

High-Definition Metrology and Vision Application Note #09-01

Dynamically Directional Waviness

The Powertrain Challenge

The leakage susceptibilities of engine blocks and cylinder heads from combustion gases,

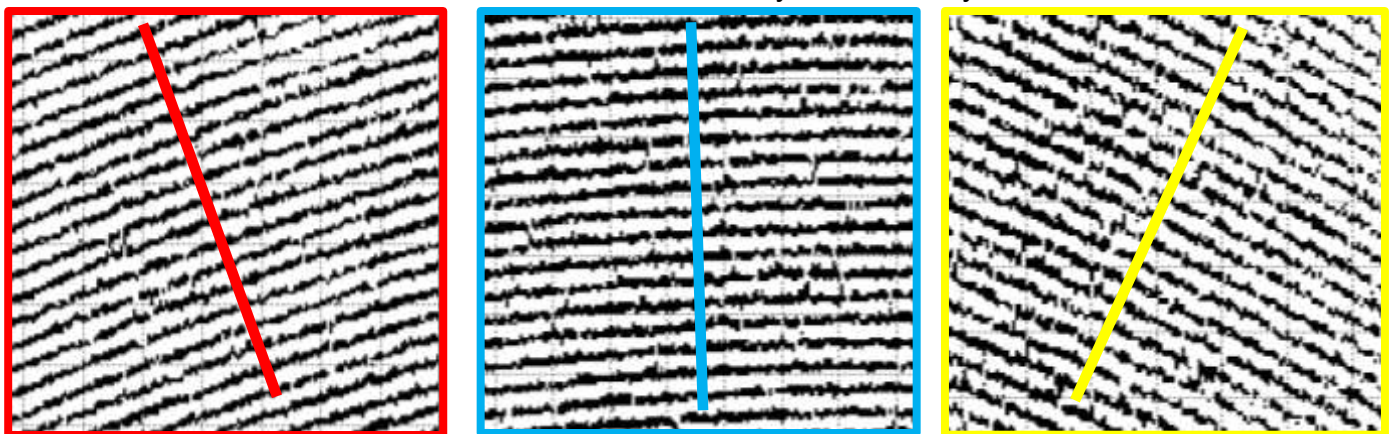


lubricants or coolant fluids are determined by the waviness of the machined mating surfaces and the conformability of

the gaskets that are required to seal between those surfaces. Fuel economy, emissions, regulatory compliance and customer satisfaction are all adversely affected if leakage occurs.

The Metrology Need

The primary waviness of such surfaces is caused by curved tool marks left by the multi-insert rotating cutter tool as it progresses across the part surface. Measurement of waviness across the entire surface in seconds is needed to produce reliable and complete indication of the leakage paths on the mating surfaces. The relevant waviness measurement will be one in which the direction of the evaluated waviness metric is adjusted at every point to be always oriented along the lay of the surface – perpendicular to the local cutter tool mark direction. The purpose of the measurement is to determine the leakage cross section that will exist if a particular gasket design is used on the cylinder head and engine block mating surfaces. This requires that the surface height be measured with high definition at every point on the surface. Then that height data must be waviness-filtered in the correct directions, which vary continuously across the entire surface.

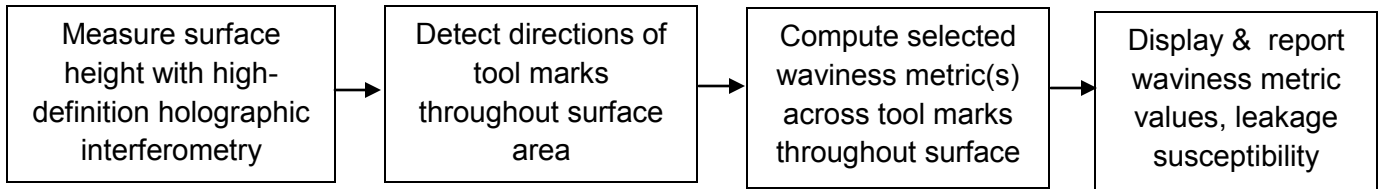


The Measurement Requirements

Waviness metrics are discussed further in another application note. The requirement is to be able to measure waviness to cutoff wavelengths as short as 0.8 mm over the entire cylinder head or engine block surface to an accuracy of better than 1 micron in a period of a minute or less. Waviness evaluation in the correct direction relative to the tool marks is critically required.

