RFM
Resources For Manufacturing, Inc.

CMM's and Accessories <> Video Systems
Manual Gages <> Surface Texture & Geometry
Contract Inspection <> Gage Repair & Calibration

P.O. Box 751432
Dayton, Ohio 45475
Ph: (937) 436-4699
Fx: (937) 436-9244

Removing Linearity From Measurements

I often find out that more and more, folks are using digital equipment for measurement, even to the extent that they cannot read Vernier scales or even a pair of dial calipers with any degree of accuracy. Since we seem to be moving in the direction of the digital readout, here is a method that will remove any linear measurement error from the gage you employ to inspect your parts.

Linearity can be removed from the measurement being taken by turning your digital equipment into a direct comparator gage. This is accomplished very easy by making a gage block stack to the exact size of the measurement to be inspected. That is, to the nominal dimension given on the blueprint. This technique has a couple of advantages.

First, by "zeroing" the digital gage to the nominal dimension represented by the stack of gage blocks, all the dimensions will be + or – numbers from that reading. An example would be as follows:

Nominal Dimension	=	2.2255
Gage block stack	=	2.2255
Zero the gage on the stack	=	0.0000

1st	part measured	=	+ 0.0002
2nd	part measured	=	- 0.0001
3rd	part measured	=	- 0.0002
4th	part measured	=	+ 0.0003

Second, the deviation from nominal is very easy to recognize as well as the range of that deviation and the mean value is also easily seen. Consider the difference of trying to decipher the dimensions when written as actual size.

1st	part	=	2.2257
2nd	part	=	2.2254
3rd	part	=	2.2253
4th	part	=	2.2258

Thirdly, it is much easier to record deviation from nominal and to enter the data when that data is in the format of the former example.

A fourth benefit is that by zeroing out the gage at the nominal dimension, there is a minimizing effect on any linearity contained within the gage because you are now not measuring from the instrument gage origin.

In the example of a tenth reading micrometer, suppose the last time it was calibrated, the micrometer scale was verified at various points along the scale with the following results.

At 2.0000 the reading was 2.0000
At 2.1000 the reading was 2.1001
At 2.5000 the reading was 2.1002, and remained that way throughout the rest of the scale.

This micrometer has a linearity of 0.0002, because linearity is defined as the largest deviation from a measurement standard minus the lowest deviation from the measurement standard. Thus in this case, 0.0002 – 0.0000 = 0.0002.

Therefore, by eliminating measuring from the instrument origin, we can eliminate linear error from the gage. This could be verified by creating gage block stacks that equate to the expected range of deviation from the nominal dimension that the parts were produced. In the example above, stacks would be made at 2.2253 and 2.2258 and compare the reading at those dimensions in order to verify that the gage was picking up this range of measurement accurately. Now lets move on to how to create those gage block stacks that will enable you to transform your gage into a comparator gage.

Step 1: From the blueprint, ascertain the nominal dimension.

Ex: 2.2255.

Step 2: On a sheet of paper, write this dimension leaving adequate room beneath for numerous calculations.

Step 3: Select the wear blocks from the set, usually 2 ea. of either .050 or .100 and subtract this amount from the target value.

2.2255
-0.1000 (2, .050 wear blocks)
= 2.1255

Step 4: Select a gage block that will remove the amount of the last decimal place. Subtract .1005 from the remainder.

2.1255
-0.1005
= 2.0250

Step 5: Select a block that will remove the next decimal place.

2.0250
-0.1250
= 1.9000

Step 6: Select a block that will remove the next decimal place.

1.9000
-0.9000
= 1.0000

Step 7: Select the 1.0000 gage block to complete the stack.

Step 8: Ring the gage blocks together by applying sufficient pressure while sliding and twisting until they are held together without falling apart and in such a way that the two .050 wear blocks are on either side of the stack.

Now bring the anvils of the micrometer into contact with the gage block stack and wring the anvils to the gage block stack and "zero" the micrometer. Open the micrometer and remove the stack. You are now ready to begin taking measurements.

Note: To verify the expected range, replace the .1005 block with a block equal to the expected high end of the range and compare the reading. Repeat for the low end of the expected range.

To insure good readings and easy to collection of measurement data, make this technique a regular method of inspection at your place of business.