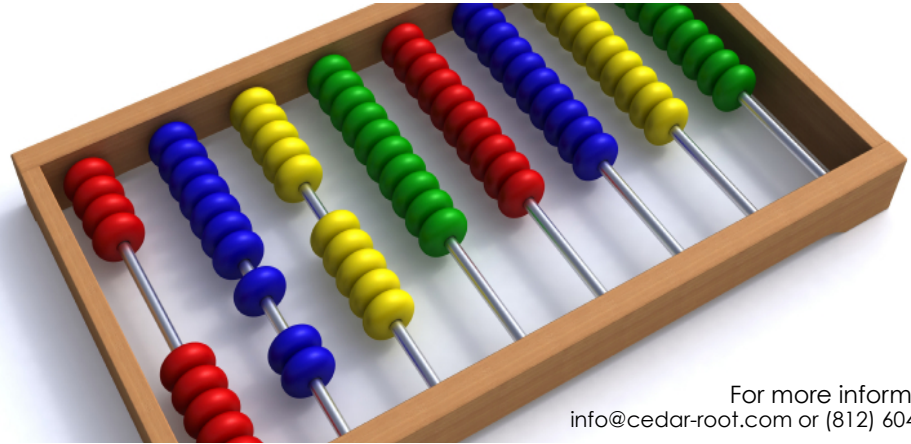


GAGE R&R

"The Punch Line"

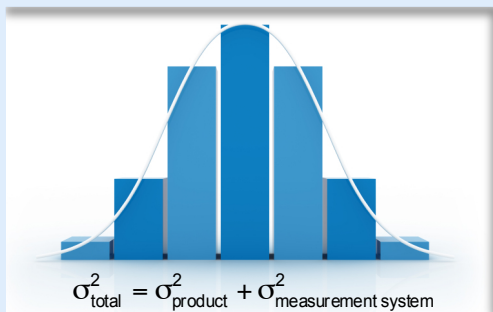


For more information
info@cedar-root.com or (812) 604-9910

GAGE R&R Output (Variable Data)

Punch Line: What's the punch line? Removing measurement system error from total observed error can be what I call a "quick win". Who couldn't use a quick win these days. This guide assumes that you are a trained Leans Six Sigma Black Belt or have practical knowledge in conducting or interpreting the output of a gage R&R study (measurement system repeatability and reproducibility study).

Let's get started. If you look at the normal distribution in the inset photo below, we ask ourselves, what percent of this variation is assigned to measurement system variation? The formula below (in the inset photo) also suggests that if we were able to significantly reduce measurement system variation, we would reduce overall observed variation. Not a bad deal, right?!



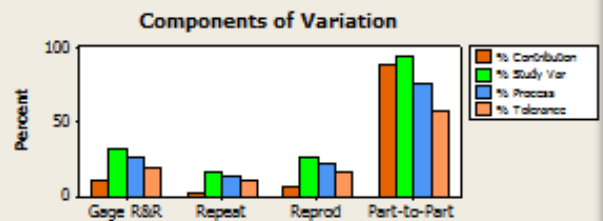
But before we can **remove** measurement system variation we have to be able to measure it and do something about it. Oops!

If you're not an aficionado of gage R&R studies, the study options could make you scratch your head. Let's keep it simple and wade through the noise.

Study purpose and options to consider when selecting the study output and analysis include the following;

- Variation of your product samples. In other words, the range of variation that these sample parts represent or should represent.
- Product Tolerance for sample product.
- Historical product standard deviation or variance.

Gage R&R (ANOVA) for Response

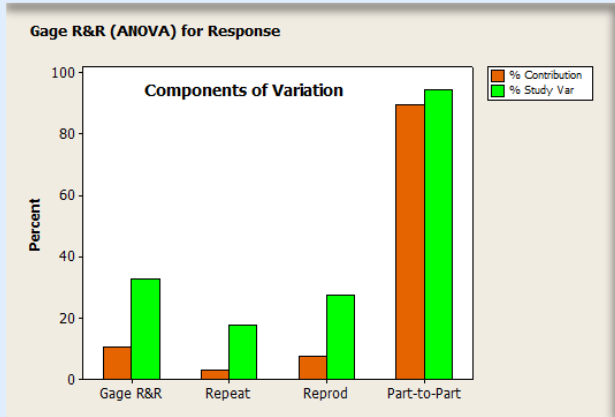


That being said, there are four measures of study variation that one can choose. Question is, which one? See Minitab graphic above. Each color bar represents;

1. % Contribution
2. % Study Variation
3. % Process
4. % Tolerance

I'm sure in Black Belt training you may have seen this output and you may remember what they all meant. However if you don't, then let's get focused on one output that will always work, **% Contribution**. The only caveat is that you really need to know the purpose of your study and the appropriate width of your product sample variation. If you don't have a handle on that, sign up for my Lean Sigma Black Belt course that addresses both variable and attribute studies.

Let's clean up the output with just % Contribution and % Study Variation.



Gage R&R

Source	VarComp	%Contribution (of VarComp)
Total Gage R&R	0.0044375	10.67
Repeatability	0.0012917	3.10
Reproducibility	0.0031458	7.56
Operator	0.0009120	2.19
Operator*Part	0.0022338	5.37
Part-To-Part	0.0371644	89.33
Total Variation	0.0416019	100.00

Source	StdDev (SD)	Study Var (6 * SD)	%Study Var (%SV)
Total Gage R&R	0.066615	0.39969	32.66
Repeatability	0.035940	0.21564	17.62
Reproducibility	0.056088	0.33653	27.50
Operator	0.030200	0.18120	14.81
Operator*Part	0.047263	0.28358	23.17
Part-To-Part	0.192781	1.15668	94.52
Total Variation	0.203965	1.22379	100.00

Number of Distinct Categories = 4

Notice the graphical output above has only two bars, **% Contribution** and **% Study Variation**. The computation for % Study Variation is not as clean as the % Contribution (shown inside red box).

In fact the % Study Variation data in the bottom table of the output below uses the VarComp data in the top table of the output. So what's the purpose of the bottom table? Not so much. Notice the %Contribution variance components add nicely together (i.e. total Gage R&R of 10.67 = Repeatability 3.10 + Reproducibility 7.56, etc.) If you try this with % Study Variation, it won't work because the standard deviation is a non linear value. In other words you can add variation together but you can't add standard deviations together.

Notice that **Reproducibility** (7.56%) is further subdivided into Operator (2.19) and Operator*Part (5.37). Both sum up to 7.56%.

Ok, what should these values be? Here's a quick table for an easy reference.

	% Contrib. (VarComp)	% Study Variation	Distinct Categories
No issues with Meas. sys.	< 5%	< 10%	> 10%
Depends on criticality can cost	5% - 15%	10% - 30%	4 - 9
Reject Meas. Sys.	> 15%	> 30%	< 4

Total Gage R&R should be 5% or less. The 10.67 percent shown in this case study is marginal. This number indicates that 10.67% of the observed variation for the sample parts is assigned to measurement system variation. Consider using this measurement system only if the process capability is very good.

As a rule, when **Repeatability** is high this usually indicates a problem with the measurement device. When **Reproducibility** is high the measurement method is inconsistent between appraisers.

I hope this quick review was useful. As always, contact me at my website or info@cedar-root.com for more information.

