



3980 Ranchero Drive Ann Arbor, MI 48108-2775  
734-761-8989 Fax 734-761-9193 [www.coherix.com](http://www.coherix.com)

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

# Accurate Prediction of Engine Leakage Using Virtual Gasket™ Technology

### The Powertrain Challenge



Leakage susceptibility of an engine's mating surfaces and associated gaskets involves the combination of the machined surfaces' waviness and the conformability of the gaskets that are used. Traditional waviness metrics, such as  $W_t$ ,  $W_a$ ,  $W_q$  or others, are inadequate to provide quantitative measurement of leakage susceptibility. Detection of leakage caused by poorly machined parts only during later engine system assembly and pressure testing is costly, wasteful and does not prevent additional parts from being poorly machined.

### The Metrology Need

Accurate and timely detection of leakage susceptibility requires simulation of the interaction of the intended gaskets with the machined mating surfaces that the gaskets seals. Measurement of waviness across the entire surface in seconds is needed to produce a reliable and thorough indication of the leakage paths on the mating surfaces. The measurement must be able to accurately predict the leakage susceptibility and indicate the specific location and the amount of the leakage cross section that will likely exist if a particular gasket design is used between any particular cylinder head and engine block mating surfaces.

### The Measurement Requirements

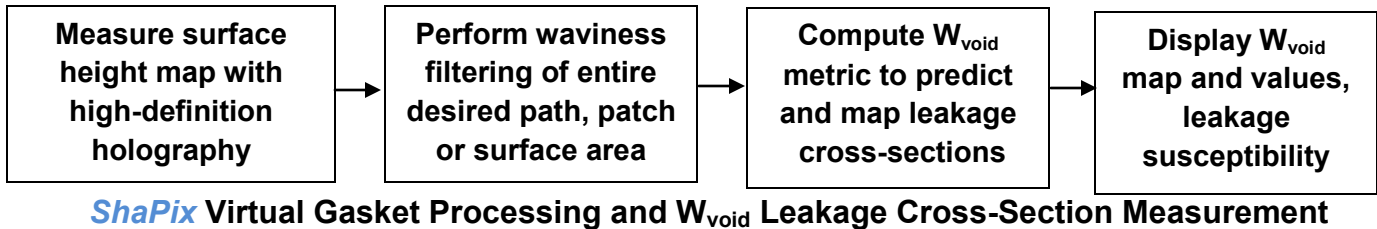
The leakage susceptibility of a mated assembly of surfaces is well-represented using a validated mathematical model of the gasket that specifically simulates the radius of curvature of the gasket under pressure. The requirement is to be able to measure waviness to cutoff wavelengths as short as 0.8 mm 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. The  $W_{void}$  waviness metric, developed by Dr. Mark Malburg of Digital Metrology Solutions, provides the only known measure of leakage susceptibility.



The Malburg  $W_{void}$  metric, incorporating a virtual gasket simulation, clearly and quantitatively portrays where, and to what degree, the waviness of a machined surface and a specified conformability of a gasket will not seal and will be susceptible to leakage of combustion gases, lubricant or cooling fluid.

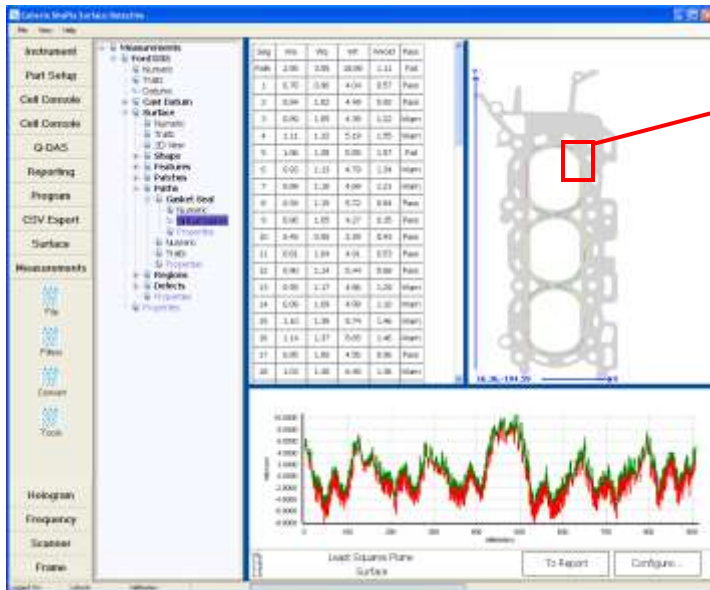
## The Coherix Solution

The **Coherix ShaPix Surface Detective™** produces a complete surface height map with a resolution of 44 surface samples per square millimeter throughout each mating surface's area of interest. This high-definition sampling is sufficient to capture the entire surface waviness spectrum. Performing waviness-filtering using the user-specified cutoff-wavelength, **ShaPix** evaluates the metric,  $W_{\text{void}}$ , to accurately measure the leakage cross-section along any specified gasket bead path, or patch, or trace, or across the entire surface. (Traditional metrics' values can also be produced to provide proof of correlation with older obsolete methods.)



## The ShaPix Results

In addition to quantitative numeric reports of one or more waviness metrics and the  $W_{\text{void}}$  leakage cross-section measurement, **ShaPix** provides an interpretable color-coded visual picture of the  $W_{\text{void}}$  values along the specified path, patch, trace, or surface, making the locations of potential leakage issues immediately obvious and enabling remedial action.



The gasket bead leak path section shown to the immediate left is the same as that for which the highly enlarged  $W_{\text{void}}$  leakage cross-section trace is shown on the first page, showing failed and passed segments of the overall gasket bead path. The **ShaPix** display can be dynamically enlarged or otherwise manipulated to examine any portion of the entire mating surface. Reports of leakage susceptibility can be formatted to suit the user. Leakage prediction measurements desired for any new type of part can be set up in 20 minutes and stored by an operator for repeated use with no programming required.

## The Powertrain Value Delivered

Measurement of leakage potential prior to engine assembly avoids wasted costs, reduces scrap, and enables immediate adjustment and control of the machining process before the additional cost of engine assembly is incurred. It enables leakage susceptibility measurement long before pressure testing would detect that more leak-prone parts have been machined. It ensures a higher-quality product that will incur lower post-delivery warranty costs and higher customer satisfaction. In this way, **ShaPix** provides greater customer satisfaction that ultimately results in repeat sales and profitability.