Measurement System Analysis

Measurement System Analysis (MSA)

In Six Sigma we have Five Stages (DMAIC)

- **Define** (We defined the problem)
- **Measure** (We measure the current status of the problem from where we want to see whether changes have been achieved or not)
- **Analyze**
- **Improve**
- **Control**

But here comes the question: if your measurement is not correct how would you know whether you have achieved your objective or not?

So for a six sigma project your measurement should be reliable.

How do we make sure that our measurement is reliable?

How much we can rely on these measurements is the question here, that will be answered by **measurement system analysis**

Measurement System Analysis (MSA)

When we say Six Sigma implementation, we have a data driven approach. Data driven approach means that we don't take decisions based on gut feeling. We take decisions based on measurements, based on facts, based on data. So you collect some information in the form of data and then you make a decision based on that. So to collect that data, you need to have some measurement, a system.

The measurement system consists of these **four parts**:

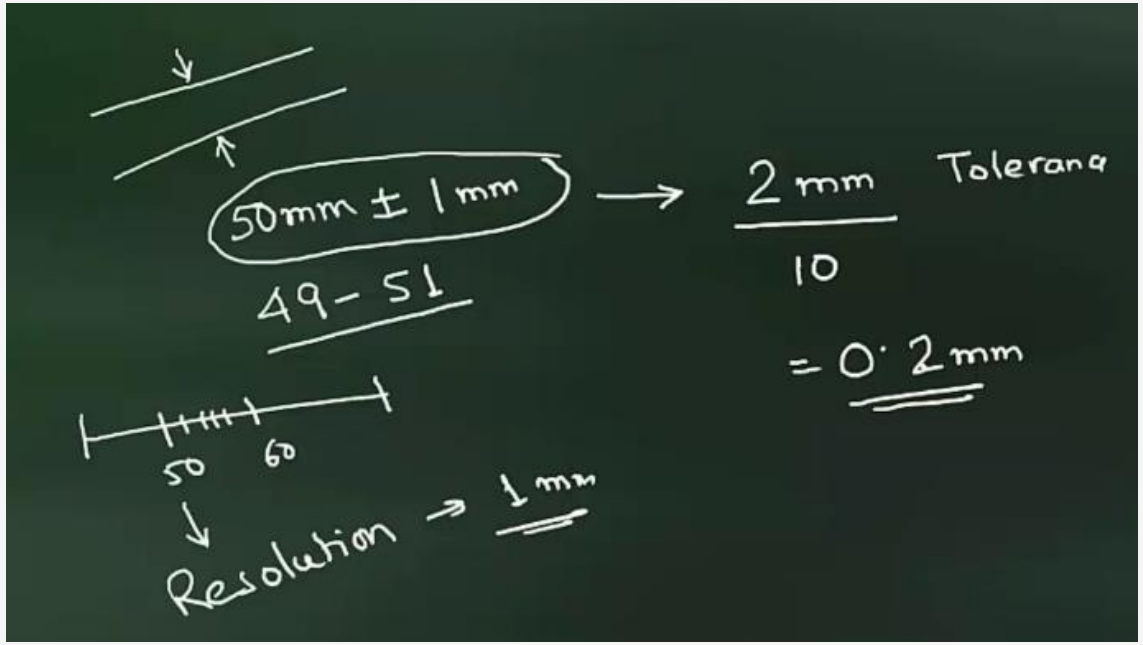
- Measurement Devices or Gage
- Measurement Procedure
- Operators and Training
- Records

MSA – Basic Definition

- **Resolution**
- **Accuracy**
  - Bias
  - Linearity
  - Stability
- **Precision**
  - Repeatability
  - Reproducibility

