

## The Importance of R&R Studies



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# Measurement Journey



To see the need for R&R studies today and for the future it can be helpful to look back – way back to where metrology came from.

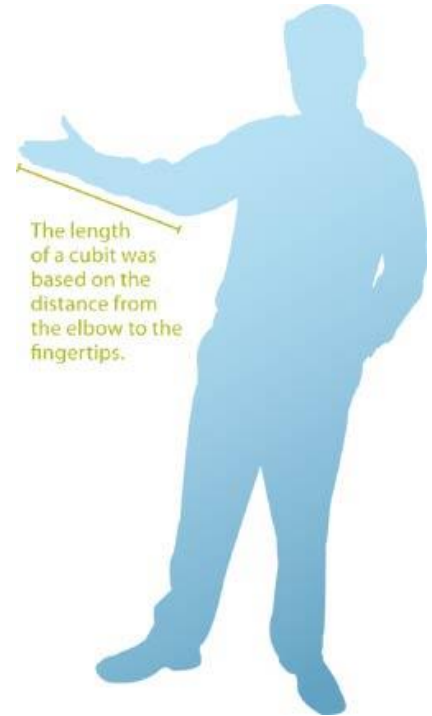
Metrology – the scientific study of measurement(s).

Human invention to help us with scientific endeavors, trade and commerce, construction, and communicating our understanding of the world around us.

# Measurement Journey

Metrology goes hand and hand with the development and advancement of cultures and societies.

- Archaeological specimens and source writings help to determine units of measurement used.
- Cubit, span, palm, finger, nail
  - The human body was the first measurement system
  - That's very problematic!



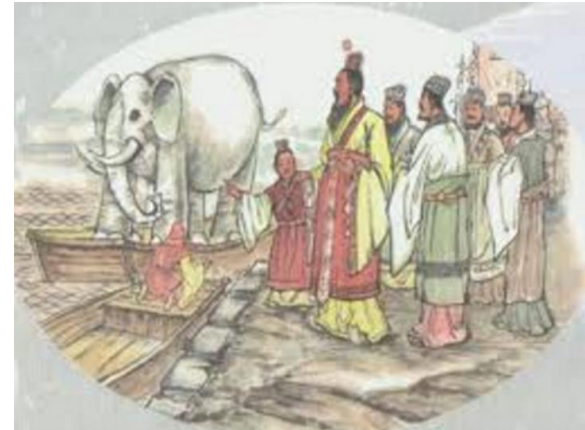
# Measurement Journey

## The Emperor and the Elephant – Chinese folktale

How to weigh the elephant?

A simple technique using stones and a boat!

Archimedes' principle indicates that the upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight of the fluid that the body displaces and it acts in the upward direction at the center of mass of the displaced fluid.



# Measurement Journey



French revolution was a significant step for metrology by helping to formalize the metric system.

Centralizing standards of measurement for various units.

“For all people, for all time” ~ Condorcet

A bale of hay or bolt of cloth was the same in Paris as it was in the rural countryside.

# Measurement Journey

Path to where we are now in metrology has been a meandering road throughout history and its never finished!



Move from established benchmarks to scientific standards.

A second is the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the **caesium**-133 atom.

# R&R and MSA Studies



R&R studies are part of MSA (Measurement Systems Analysis) which all come from the AIAG.

- Commissioned by the Big 3 – Ford, Chrysler, and General Motors
- Began in the late 70's with the publishing of white papers
- First edition MSA manual was first released in Oct 1990
- Currently on fourth edition, released in June 2010

# Onward with MSA studies



MSA studies are one more step in the journey of discovery with real applications to manufacturing and quality efforts.

Techniques or “tools” to help you learn more about your measurement systems.





# MSA Studies

You have various tools in your toolbox.

A simple screwdriver is common; most people know how to use it.

It is like a calibration – checking to see if your gage is measuring correctly against a known reference value.



# MSA Studies

You also might find lots of unique or “special” tools in your toolbox.

