“GAUGE REPEATABILITY AND REPRODUCIBILITY (GR&R)”

QUALITY TOOLS

Description of GR&R
Gauge Repeatability and Reproducibility (GR&R) is one of the tools in Measurement System Analysis (MSA) to assess precision errors. Precision is the degree to which repeated measurements under the same conditions show the same results.

A GR&R study involves taking one part and measuring it several times, by several different people. Given that the part remains unchanged, any variation in measurement indicates the Repeatability of the gauge and Reproducibility of the measurements by different people. This process is repeated on several different parts to assess the result.

There are two main types of GR&R: 1) Continuous GR&R utilized for continuous data resulting from measuring a product or service characteristic such as length, weight, pressure, temperature, etc.; 2) Attribute GR&R applied for attribute data arising from classifying things such as good/bad, pass/fail, on time/late, etc.

For simplicity, discussion will be focused on Continuous GR&R although the same principle applies to Attribute GR&R.

When to use GR&R
1) Before a measuring equipment is issued for use
2) Routine check to ensure measuring equipment has not degraded
3) If measurement data is suspected to inaccurate
4) When a sound measurement system is required such as before implementing SPC or before conducting designed experiments
5) After repair of the measuring equipment
6) In a six sigma project, during the Measure phase where the quality of the data is evaluated before any measurement and analysis are conducted
7) To measure the need for training in how to use measuring instrument

How to use GR&R
It is not the absolute level of GR&R that is important but the relative level. The acceptability of GR&R results is assessed on the ratio (expressed as %) of the GR&R variation to the process (part to part) variation and to the customer tolerance. Typical acceptability criteria for both ratios are:

- Marginal = < 30%
- Good = < 20%
- Excellent = < 10%
The steps involved in a GR&R study are outlined below:

1) Select part samples
This is the most critical step in performing a GR&R. Select samples that represent the true variation of the process. If necessary, samples are collected over a period of days or weeks to get samples that represent the process. Minimum sample size is 5 but ideal is 10 pieces to be measured three times by three different persons resulting to 90 measurements.

2) Label samples 1 to 10
Samples should be measured in random order if possible.

3) Measure samples
The minimum number of trials per appraiser is two, ideal is three. Have the appraiser measure the 10 samples in random order two or three times. Repeat for the next two appraisers.

4) Calculate % GR&R
This can be accomplished using statistical software like Minitab. Minitab utilizes ANOVA (Analysis of Variance) to show the part-to-part and operator-to-operator variations as well as part-operator interaction. If Minitab is not available, free excel spreadsheets are available online.

5) Determine acceptability
Use the acceptability criteria above to determine if the measurement system is acceptable

6) Take action
If the % GR&R is not acceptable, options available include leave as is and accept the risk or improve the measurement system.

**Tips on use of GR&R**

1. The measurement system should not be altered or adjusted for the GR&R otherwise it does not represent normal condition.
2. Use “actual” production parts and properly mark samples.
3. It is important to select appraisers who routinely use the measuring equipment rather than engineers or quality professionals.
4. Samples should be randomly measured and ideally “anonymous” to the appraiser to prevent any bias.
Application of GR&R

Below is a sample of a GR&R study from http://asq.org/sixsigma/2008/10/gage-r-r-with-anova-xbarr-analysis.html?shl=088720

For template follow the link: http://asq.org/sixsigma/2008/10/gage-r-r-with-anova-xbarr-analysis.html?shl=088720

References

http://chartitnow.com/R&R.html
http://www.qualitytrainingportal.com/resources/msa/grr.htm