**Key Concepts**

◊ MSA Gage R&R is a test of your measurement system, not your parts.
◊ You need **bad parts** to conduct a good Gage R&R study.
◊ Parts in the study should span the distance between the specification limits.
◊ If your parts don’t have enough variation, then the Gage R&R study is invalid.
◊ The NDC metric indicates if there is enough part variation for a good test.
◊ NDC (number of distinct categories) should be ≥ 5.

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**Three Types of Variation**

<table>
<thead>
<tr>
<th>Parts</th>
<th>Equipment</th>
<th>Appraisers</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="cylinders.png" alt="Cylinders" /></td>
<td><img src="measuring_tool.png" alt="Measuring Tool" /></td>
<td><img src="people.png" alt="People" /></td>
</tr>
</tbody>
</table>

% PV
Three Types of Variation
Differences between the parts.

% EV
Repeatability
Can the same person get the same result using the same gage on the same part in two or more trials?

% AV
Reproducibility
Can two people measuring the same part with the same gage, get the same result consistently?

**How to Conduct a Gage R&R Study**

**What You Will Need**

1. Five to ten parts that span the distance between the upper and lower spec limits. The parts should represent the actual or expected range of variation.

2. Two or three appraisers (people who measure the parts).

3. One measurement tool or gage.

**Steps to Follow**

1. Number the parts in random order, not in order of size.

2. Have each appraiser measure each part two to five times.

3. Input the measurements into the QI Macros Gage R&R Template.

4. Is the NDC ≥ 5? If no, your parts are too similar.

**Interpreting the Results**

You want most of the variation to be between the parts, and less than 10% to be caused by the measurement system (appraisers and equipment).

- % R&R<10% - Gage system is okay (most variation caused by parts)
- % R&R<30% - May be acceptable
- % R&R>30% - Gage system needs improvement (appraisers and equipment > 1/3 of the variation)
### Types of Gage R&R Studies included in QI Macros for Excel

#### Gage R&R Study (Long Form) - Type II
- Average and Range Method and ANOVA Method
- 10 parts x 2 or 3 appraisers x 2 or 3 measures
- Calculate the “bias” of a gage using a “target” or “reference” value.
- Calculate if a gage over or under reads across a range of different sized parts.

#### Range Method (Short Form)
- A quick approximation of overall measurement variability.

#### Attribute Gage Worksheet
- For Pass / Fail Gages

#### Bias and Linearity
- **Bias**
  - Calculate the “bias” of a gage using a “target” or “reference” value.
- **Linearity**
  - Calculate if a gage over or under reads across a range of different sized parts.

#### Destructive Testing
- When a measurement can't be repeated because the product is destroyed during the test.

#### Type 1 Gage R&R
- 1 part
- 1 appraiser
- 50 measures

#### Type III Gage R&R
- 25 parts
- 1 appraiser
- 2 or more measures

#### Attribute Agreement Analysis
- Evaluate appraisers making subjective judgments.

#### Analytic Attribute Method
- Assess the repeatability and bias of an attribute gage.

### Advantages of Using QI Macros Gage R&R Template
- Just drop data into yellow shaded input cells.
- Performs calculations and interprets the results for you.
- Red alarm if NDC < 5.
- Reduces risk vs. manual calculations.
- Saves time!

### Example of QI Macros Gage R&R Template

#### Download 30-Day Trial at: [www.qimacros.com](http://www.qimacros.com)