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White Paper - Measurement Systems Analysis

Updates in the AIAG MSA manual 4th Edition

Automotive Industry Action Group released the 4th Edition of the Measurement Systems Analysis manual. The manual has been updated in terms of more detailed explanations, as well as changes in calculations for studies. New statistical evaluations have been introduced, to make the studies more meaningful. We discuss here, the changes that have been made in the 4th Edition.

Calibration Systems:

In the introductory chapter on Standards and Traceability, a section clarifying the role of calibration systems is added. It discusses the purpose and the process of calibration.

Explanation on evaluating the adequacy of measurement system discrimination:

A short narration on an judging the adequacy of the measurement system from a normal probability plot is added in the section on Measurement issues.

Assembly or Fixture Error:

Under the section of Analysis of Results, a discussion on errors caused by poor gage assembly or improperly designed fixtures is given. This is an additional source of errors to the Location and Width errors discussed in the earlier editions of the manual.

Identifying Measurement System issues from SPC studies:

Under the same section of Analysis of Results, a note is added on how to set priorities of focus of MSA studies. The note explains how to identify potentially unacceptable measurement systems from SPC control Charts.

Comments on actions to be taken for high %GRR measurement systems:

In addition to the acceptance criteria for %GRR based on the 10% and 30% threshold values of %GRR, the manual now gives comments on what possible actions need to be taken for each range of values, and applications for which the measurement systems should be used. The manual reiterates the fact that GRR guidelines as threshold criteria alone, cannot determine the acceptability of the measurement system. Acceptance of a measurement system needs to look at the criticality of the measurement application. This is illustrated through an example.



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Bias Study:

The calculations for bias have undergone a change in the 4th Edition of the manual. Calculation of %EV (equipment variation) has been introduced in the bias study. In the bias study the %EV determines whether the inherent repeatability error is large. The t statistic compares the bias with the repeatability of the measurements obtained. A Statistically significant bias is rejected, while a not significant bias leads to the acceptance of the bias study. However a large %EV is likely to condone relatively large bias values as not significant. This can lead to confusing results. Hence the evaluation of %EV is recommended as a precursor to bias evaluation.

Testing acceptance of a Bias study based on p values is discussed.

Linearity Study:

Similar to the evaluation of Bias, Linearity evaluation also will require %EV calculations to be done. Linearity too is also screened by a precondition of a small %EV. Again, similar to Bias a Linearity evaluation based on large inherent repeatability error may lead to misleading results.

Repeatability and Reproducibility study- ANOVA approach is preferred:

The 4th edition highlights the fact that the ANOVA method of analysis of GRR results identifies the appraiser-part interaction. It is thus recommended as the preferred method of analysis. ANOVA can be performed using a suitable computer program.

R&R studies are now recommended to be done with a minimum of 10 parts.

Calculations are now recommended with the standard deviation focus rather than the total coverage focus.

Repeatability and Reproducibility study- Comparison with the target Ppk:

The earlier editions of the manual recommended that %GRR be calculated with Study Variation, Process Variation or the Part Tolerance. In addition to these three approaches, the MSA manual now recognizes that the actual process variation will be tighter than the tolerance width to the extent of the planned Ppk. The %GRR can be calculated with the target value of Ppk as the base line.

Application of Number of Distinct Data Categories – calculating with the Ppk approach:

Application of nDC is explained in details. Calculation of nDC taking the Pp/ Ppk approach is explained.

Attribute Measurement Systems Study:

The zone of ambiguity around the Upper and the Lower limits is explained in details. Calculations are recommended with a coverage factor of 6 times standard deviation as against 5.15 std. dev recommended by the earlier edition.



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Attribute Measurement Systems Study - Explanation of sample size:

A discussion on sample size and guidelines for sample selection are given in details in this edition.

Attribute Measurement Systems Study- Guidelines based on Ppk:

Measurement system variation can be compared with either the process variation or the tolerance. Guidelines of which comparison should be done are given based on Ppk.

Attribute Measurement Systems Study- Analytic Study:

Calculations for the Gage Performance curve are updated to report the standard deviation of Gage Repeatability instead of the 99% coverage (5.15* std dev) reported in the earlier edition. This is keeping in line with the standard deviation focus to variation that this edition of MSA has taken.

Non-replicable measurement systems:

Explanation for application of MSA on Non-Replicable measurement systems (destructive measurement systems or systems where parts change on use/ test) is provided in an updated format.



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