MSA – Basic Definition

- **Resolution**



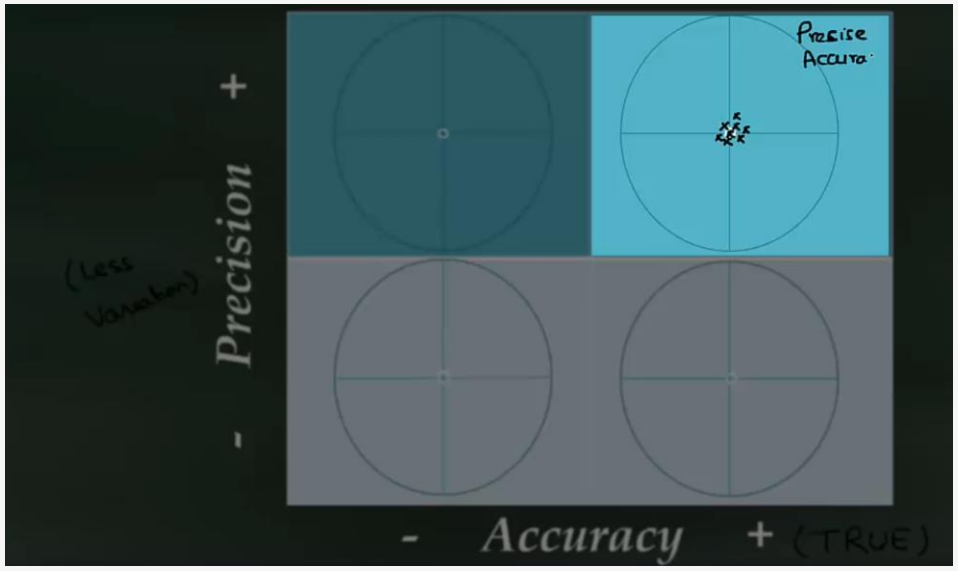
Rule of Ten:

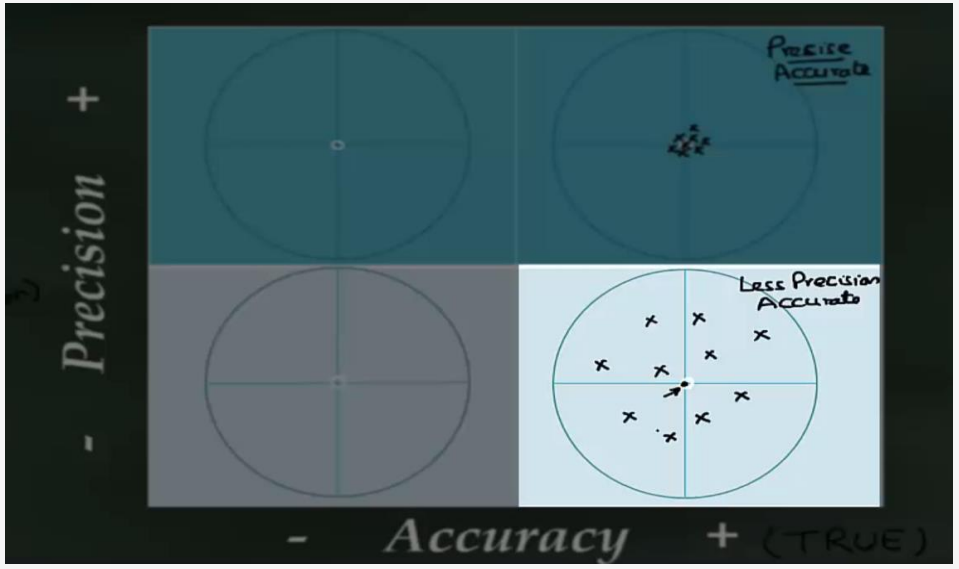
The resolution
of measuring system or the gauge should be
one tenth of the tolerance.

