Turbine Alignment Goes Digital

With production at risk, power and processing plants seek faster and more accurate methods for getting turbine components properly aligned and running well. Measuring digitally – using laser trackers and 3D scanners – helps root out problems quickly, and makes turbine maintenance truly preventive.

A steam or gas turbine with all components properly aligned will help keep a power or processing plant operating at full capacity. Let the alignment fall out of tolerance and the result may be lower efficiency or even equipment downtime. The potential cost: millions of dollars in lost production.

That's a risk no plant manager wants to take. It's little surprise, then, that industrial leaders worldwide are looking past the old-school methods of turbine alignment: piano wire, bubble levels, and plumb-bobs.

"Hand measurements simply aren't accurate enough," says William Bonner, managing director of Dimensional Engineering, Inc. "The new school is digital," he asserts, "and laser tracking and scanning is the enabling technology."

Bonner's Michigan-based company helps companies worldwide solve engineering problems using 3D digital data capture and analysis. His team utilizes laser trackers and 3D scanning devices for collecting equipment design data to a degree of precision far exceeding what's possible with hand measurements.

Quality inspection of turbine equipment is a Dimensional Engineering specialty. The firm helps clients root out problems in turbine operation, make the needed modifications, and validate the equipment designs more quickly, easily, and accurately than ever before.

Best of all, the benefits of this digitally assisted approach go straight to the client's bottom line. "The turbine equipment stays up and running," Bonner says, "and the plant's production stays high."

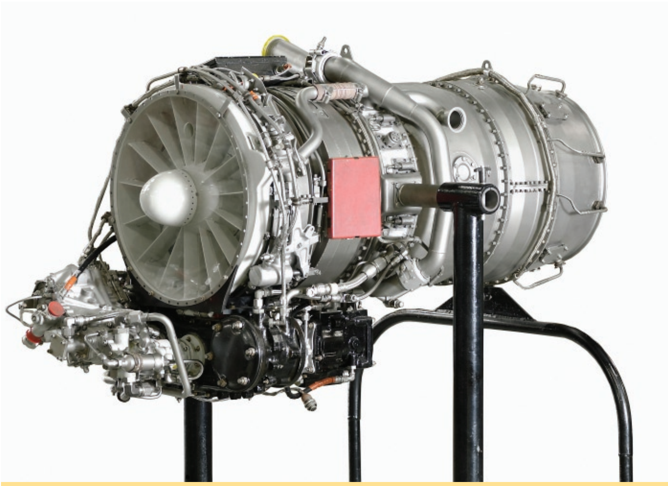
Lessons learned from Dimensional Engineering's recent work for major industrial clients may help guide other companies as they seek to achieve optimal turbine performance.

Vibration Study

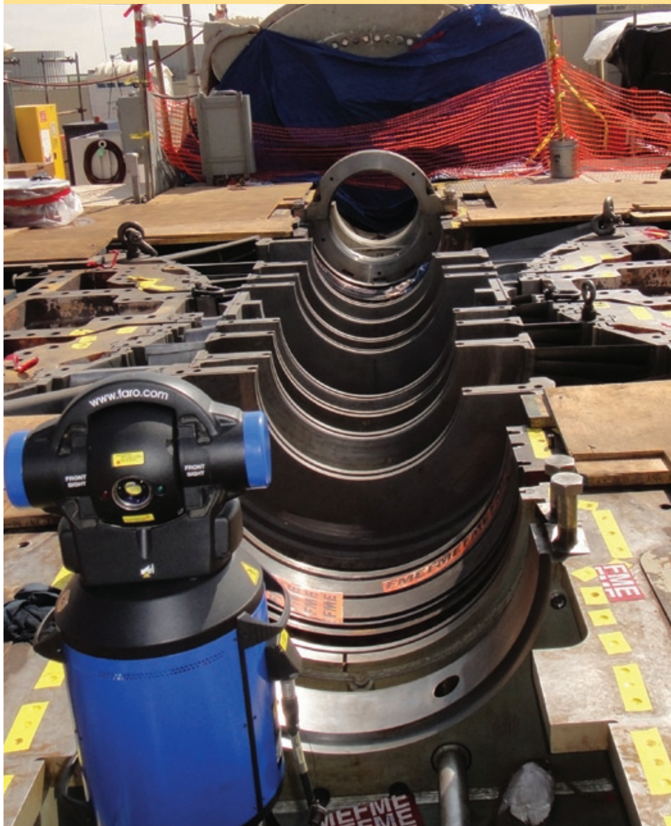
Excess vibration can be a sign that turbine equipment is misaligned. Dimensional Engineering recently worked with operators of a large-capacity propane dehydrogenation plant in Texas to get to the root cause of worrisome vibration in four gas-generating jet engines driving the plant's 1.4 billion pounds of annual propylene production.

First task: capture the digital measurements needed to evaluate the turbines' performance. Dimensional Engineering scanned and validated all bearing and mounting surfaces for proper alignment, and inspected piping to ensure correct fit within the coordinate system.