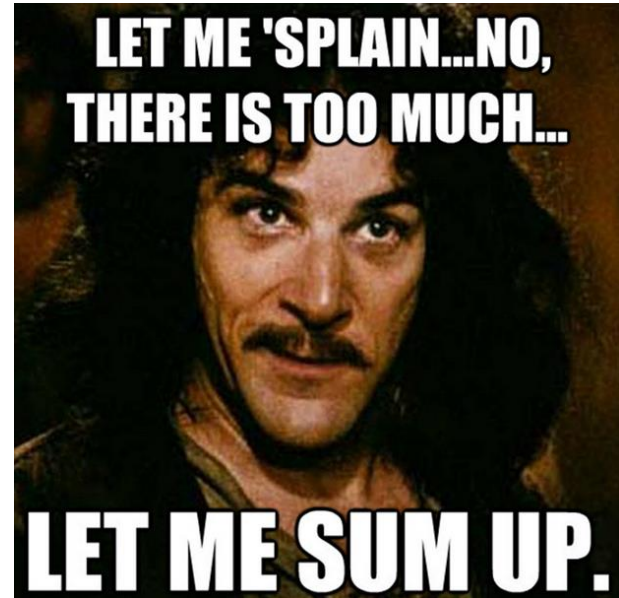


# Variable R&R Study

## Variable R&R studies

Normally I can take up to 3 hours to discuss and review just R&R studies...

So,



# Calibration vs R&R

## Checking for Accuracy – Within Tolerances



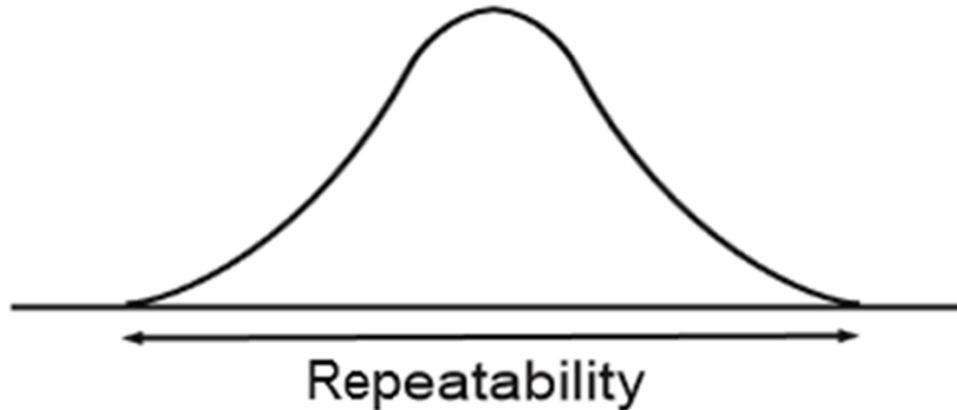
# Calibration vs R&R

An analysis of my ENTIRE measurement system



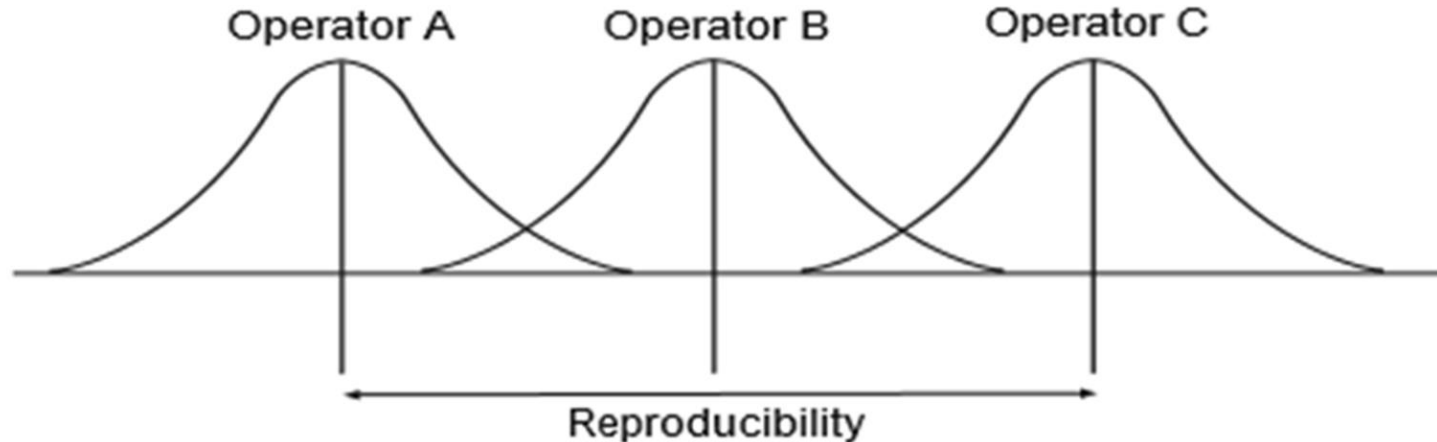
# Variable R&R Study

Repeatability (EV) is seen in multiple measurements by one gage, one person, and one part.