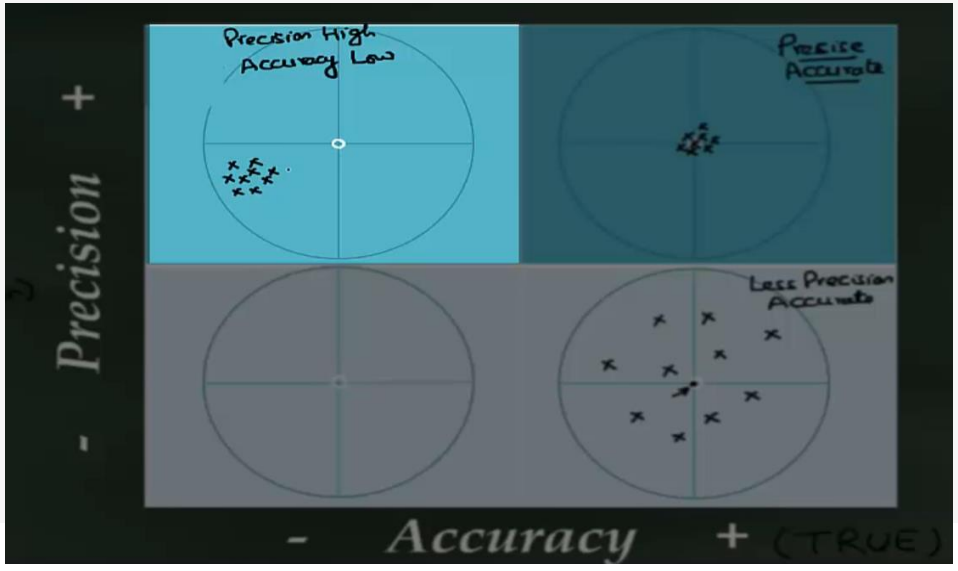
MSA – Basic Definition

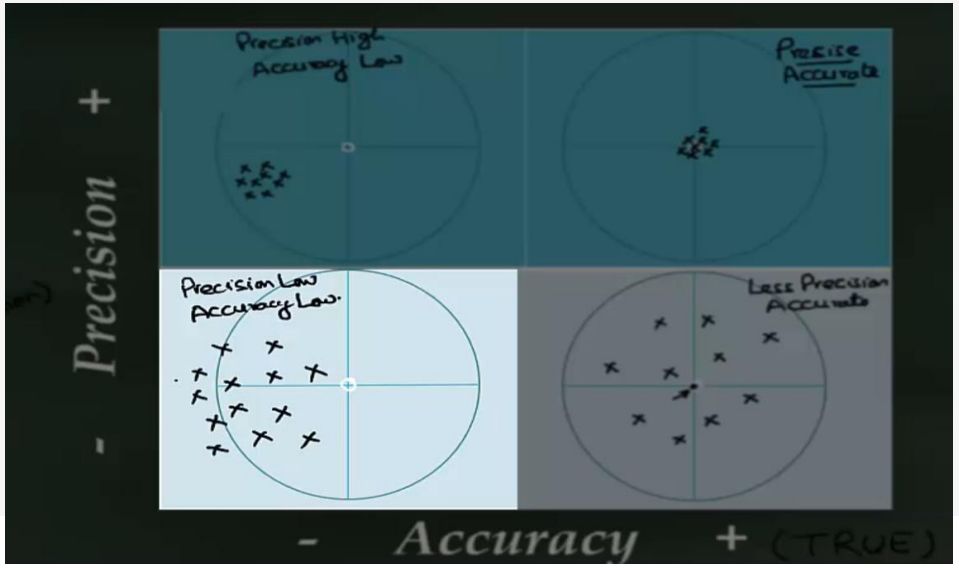
- **Accuracy (On the Average)** -> **[**accuracy is related to the average being close to the true value**]** -> **Close to Mean**
    - Bias
    - Linearity
    - Stability
- **Precision (Consistency)** -> **[**Consistency means the number of readings are close to each other. You don't have too much variation. All the vales are near to each other**]** -> **Related to Standard Deviation**
    - Repeatability
    - Reproducibility

Accuracy vs Precision (Graphical Representation)