The Coherix Solution

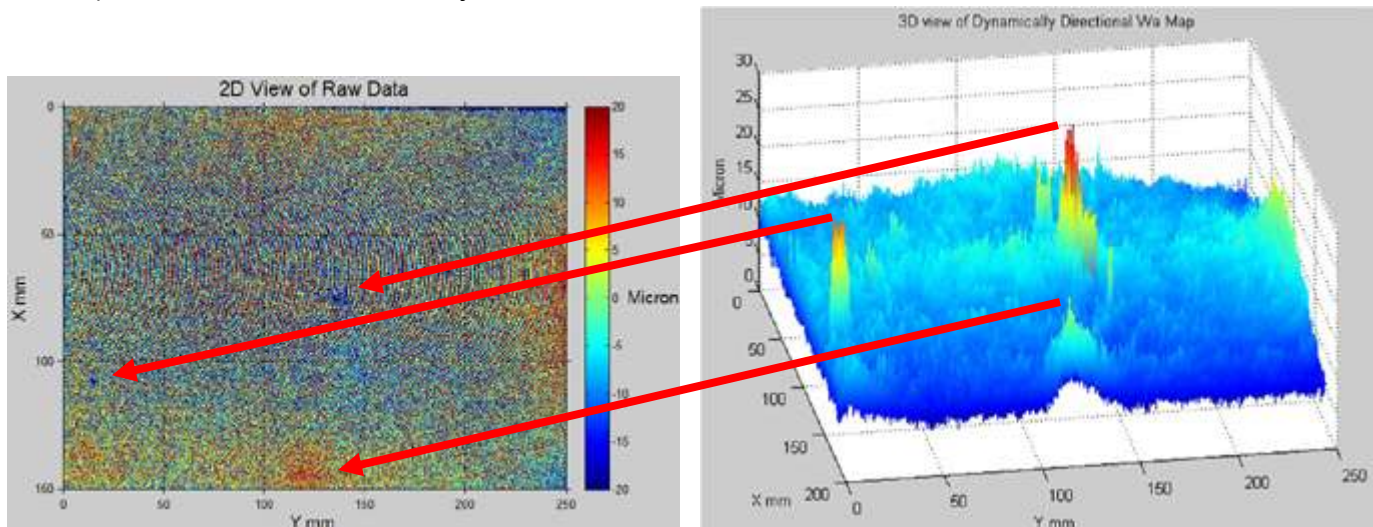
The **Coherix ShaPix Surface Detective™** produces a height map with a resolution of 44 surface samples per square millimeter throughout the surface area of interest in 30 to 60 seconds. This high-definition sampling is sufficient to capture the entire surface waviness spectrum. ShaPix then identifies the direction of the tool marks everywhere on the surface. It then measures the specified waviness metrics for the patches or gasket bead paths that the set-up operator has specified and can also measure the waviness everywhere on the surface when complete leakage paths are desired to be found and measured.



ShaPix Dynamically Directional Waviness Measurement

The ShaPix Results

In addition to quantitative numeric reports of waviness metrics and leakage cross-sections, **ShaPix** provides an interpretable visual picture of the dynamically directional waviness of the surface, making the locations of waviness issues immediately obvious and enabling remedial action. The pictures below show an example of the color coded original surface height map data for a surface area produced by **ShaPix** and the 3D dynamically directional waviness map for the same surface also produced by **ShaPix**. Three corresponding points in these images where peak waviness (W_a values) occurred are indicated by the arrows.



The Powertrain Value Delivered

Measurement of leakage potential prior to engine assembly reduces costs, reduces scrap, and enables immediate adjustment and control of the machining process. It ensures a higher-quality product that will incur lower post-delivery warranty maintenance costs and provide greater customer satisfaction.