# Variable R&R Study

Reproducibility (AV) is the variation between the averages of different operators.



# Variable R&R Study



Gage R&R combines the variation in the repeatability and reproducibility, to define the capability of the measurement system. The R&R can be compared to the variation in a production process, thereby estimating the proportion of variation due to measurement. R&R can also be compared to the specification to assess the measurement system's adequacy.

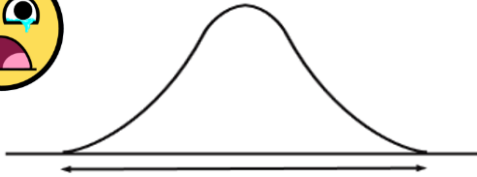
*Just remember this:*

Repeatability (EV) combined with Reproducibility (AV) = R&R

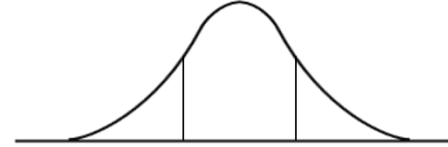


# Variable R&R Study

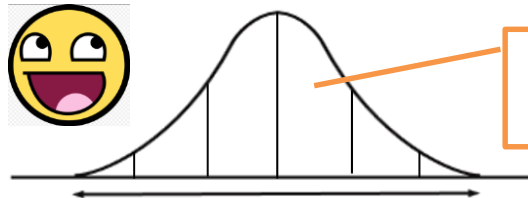
## Number of Distinct Categories (ndc)



1 Data Category



2-4 Data Categories



5 or more Data Categories

Minimum Required  
for R&R

# Variable R&R Study



R&R % is what most managers, customers, and auditors want to see.

0 - 10 % → Acceptable

10 - 30% → Marginal acceptance

30% + → Unacceptable

# Variable R&R Study



## When should you complete an R&R study?

- Whenever a measurement is being used to assess the quality or quantity of a product
- Before accepting a new measurement system
- Comparing an existing and proposed/new measurement system
- To assess equipment suspected of being deficient
- Comparing measurement equipment before and after repair
- To assess the portion of process variation that is due to measurement
- Comparison of measurement systems between a company and their equipment supplier
- Comparison of different instruments/instrumentation on the same process
- Estimating the proportion of process data due to measurement rather than process variation
- Whenever a test result is being used for SPC
- Measurement systems/equipment used at critical decision points
- Comparison to customer methods of measurement
- Comparison to competitor methods of measurement
- Comparison of methods within an organization
- To assess equipment deterioration
- Comparison of different methods of testing
- To assess the impact of changing environmental conditions
- When trying to establish the causes of variation in a production process
- Comparison of two pieces of equipment in the same laboratory
- Evaluating suspect measurement equipment
- To ensure testers keep the same standard of testing and do not deteriorate
- Appraisal of a new tester — to assess whether training has been effective
- To determine if significant differences exist between testers.

WHEN YOU HAVE TO

# Variable R&R Study



Why do an R&R study?

Method for determining if a measurement system is capable of distinguishing (measuring differences) among the units produced by a process.

# Measurement System



- Materials – Pieces/units to be measured
- Machine – Gage or tool used to take measurement
- Method – Procedure followed
- Manpower – Who is taking the measurements
- Milieu (Environment) – Surroundings / climate

# Stages of Variable R&R Study



## Four stages to a study

1. Setup
2. Conduct
3. Compute
4. Analyze

## Who will be involved?

- Administrator
- Operators / Appraisers
- Interested parties

## R&R Study – Results analysis

- Verify the Number of Distinct Categories (want 5 or more)
- Examine the %RR values and the factors contributing to that percent (%EV and %AV)
  - <10% generally considered acceptable
  - 10–30% may be acceptable (room for improvement)
  - >30% not acceptable – need to improve



## R&R Study – Results analysis

Results show an undesirable %RR?

1. Double-check data, verify the validity of the numbers.
2. Examine accompanying charts. This can shed light on main sources of variation or issues.
3. Talk with the team, make an improvement plan, set plan in motion, and finally retest at later date.

# Tools you never knew you had

## Summary

We all have the ability to use these “tools” to discover new things about our measurement systems.

You may not look at your toolbox in the same way...



Thank you



Thank you Dirk and Quality Digest!

