

High-Definition Metrology and Vision Application Note #09-03

Measurement of Multi-Surface Relationships on Parts

The Powertrain Challenge



Photo of a multisurface part

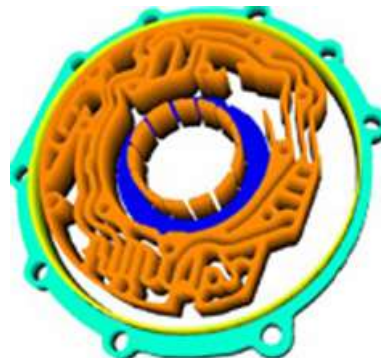
The co-planarity, parallelism, distance (pocket depth or separation), concentricity, angularity, and other 6-degree-of-freedom relationships among the multiple surfaces on certain parts can determine whether or not they will fit, assemble and perform satisfactorily. Many surfaces may be involved in a single part. The correctness of their relationships needs to be verified quickly if wasted downstream production costs, reduced production output and continuing scrapping of faulty parts and assemblies is to be avoided. Examination and micron-level measurement of all of the entire critical surfaces is needed if the true relationships are to be reliably and accurately verified. The cost of some parts, like the one shown to the left, is sufficiently high that spills and scrap can have significant adverse manufacturing cost impact.

The Metrology Need

Multiple surface segments may exist on a part that all need to be co-planar. In other cases the parallelism of two displaced surfaces must be verified. In a third class of applications, surfaces



The face of a pump housing with three surface planes required to be parallel



around a part axis or future shaft opening must be concentric. The surfaces may be on the same side or on opposite sides of the manufactured part.

To be useful, the set-up of the diverse multi-surface relationship measurements required for different parts must be quick, straightforward and not require any computer programming skills.

The Measurement Requirements

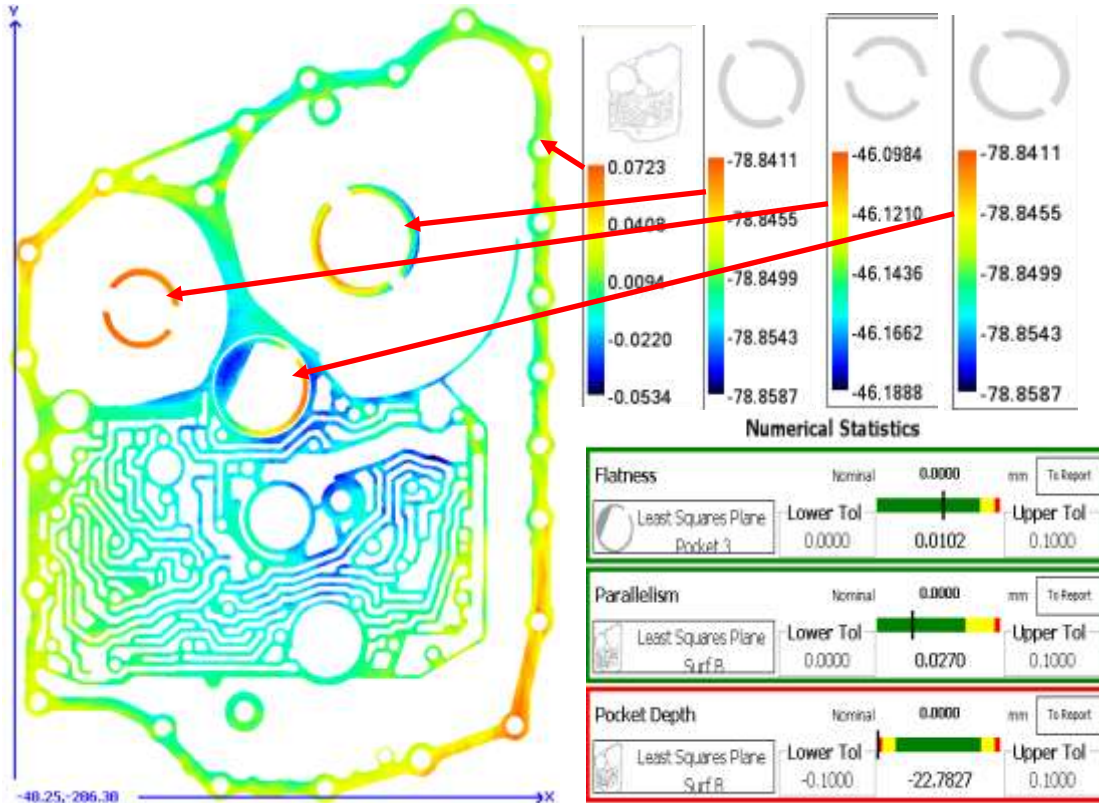
To ensure that measurements consider each part surface's complete shape, high-definition measurement of each entire surface is required to an accuracy of 1 micron in seconds. The measurements must rapidly produce information regarding over-all surface flatness, and the 3D orientation of each surface in a single coordinate system. The measurement result must clearly and accurately indicate any locations on each of the part surfaces where the surface relationships violate specified tolerances. Three-dimensional color-coded visualization is required to make obvious the nature and the amount of any deviations from correct local or global relative surface orientations. Reports must be transmitted to any required plant manufacturing data base system.

The Coherix Solution

The **Coherix ShaPix Surface Detective™** produces a height map with a resolution of 44 surface samples per square millimeter throughout the surface area of interest. Large surface areas are combined accurately via a software 3D “stitching” process to provide a complete 3D view of the complete part that can be manipulated to be seen from any perspective. Part surface relationship values and their variations are color coded for easy interpretation. Surfaces not simultaneously visible are related through the use of supplied fiducial devices embedded in the part fixturing.

The ShaPix Results

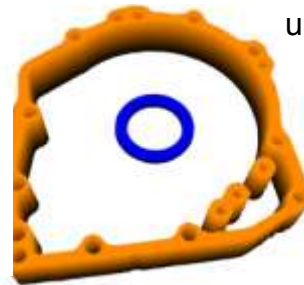
The **ShaPix Surface Detective™** shows, in an immediately obvious visual form, the shape and relationships of all of the part surfaces that have been specified to be measured. In addition to these easily-manipulated displays, **ShaPix** provides any desired detailed multipage reports of operator-specified measurements and multi-surface relationships, with the report automatically formatted as the set-up operator required.



Multi-Surface Imaging – Parallelism, Depth and Profile



Multi-surface depth and parallelism measured



The Powertrain Value Delivered

In a single launch program phase, the **ShaPix Surface Detective™** holographic interferometry system saves many times its cost for the system integrator, as well as the powertrain manufacturer to achieve shorter time to market and lowered launch cost. Ongoing measurements ensure tight and accurate process control. The minimal one-time interval needed to set-up **ShaPix** to measure a new part type – typically 20 minutes with no programming required – allows **ShaPix** to be used repeatedly to speed launches of every mating part and surface in a transmission or engine system.