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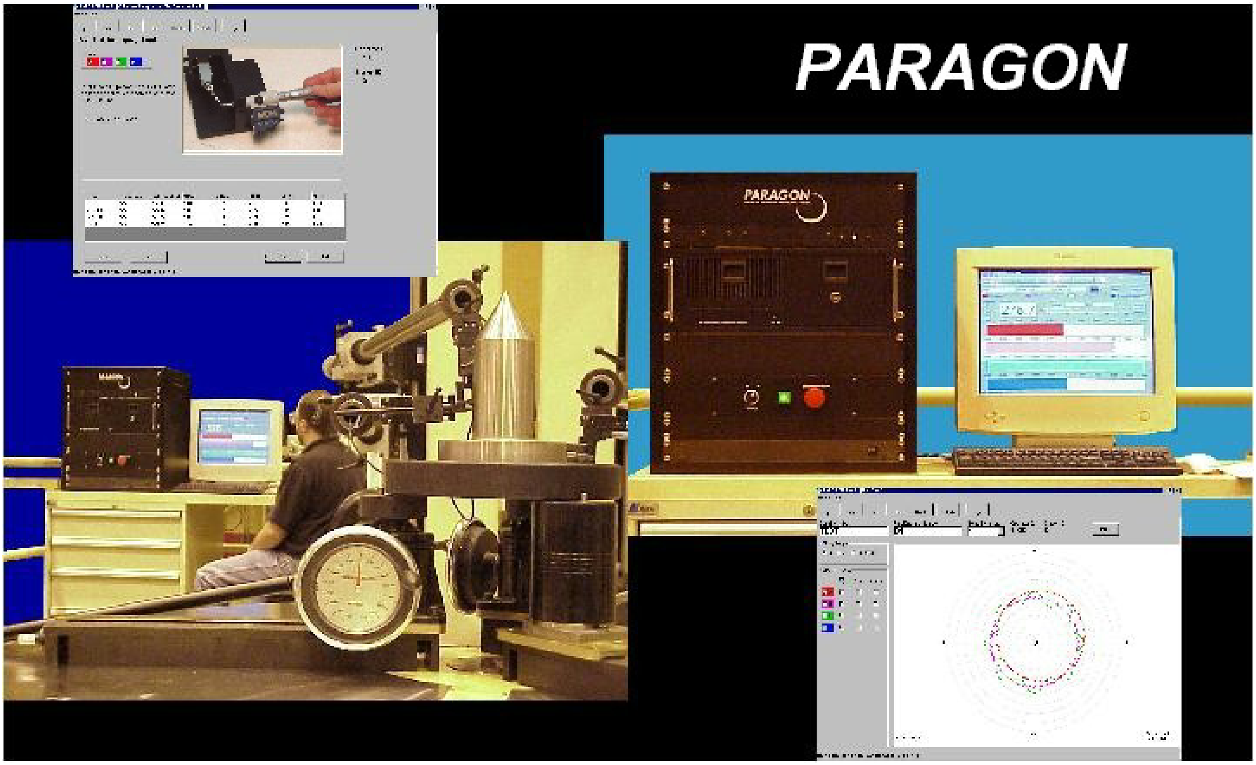

High Accuracy Turbine Rotor Measurements Eliminate $150,000 Stacking Errors

A new PC-based metrology system that accurately measures huge gas turbine components can save $150,000 in rework costs for each stacking error it prevents. Circular geometry measurements of rotors for gas turbine generators are important because the accurate assembly of these components has a critical impact on bearing life. Previous systems have proven less than satisfactory at this task, primarily because of the large number of data points that need to be collected to accurately determine runout, concentricity, eccentricity, and flatness of the parts, and because of the conditions under which those measurements must be made. Turbine Metrology's PARAGON system solves this problem by acquiring over 1.2 million samples per second, making it possible to perform all the necessary measurements in a single revolution of the part. Key to the success of the new unit is an iDSC 1816 data acquisition processor (DAP) board from Microstar Laboratories, Bellevue, Washington, that simultaneously collects and processes eight channels of data without requiring any low-level attention from the host PC. This makes it possible to quickly and thoroughly evaluate the huge rotors as soon as they are machined so that rotors can be stacked up with others whose dimensions complement their own to produce smooth-running turbines.

The rotating parts of a turbine rotor unit range up to 96 inches in diameter, 120 inches in length, and may weigh up to 25,000 pounds. During assembly, approximately 24 of these components are stacked up and bolted together to form the spinning core of the power generation unit. The accuracy of these components is critical to the performance of the finished unit. If each part is only a few thousands of an inch out of flat, for example, the accumulated tolerances will result in a "stack" in which the bearing surfaces are out of alignment, leading to premature bearing wear and possibly catastrophic failure. Using current manufacturing methods, it is virtually impossible to build these massive parts to small enough tolerances that they can be simply bolted together without inspection. Instead, turbine manufacturers attempt to accurately measure each of the many rotors in the assembly and then match them up based on their flatness measurements in such as way that the entire "stack" will run true. This creates a major measurement problem: the large physical size of the parts means that an enormous number of data points must be collected in order to accurately characterize them, yet currently high production volumes leave very little time to perform the necessary measurements. Making these measurements on the shop floor, in an environment of high vibration and noise, adds an additional challenge.

Previous attempts at rotor measurement

Early attempts to perform circular geometry measurements involved small, laboratory-type machines capable of reading only one surface of the part at a time. This made the measurement and correlation of multiple surfaces a very tedious process. A few systems have been designed to measure and compare two to four surfaces in near-real time but these systems are either slow, based on flawed algorithms, or not suitable for use in a production environment. In addition, these systems do not collect the number of data points necessary to allow adequate filtering of the signals and cannot produce "clean" data set sufficient to characterize large parts. While it would be possible, with a one or two channel system, to collect more data by making consecutive readings of single surfaces and comparing them later, this approach is unsatisfactory because of the difficulty of absolutely indexing signals from different revolutions. Added to this is the fact that increased amount of setup time would make it difficult to meet production volumes.

Turbine Metrology set out to solve these problems by designing their new PARAGON system from the ground up. The key, according to Neill Fleeman, Technical Director of the firm, is the ability to collect far more samples in a single revolution. “I have been working on this problem for a decade and have seen first-hand the many unsuccessful efforts to resolve it,” Fleeman said. “The mechanical aspects of the process are difficult; these large and heavy rotors must be centered and rotated accurately enough to prevent their runout from affecting the measurements. But the hardest part has always been processing the enormous volume of data required to thoroughly characterize parts of these sizes while eliminating the influence of external seismic and acoustic inputs. I have seen systems that were down more than they were operating, that created larger errors than they were trying to measure, and that gave results that were based more on noise than on actual part geometry. Since restacking an assembled rotor can cost upwards of $150,000, these measurements are critical. When I finally had the opportunity to start addressing this problem with a clean sheet of paper I decided to take a different approach.”

The net result is a system that can fully characterize the turbine rotors with respect to runout, eccentricity, concentricity and flatness by collecting 720,000 measurements in a single revolution. The manufacturer of the rotors now can accurately determine their dimensions at an early stage of the manufacturing process. Rarely will the turbine manufacturer determine that the dimensions of the piece make it impossible to use; in most cases, they will find that the rotor is within specifications and, because they will have its precise dimensions, they will be able to match it with other complementary rotors in order to produce a final assembly that will run true enough to maximize bearing life and avoid costly tear-downs. Turbine Metrology already has sold five of the highly specialized PARAGON workstations to rotor and turbine manufacturers that are anxious to take advantage of these unique capabilities.

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