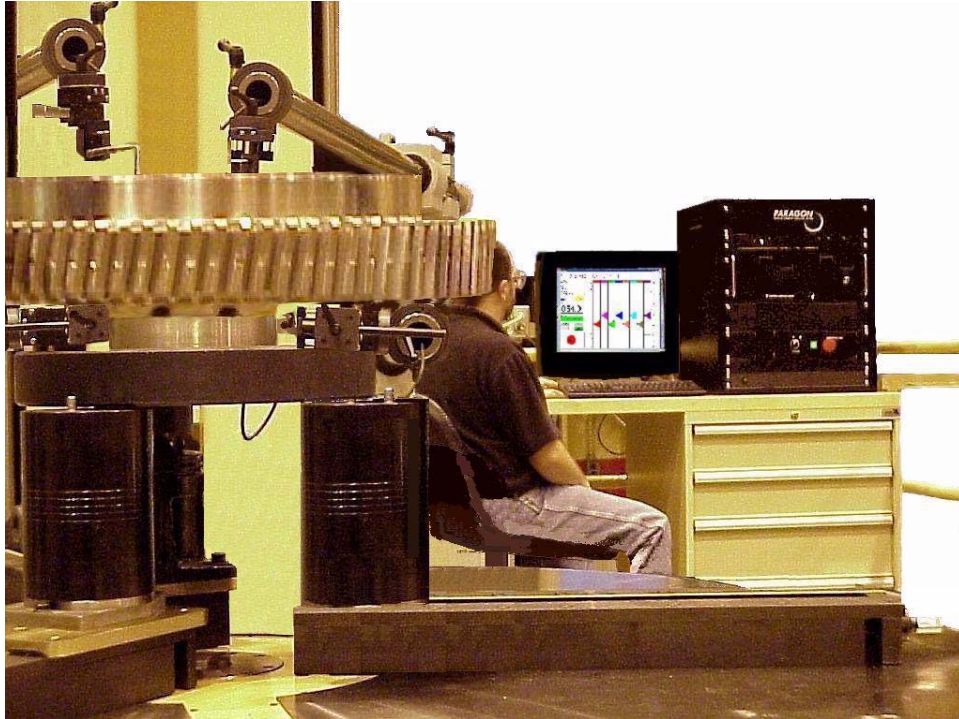


Perfection on a Budget

New Paragon V2 system saves tens of thousands of dollars in equipment investment by utilizing customers' existing manual spin tables and eliminating fixturing.



For the smaller shop or the turbine manufacturer converting from manual methods, the investment in hardware required to support new computerized roundness measurement equipment may be considerable. New motor driven inspection tables with X-Y centering and leveling are usually required, along with a new set of fixtures to suit the table. In addition, with the motor driven tables come safety considerations and requirements for light curtains, pressure mats and emergency off switches. **Turbine Metrology's** new second-generation **Paragon Circular Geometry Inspection System** minimizes these expenditures, however, by eliminating in most cases the need for part leveling and centering, and motor drives, with all their accompanying headaches. For the shop on a limited budget or in transition to this new technology, considerable savings have been realized by allowing use of existing simple manual "spin" tables in conjunction with the new electronics.

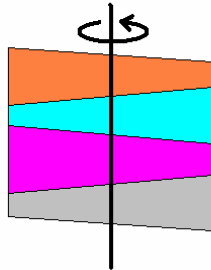
Background

Manufacturers and re-builders of turbine units for power generation and aerospace require accurate measurements of the turbine rotor's component parts in order to determine the optimum assembly orientations for these parts. Built by stacking one component on top of another, slight variations in the parts can lead to considerable misalignment at the end of the stack and out-of-balance mass distributions which will lead to poorly performing engines with high vibration levels. By very accurately measuring the components, however, a computer program can be used to predict orientations of the parts in which the wiggle in one part compensates for the wobble in another.

Possible random stacking outcome



Oriented stacking



Assembly using this method has led to a dramatic reduction in engine assembly problems in recent years, and increasingly service shops are adopting the new technology. But the measurements have to be very accurate and up until now the requirements to achieve this accuracy were complex and expensive.

LEFT: Random stacking may lead to assembly problems. Oriented stacking leads to better balanced, smoother running rotors.

