

Design and Analysis of Gauge R&R Studies: Making Decisions Based on ANOVA Method

Afrooz Moatari Kazerouni

Abstract—In a competitive production environment, critical decision making are based on data resulted by random sampling of product units. Efficiency of these decisions depends on data quality and also their reliability scale. This point leads to the necessity of a reliable measurement system. Therefore, the conjecture process and analysing the errors contributes to a measurement system known as Measurement System Analysis (MSA). The aim of this research is on determining the necessity and assurance of extensive development in analysing measurement systems, particularly with the use of Repeatability and Reproducibility Gages (GR&R) to improve physical measurements. Nowadays in productive industries, repeatability and reproducibility gages released so well but they are not applicable as well as other measurement system analysis methods. To get familiar with this method and gain a feedback in improving measurement systems, this survey would be on "ANOVA" method as the most widespread way of calculating Repeatability and Reproducibility (R&R).

Keywords—Analysis of Variance (ANOVA), Measurement System Analysis (MSA), Part-Operator interaction effect, Repeatability and Reproducibility.

I. INTRODUCTION

THE manufacturing environment, by its very nature, relies on two types of measurements to verify quality and to quantify performance: (1) measurement of its products, and (2) measurement of its processes. Therefore, product evaluation and process improvement require accurate and precise measurement techniques. Due to the fact that all measurements contain error, and in keeping with the basic mathematical expression:

Observed value = True value + Measurement Error, understanding and managing "measurement error", generally called Measurement Systems Analysis (MSA), is an extremely important function in process improvement [1].

Measurement System Analysis (MSA) is a comprehensive collection of tools for the measurement, acceptance, and data or errors analysis which consist of topics such as Statistical Process Control (SPC), capability analysis, and Gage Repeatability and Reproducibility (GR&R). Measurement System Analysis (MSA) is used in order to discern simple and complex measurements of products with physical instruments or even visual inspection. This has a strong relation on human

judgments of product specifications and attributes.

Despite the comprehensive aspect of MSA and the importance of gage control, specialists in productive industries, express their anxiety about the measurement reliability which is used in decision making. Quality of a measurement instrument or method is effective for the validity of a production process and statistical methods based on these data. For making correct decisions, relying on a measurement system and the same for the statistical method used, is necessary as it could be said, when the data quality are low the benefits of a measurement system is also low; likewise when the data quality is high, the benefit is high too [2].

II. PROVENANCE AND REASONS OF MEASUREMENT ERRORS

A simple division for measurement errors resources are the two categories: regular errors and accidental errors. Measuring an instrument's regular errors usually might be done by its constituent or the calibration lab.

On the other hand, accidental errors are those which occur because of the differences between measurement instruments, operators, not a permanent bias in instrument, environmental changes and different adjustments.

Therefore, it would be necessary to analyse measurement capacity by accuracy and precision definitions:

A. Accuracy: Shows difference between the average values of the observed measurement and the actual measurement. As much as this difference is smaller, the measurement system will have the better accuracy and the probable average of distribution measurement would be adapted to the real value.

Accuracy could be divided into three aspects:

1. Stability: Total measurement consistency resulted from a measurement system, while the specification of a part is measured over times.
 2. Bias: Differentiation between averages and actual value of the measured part.
 3. Linearity: Measuring bias values through the expected range of measurements.
- B. Precision: Variation that occurs while measuring the same part with same instrument. The measurement system's precision might become higher, if the variation becomes lower.

Precision could be divided into two aspects:

1. Repeatability (equipment variability): Variation in repetitions measurements of a part using unique

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Design Analysis Of Gauge Rr Studies

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