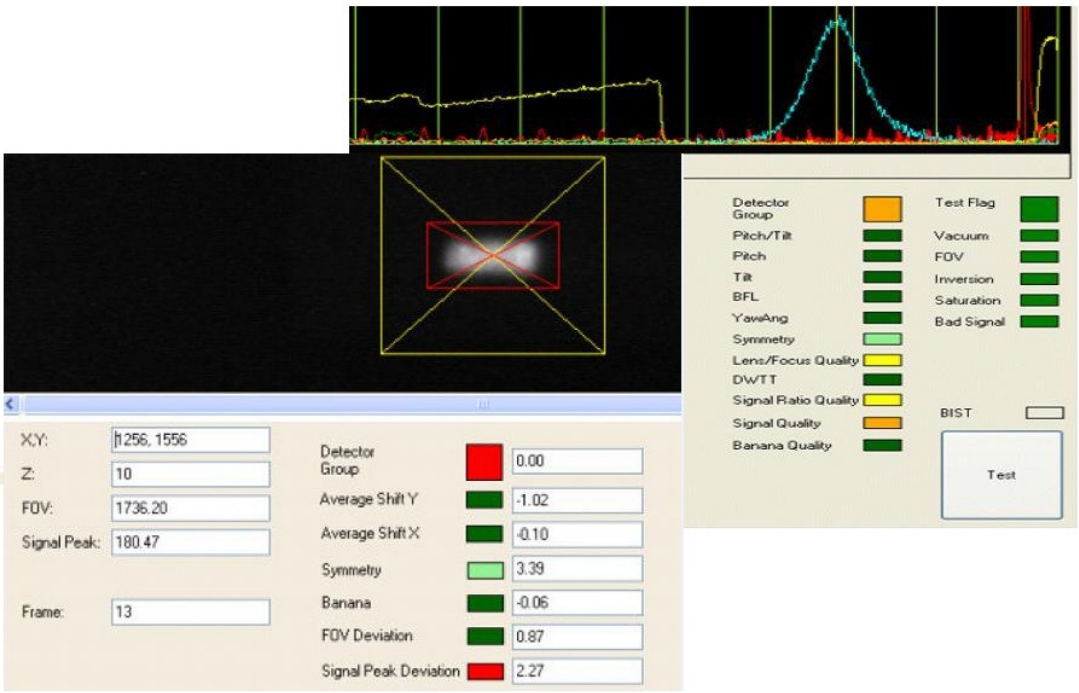
# Process control using parametric testers

by: Yuval Sharon M.Sc. CSTM Ltd
Website: www.cstm.co.il, Email: yuval@cstm.co.il




**Abstract:** The article suggests that systematic parametric testing of a manufacturing process has a significant advantage in increasing the yield, and its effect becomes noticeable in cases where the process is not finalized.

**About the author**: Mr. Sharon serves as the CTO of CSTM Ltd, a Jerusalem based engineering company that specializes in undertaking engineering projects that combine optics, mechanics and electronics, Mr. Sharon holds an M.Sc. degree in applied physics from the Hebrew university (1992) and a B.Sc degree in Electro-Optics from the Jerusalem College of Technology (1984)

## Custom Parametric testers

Unlike single threshold (Go-NoGo) based testers, parametric testers provide quantitative data which relate to the level of the product quality, and thus allows to:

a) monitor the distribution of relevant parameters which characterize the process for $C_{PK}$ analysis and SPC.

b) flow the shifting of the properties of a specific process work point with time

c) sort the resulting items (Grouping)

d) generate a direct product quality based feedback

## Definition of a Parametric tester

A parametric tester can be defined as a tester possessing the following characteristics:

*1)* ***Ability to sample several parameters simultaneously*** - the reason for this request is that in most cases we do not know initially what are the quality parameters for controlling the process, and usually when the sampling is carried out it is possible to obtain from it several simultaneous parameters of which one is likely to prove better than the others. Therefore when designing such a tester it is a good custom to enable multi-parameter sampling if it does not cost too much.
Example - for instance if illumination uniformity in a camera is of interest, it is possible to define parameters such as: Standard deviation of the illumination in the four corners, the difference between the average of the four corners and the middle, the min-max difference in illumination in the entire field.
Another example - In case the boresight error is of interest and the shift of the image upon the detector is sampled, several parameters may be considered: the 2D linear shift of the image, the 3D angular shifts between the optical axis to the mechanical axis, and the curviness of a straight line.