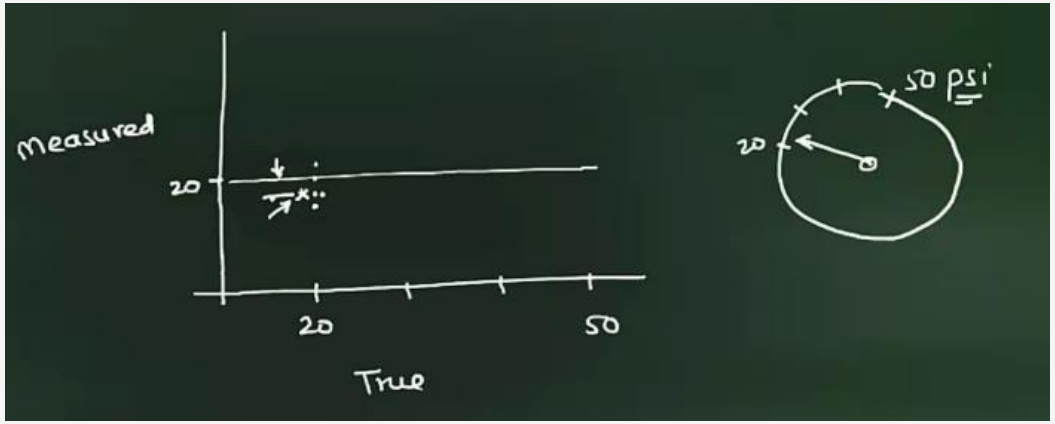


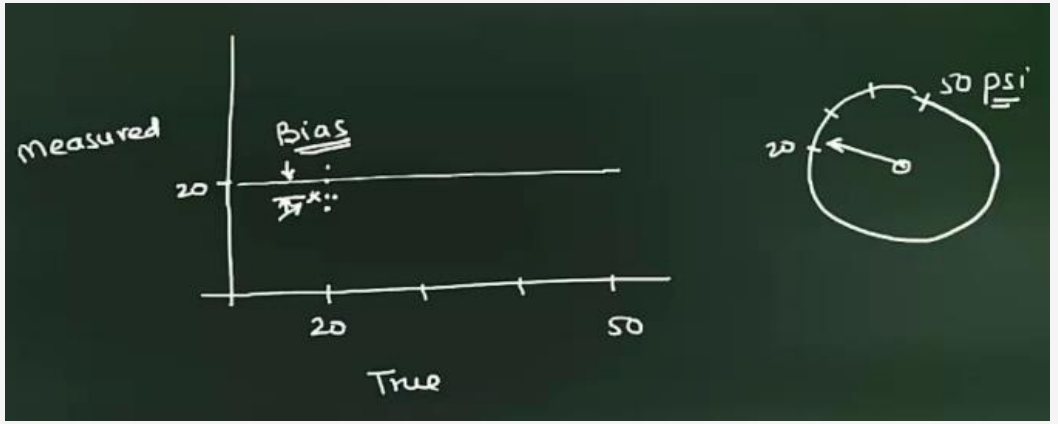


MSA – Items related to Accuracy

- **Accuracy (On the Average)** -> **[**accuracy is related to the average being close to the true value**]** -> **Close to Mean**

  - Bias – is the difference between the gold standard and the average value of measurements.. How much it is deviating from the true value
  - Linearity
  - Stability

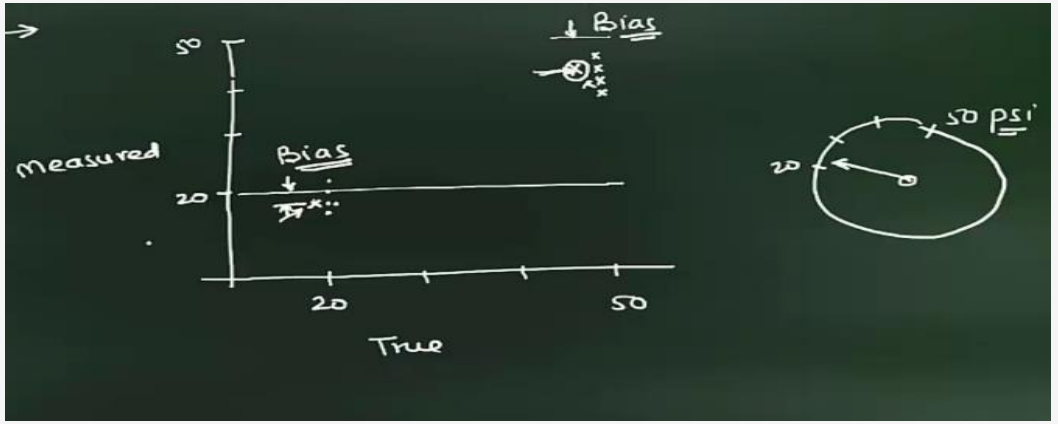




MSA – Items related to Accuracy

- **Accuracy (On the Average)** -> [accuracy is related to the average being close to the true value] -> **Close to Mean**

  - Bias
  - Linearity - when the bias is not seem at all the places, that gives the problem of linearity
  - Stability



MSA – Items related to Accuracy

- **Accuracy (On the Average)** -> **[**accuracy is related to the average being close to the true value**]** -> **Close to Mean**

    - Bias
    - Linearity
    - Stability - is related to the time

so whether you take a measurement today for 20 PSI and then you take the measurement of 20 PSI tomorrow, maybe the next month, the month after that, if there is a shift between that, then it is a problem of stability, then your system is not stable because your measurement is changing with time. So that's the problem of stability.

