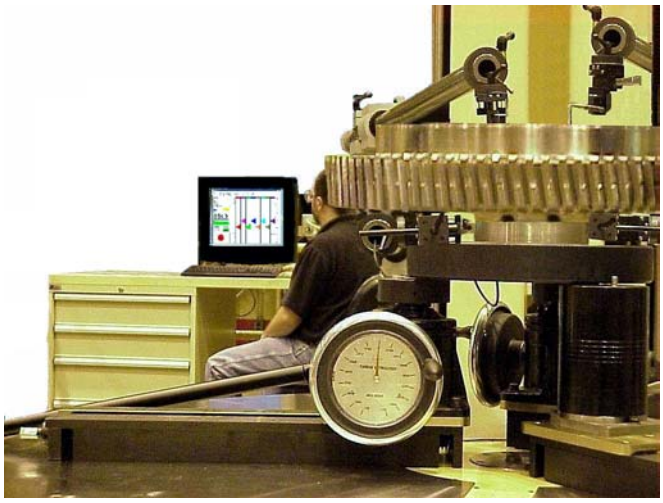
Metrology

Paragon or Paradigm?

New Digital Gauging Offers Entry-Level Users a Choice of Technologies



Advancements in digital technology now make it possible for Circular Geometry Inspection Systems to be constructed that offer an entirely digital signal chain from the gauge head to the computer. These systems, often built up of modules to handle gauge head and inspection table positional inputs, may offer Users additional flexibility as well as lower initial hardware costs as compared with existing analog systems. But how do they compare with analog systems in terms of performance?

A decade ago digital gauging technology was not sufficiently developed to be used for CGI in any meaningful way. Digital gauge heads, as an offshoot of SPC technology, had very long response times, severely limiting the amount of data that could be taken. Using RS-232, these systems often had maximum throughputs of 5 - 10 total readings per second, meaning that the acquisition rate of a four channel CGI system using a quadrature encoder to determine angular position was just 1 – 2 readings per surface per second. Considerations of statistically adequate sampling aside, to obtain the standard 3600 points per measured surface (1/10th degree resolution) would have meant part run times of one hour and for Paragon's high resolution 36,000 points per surface mode, ten hours. Clearly this was inadequate for realistic testing.

Recently digital systems have been introduced that have increased acquisition speed nearly a thousand-fold (3000 readings/sec), enough to make the digital option attractive for some situations. Clearly the 5 volt output of a digital gauge head can be much more immune to electronic noise than a low-level analog signal, and digital signals can be sent a longer distance without fear of degradation. If over-sampling is not required to enhance accuracy, data throughput is well above the speed constraints imposed by the mechanical components of the CGI system.

Turbine Metrology designed its Paradigm system for a major US automotive supplier. This Customer required multiple workstations in a shop-floor setting and did not require the ultimate in accuracy, but had a definite budget restraint. In addition, the Customer's testing requirement was for only two surfaces. In this situation TM's existing analog **Paragon** CGI system, with high-speed

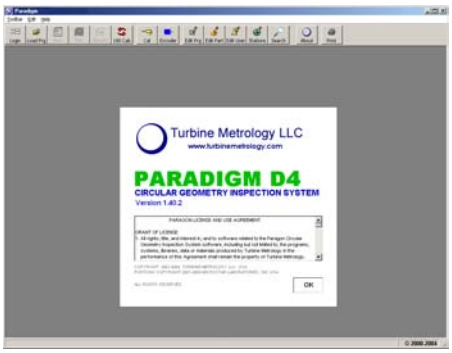
simultaneous sampling hardware and a minimum of 8 input channels, was an overly complex solution. A modular digital solution could accommodate only two channels of gauging. The digital **Paradigm** solution was therefore more cost-effective and provided accuracy within the Customer's requirement.

For ultimate accuracy, however, the digital solution still lags behind. Even the thousand-fold increase in speed enjoyed by the new digital hardware is really not sufficient to provide enough readings (oversampling) of each point to give a statistical meaningful representation of the point. And sampling, after all, is critical to accurate measurement. Because all calculations done by CGI systems, regardless of type or manufacturer, must use standard mathematical calculations based on ISO standards, what makes one system superior to another, then, is the speed at which the surface can be sampled, the sampling method employed, and the number of times the surface is sampled to create a final value.

For most CGI systems currently on the market, sampling is a primitive procedure. When the processor receives a signal from the inspection table telling it that is in the proper position for reading the part surfaces, the appropriate inputs are read once, or at the most twice, sequentially. Considering that the reading is subject to analog-to-digital conversion accuracy of +/- 1 LSB, aperture jitter, and a number of other factors, it becomes obvious that one or two readings of each point, sampled non-simultaneously and containing processor interrupts, does not offer a statistically valid data set. While specs published for some digital gauge heads indicate theoretical accuracies in the range of .000001" (.025 microns), as a practical matter, whether with **Paradigm** or a similar digital product, real-world accuracy is not as good as that achieved by an analog system sampling hundreds or thousands times more data. The same could be said for any analog system (regardless of the resolution of the A/D converter) that limits itself to one or two non-simultaneous readings at each point.

Recognizing this, TM's **Paragon** system was designed around hardware that allows simultaneous sampling of each part surface at a rate of up to 153,600 times per second – better than 150 times the maximum data rate that can be achieved by current digital systems. Run from a dedicated on-board microprocessor with an A/D converter for each channel, **Paragon's** simultaneously sampled data is also free from operating system and processor interrupts which create data skew. Twin Digital Signal Processors insure input to the A/D converters is free from noise or other sources of error prior to the conversion process.

Which type of system is right for your needs depends on your budget and the level of accuracy you require. If the advances in speed digital systems have achieved in the past decade continues, in another decade they will surpass analog systems in their throughput. For right now, however, the speed of the analog CGI systems still makes them the best choice for ultimate accuracy.



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