*2)* ***Direct feedback for grouping*** - this feedback can be used for batch preparation for the next step in the process or to disqualify items from entering the next step in the process or to match an item to be used in a specific type of product. In general any grouping or binning of the resulting items will always improve the final yield.

*3)* ***Data log generation*** - enables offline work by the process engineer

*4)* ***Built in test*** - enables a simple built in test procedure using golden samples.

## Process control using parametric testers

A parametric tester enables the process engineer and the QA engineer - who are responsible for the yield - to carry out the following actions:

- Investigation of points to improve the process - by introducing a change in the process and systematically checking the obtained result.
- Search of a robust work point
- Failure analysis - post failure search of a trace of any gradual deterioration of the selected work parameters (to understand the cause and effect)
- monitoring of selected parameters - to detect any process instability due to existence of parallel competing processes.

## Example of a problem solved by a parametric tester

A custom tester for monitoring the quality of an injection molded miniature camera, was used for final testing of the assembled camera. The quality of the final camera was sensitive to changes in two angles, Tilt and Pitch, which were monitored to an accuracy of 0.25mRad.

- Tilt - is defined as the angle of rotation of a target image about the optical axis
- Pitch - is the linear vertical shift of a target image relative to its desired position divided by the focal length of the lens (a kind of Boresight angle)

