SoftOrient™ R&R

Procedure :

The general procedure for a "AVERAGE AND RANGE METHOD" for a "VARIABLE MEASUREMENT SYSTEM STUDY" as specified in section 4 of the MEASUREMENT SYSTEMS ANALYSIS REFERENCE MANUAL produced by the AIAG

An R&R study was performed using a certified hard fixture with ten parts and three operators. Each part was measured twice with a Sheffield RS5 CMM. Ten surface and trim measurements were analyzed for the study. These measurements were evenly spread about the part, some on or near datum surfaces and others far removed from datum surfaces

The results for the hard fixture are shown below. The range (the difference between individual measurements on the same part for a single operator) for all operators is shown to give an indication of the absolute repeatability of measurements (units are mm). The X-diff (the maximum difference between the mean measurements for different operators) is shown to give an indication of the absolute reproducibility. Rp (the maximum difference between average measurements for all operators for different parts) is shown to give an indication of a the absolute part variation. The percent contribution of equipment variability (EV), auditor variability (AV), gauge repeatability and reproducibility (R&R) and the part variability are shown. In all cases the minimum, average and maximum values are shown

Hard Fixture:

	Minimum	Average	Maxi-
R-bar all	0.002	0.069	0.242
X-Diff	0.028	0.066	0.110
Rp	0.037	0.294	0.635
%Cont EV	1.2	28.1	43.0
%Cont AV	0.2	16.4	84.7
%Cont	5.5	37.4	92.8
%Cont PV	7.9	55.5	94.5

The table shows that the equipment variability and auditor variability can amount to a significant fraction of the total variability. Also the gauge R&R varies greatly over the ten measured features.

A similar study was performed using SoftOrient in place of the hard fixture. Parts were held on a magnet. A CMM program measuring six surface points on the datum surfaces was run. The data produced by this program was used by SoftOrient to produce a part alignment. The same ten point program used for the hard gauge study was then executed. Two operators were used for the SoftOrient study (the value of K2 used in the calculation of AV was adjusted accordingly). Results for the SoftOrient trial are shown below.

SoftOrient:

	Minimum	Average	Maximum
R-bar all operators	0.003	0.008	0.020
X-Diff	0.000	0.002	0.003
Rp	0.015	0.156	0.257
%Cont EV	0.8	6.9	36.0
%Cont AV	0.0	0.0	5.4
%Cont R&R	0.8	6.9	36.0
%Cont PV	64.0	93.0	99.2

The repeatability for an individual operator is improved by about a factor of eight. The reproducibility errors between operators are almost eliminated. For nine out of ten measurement features the gauge R&R contributes less than ten percent of the total variability. The tenth measurement was very close to a datum point. The part variation was very small at that location (Rp 0.015 mm). As a result the repeatability (R-bar 0.004mm) and reproducibility (X diff 0.001mm) although quite small, became a significant fraction of the total variability.