MSA – Items related to Precision

- **Precision (Consistency)** -> **[**Consistency means the number of readings are close to each other. You don't have too much variation. All the vales are near to each other**]** -> **Related to Standard Deviation**
    - Repeatability – Same Part, Same Operator (variation due to gage)
    - Reproducibility – Same Part, Multiple Operator (variation due to the Operator)

    - Total gage variation = Repeatability + Reproducibility

MSA – Gage R & R Study

Why we need Gage R&R study?

- To investigate:
    - Whether your measurement system variability is small compared with the process variability
    - How much variability in the measurement system caused by differences between Operators (Reproducibility)
    - Whether your measurement system is capable of discriminating between different parts.

The measurement system variation should be 10 percent or less compared to the overall process variability or the part variability. Less than 10 percent is good, but at some places it would see that 10 to 30 percent, 10 percent to 30 percent is also acceptable when the criticality of the part is low. ,

if your measurement system variability is 30 percent or more of the process variability, then your measurement system is not right. You need to change your measurement system. You might need to change your gauges. You might need to change your operators. You might need to train your operators.

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So here you need to understand that when you do this Gauge R&R Study and our study, you don't need to take all the good pieces to do this study.

You might need to **repeat the study** when your process changes, when you're operator changes. In all those cases, you will have to repeat this study to ensure that your measurement system is still effective.

MSA – Gage R & R Study – Crossed vs Nested Study

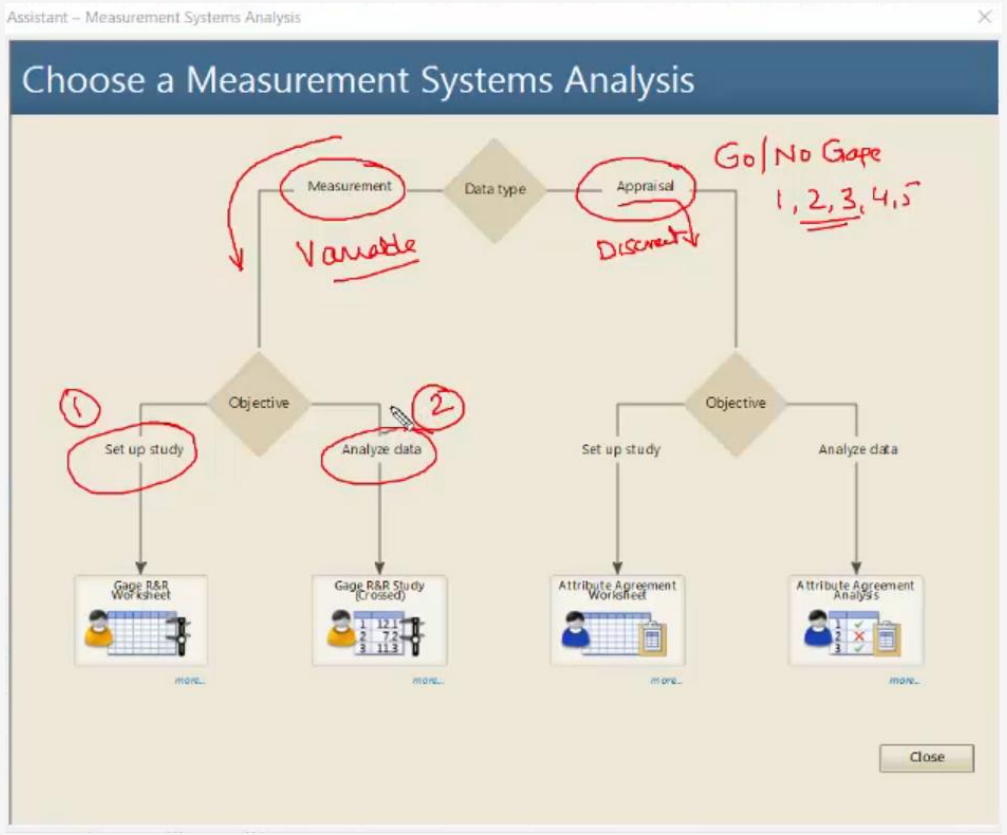
Crossed gage R&R Study

A study in which each operator measures each part.

Nested gage R&R Study

A study in which only one operator measures each part, usually because the test destroy the part, e.g. destructive test, at what pressure the pipe fails, at what pressure the wall starts leaking.

MSA – Gage R & R Study – Minitab



Assistant -> MSA