Fig.1 shows raw results of gathering the Tilt\Pitch data for a batch of cameras

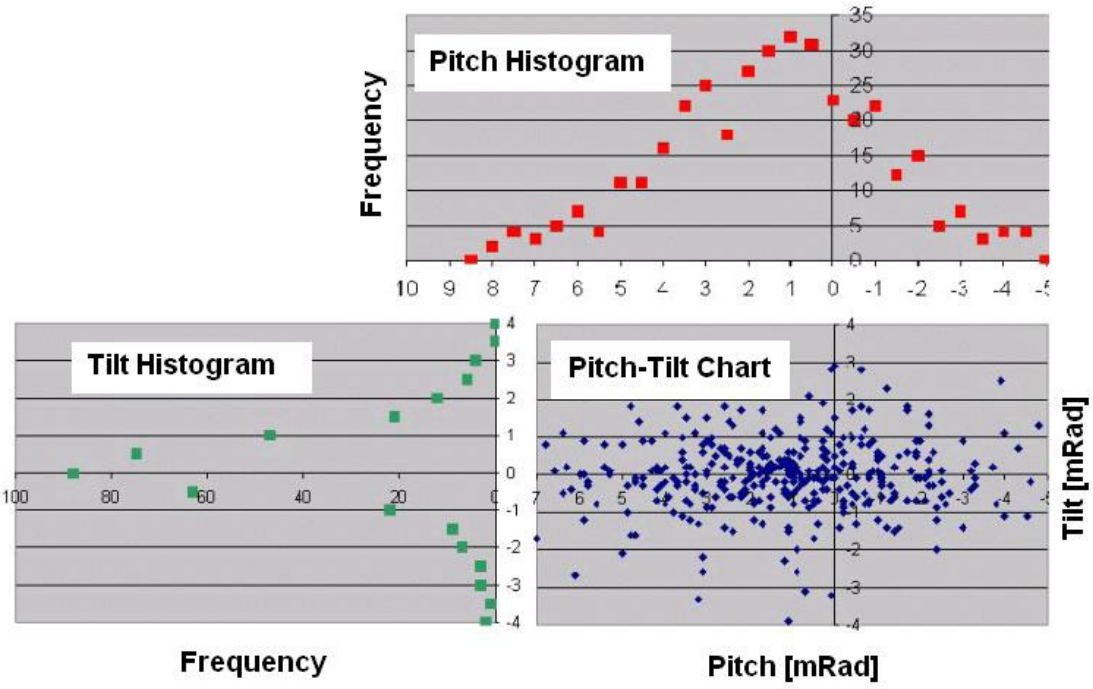



**Fig.1**: Boresight measurement in cameras - monitor the Optical to Mechanical axis alignment

The results in blue are the raw results, and green and red results show histograms of the Tilt angle and Pitch angle respectively.

These Histograms are seen to be close to a bell curve as expected. Furthermore, it is seen that the Tilt curve is closer to a bell curve than the Pich curve, and much more centered. Therefore, it was decided to carefully monitor the more stable Tilt, to see if any changes occur during production.

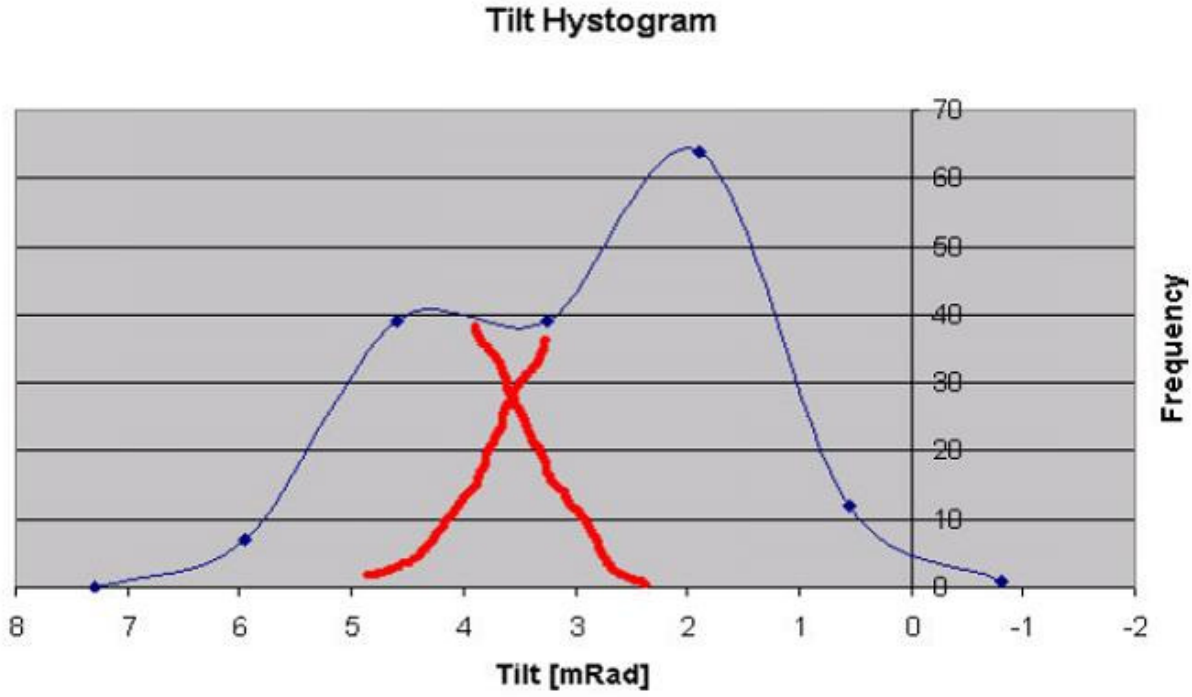



**Fig.2**: Parametric test jigs supply quantitative results for monitoring process stability

Search for a stable working point revealed a state in which the production hits instability. The tester discovered (see Fig.2) a split of two competing sub-processes which was expressed as two overlapped bell curves. This discovery suggested that the injection process was oscillating between two modes. Finding and rectifying the problem increased the yield.