Wavefront Issues to Address for ANSI US Standard: 6/25/06

1. Slope requirement for a surface or wavefront:

Slope specifications are currently written as follows:

A slope value is calculated for every pixel in the data acquisition array based on the following relationship:

Y-slope = pixel above minus pixel below divide by two.

X-slope = pixel left minus pixel right divide by two.

Slope Mag = SQRT $[(\text{Y-slope})^2 + (\text{X-slope})^2]$

The result is in fringes/pixel or nm/pixel etc. The value is further converted to fringes/mm or nm/mm by multiplying this result by pixel/mm.

This method for defining slope is adequate for smooth wavefront functions where the change in pixel values is small. Also, when the part diameter is small, the pixel/mm value can get large which in turn gives large values for slope in terms of nm/mm even for small changes in pixel values due to erroneous data acquisition "noise", rendering the specification technique ineffective.

2. Smoothing:

Common methods for smoothing data are convolutions or polynomial fitting. This is a common practice for surface and wavefront measurement applications to suppress the influence of data acquisition "noise" sources.

Convolution smoothing - Every pixel in the data acquisition array is averaged by itself and all of it's adjacent neighboring pixels. Therefore 9 pixels would be averaged except for edge pixels. This would be defined as a 3 by 3 averaging kernel, which represents the 3 row and 3 columns of pixels.

Convolution kernels can be increased to 5 by 5, 7 by 7, etc. etc, at the cost of suppressing higher frequency spatial features in the data acquisition array.

Polynomial Fitting — The use of a polynomial such as the Zernike polynomial can be used to report the result of a surface or wavefront as a function of a least squares fit of the acquired data. This will sufficiently suppress all spatial content that is beyond the degree of the polynomial used.

3. Datapoint Statistical Analysis:

The peak-to-valley (PV) or slope specifications are highly influenced by the value of all pixels in the data acquisition array because the result reported is the maximum value obtained within the array, which can involve thousands of individual pixel datapoints. It is common to report the number ofdata points acquired in the data acquisition array that fall outside of some threshold limit, and further statistically evaluate the number ofpixel datapoints that fall within the threshold limit as a percentage.

Erroneous noise sources that exist in data acquisition can have a detrimental effect on the value reported for PV and slope to name a few. A percentage of all datapoints that meet a defined threshold value can be assigned to the specification of single pixel dependent tolerances.

4. Universal Units Definition:

Historically, wavefront and surface units are reported in waves or fringes. This method for defining results is ambiguous unless the wavelength is defined as well. The metric of nanometer does not rely on the definition of the wavelength.