In the old days, measurements for stacking were done by measuring the mating surfaces of a component in eight or twelve places using a dial indicator or an electronic gauge head. Components were located on a manual spin table by dedicated fixturing bolted as closely as possible to the rotating center of the table. Taking only a few points, and with no means to eliminate the effects of off-centered part placement and part tilt, these measurements were crude, inaccurate, of little statistical significance, were not correlated to each other, and were prone to human error since the indicator reading was recorded manually, usually with pencil and paper.



RIGHT: A technician checks a turbine wheel by means of an electronic gauge head and analog scale. The wheel rests on a manual spin table (out of frame).



New Technology

LEFT: The Paragon system shown will collect one hundred thousand times more data on each surface than the method above.

Modern systems introduced computer driven data acquisition of an increased number of surface points, often on more than one surface at a time, and allowed the measurements to be correlated and mathematically corrected for off-centeredness and tilt. The measurement of 1000 or 2000 points on each surface went a good deal farther in characterizing the parts' mating surfaces and helped contribute to good stacking.

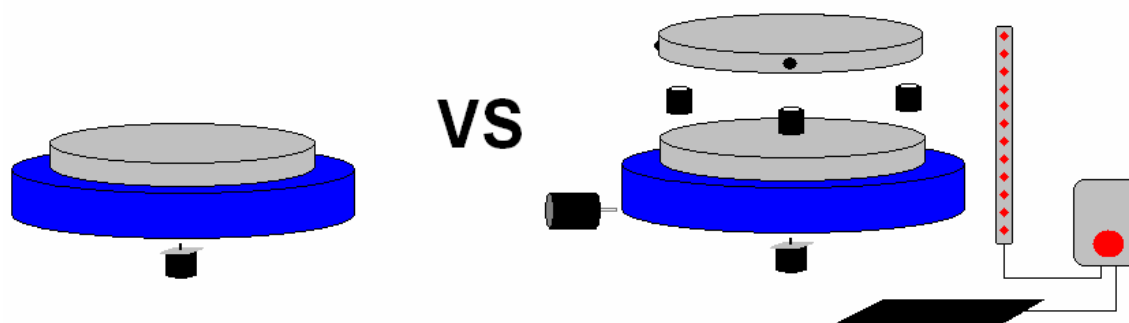
However, all but the smallest and simplest of these systems required the use of expensive new motor driven inspection tables with motor drives and X-Y centering and leveling platens. As the pricing for these very precise mechanical components can account for 40% - 60% of the cost of the entire system, small manufacturers and shops often found the costs of these modern systems prohibitive.

Therefore, when the General Electric Company approached Turbine Metrology LLC in 2000 with regard to the design of a new state-of-the-art roundness system, TM Technical Director Neill Fleeman wanted to simplify the mechanical requirements for these systems by utilizing electronic and computational techniques beyond the current generation of metrology systems. He proposed to do this by utilizing a

combination of speed and processing power not previously seen in the industry. (See the article in *Engineering* magazine, October, 2002 issue entitled "Perfect Circle").

Debuting in 2001, TM's Paragon system has set the modern standard for data collection by making over one half million readings to characterize 3600 points on each part surface. Due to Paragon's multiple microprocessor structure and Digital Signal Processors (DSPs), rock solid, statistically relevant data is delivered to the mathematical algorithms in a steady stream, without gaps from operating system interrupts and free of anomalous values.

This scheme allows Paragon to correct for part off-centeredness and tilt up to the limit of gauge head travel. Savings are not only realized by eliminating the need for the X-Y centering and leveling inspection table platens but also by saving valuable operator setup time. Operators can in most cases simply drop the parts on their existing fixturing and let Paragon's math modules do the rest.



ABOVE: Paragon V2 allows testing on manual spin tables (left) eliminating the need for more complex setups with drives, centering, leveling and safety equipment (right).

The recently introduced Paragon V2 goes one step further by eliminating the motor drive requirement for the tables and the associated safety equipment required by regulations. This represents another considerable savings in initial investment to the customer. Let's consider the numbers for a typical project requiring a one meter (1000 mm) diameter table for a customer with an existing 1000mm spin table:

1000 mm table	X-Y platen	Leveling	Drive	Encoder	Safety Eqpmt	Total
(new) \$40,000	\$10,000.00	\$5,000.00	\$5,000.00	\$2,000.00	\$12,000.00	\$74,000.00
(existing) \$0	NR	NR	NR	\$2,000.00	NR	\$2,000.00
SAVINGS						\$72,000.00

For the low volume service shop or the manufacturer on a budget, savings of this magnitude may well mean the difference between purchasing a system or continuing with outmoded technology.

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