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GD&T Limitations and Weaknesses

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Abstract: CMSC 2014

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GD&T Limitations and Weaknesses

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Abstract:

This paper presents test results from a project to determine limitations and weaknesses of GD&T inspection techniques and effects. The goal of the effort is to understand how to avoid rejecting good parts or accepting bad parts when using GD&T inspection criteria. The costs of the errors either in the GD&T Standard, its implementation or in measurement process in wasted time, materials and process variability are considerable.

There are numerous aspects and parameters that play roles in any inspection process however the GD&T standard and the way it is used have a number of significant limitations and weaknesses that increase the likelihood of producing unreliable results.

Tests included evaluating the following effects:

1. Datum Extents and Dependence (Small/narrow ill-defined)
2. Feature Sampling Density
3. Use of Max Error (MPE) thresholds as acceptance criteria leads to rejecting good parts vs. Statistical Confidence.
4. Use of Guard Banding to Improve Reliably
5. Effects of a Minimum Datum Alignments leads to rejecting good parts and accepting bad parts
6. Measurement Uncertainty Variation relative to required sampling density
7. Surface Datums vs. Datum Targets
8. Imaginary Feature Dimensions
9. Fitting Features within Envelopes
10. Misuse of Material Condition Modifiers

The results are presented in terms of comparing the probabilities of making either a type I or type II error (i.e., rejecting a good part vs. accepting a bad part). For example when inspection acceptance is based on MPE this leads the inspection process to use a minimum sampling strategy (e.g., flatness using 3 pts) producing unreliable results.

The conclusions show integrating statistical confidence thresholds (Average/RMS/Stdev/Confidence Interval), sufficient and distributed sampling relative to measurement uncertainty increases the reliability of GD&T inspection results. The limitations and weaknesses can be overcome using a simple set of pragmatic metrology practices which are outlined in the body of the paper.