After completing the initial inspection, Dimensional Engineering technicians were able to monitor three-dimensional movement of each



Digital measurements have made scheduled maintenance of this steam turbine engine at a West Texas power plant an iterative process of measure, assess, and adjust from stage to stage to stage. Using laser trackers and 3D scanners, field engineers can work far more quickly – and be far more confident of their accuracy – than if they were to measure purely by hand.



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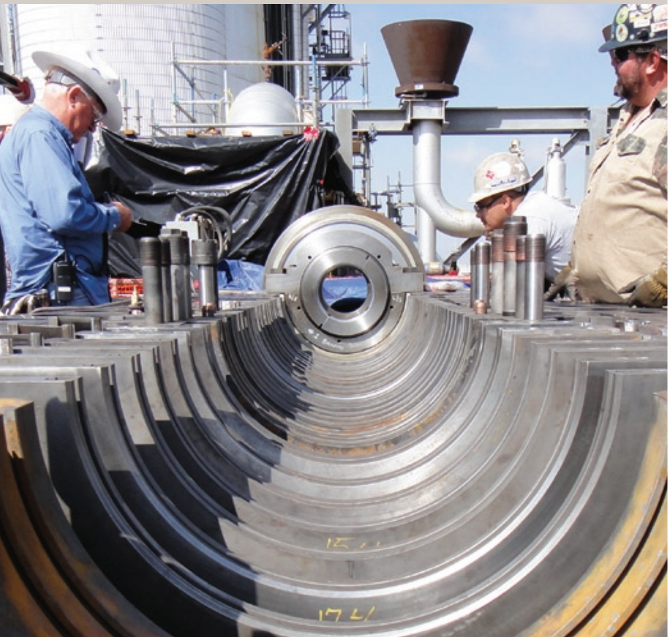
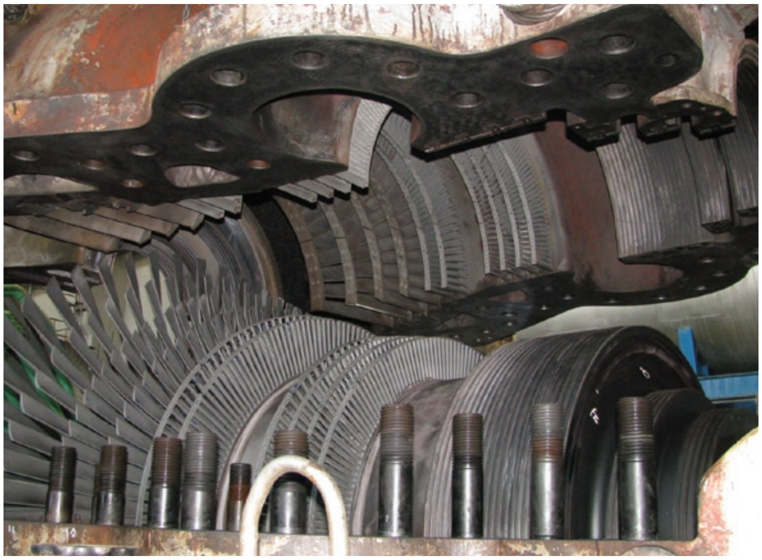
engine at up to 90% production capacity. In this way, they determined the overall vibrational envelope.

The engines, as the analysis showed, had a foundation problem. Jason Self, a project engineer for Dimensional Engineering, explains: "Thrust from all-out operation was moving the engines forward within their cradles. Plus, as the engines heated up, thermal expansion grew them outward. The engines and cradles became misaligned, and this, in turn, strained the flanges connecting the huge pipes that feed exhaust from the engines to the plant's chemical reactor."

The resulting vibration, per Self, caused excess wear and tear on parts. "These are extremely powerful engines," he says. "Their normal operation requires parts to be swapped out regularly. With the added vibration, some parts needed replacement even faster than usual."

"There's no reason a well-tuned turbine engine can't keep performing as it was designed for as long as the useful life of its parts."





Proper alignment of all system components now promises to help keep power generation at or near capacity.

Foundation Effects

Concerns with vibration in a turbine-driven compressor have likewise impelled a major chemical processor to secure Dimensional Engineering's troubleshooting services.

The company is a leading producer of polyvinyl chloride resins, chlorine, and caustic soda. At one of their plants, higher-than-normal vibration is pointing to a possible misalignment of the shaft connecting the steam turbine engine to the compressor.

"It seems to be a coupling problem," says Bonner. "Everything aligns when the engine is cold, but as soon as it heats up, the connection slips and the vibration starts."

As at the propylene production plant, Dimensional Engineering is looking to the equipment's foundation as the possible source of trouble. They're using laser trackers to digitally measure movement and expansion in the foundation as the turbine is brought up to full operational capacity.

In studying foundation effects, Dimensional Engineering is ever careful to consider the foundation's age. Self says, "It's common for a turbine engine to be cradle-mounted within a foundation made of steel-reinforced cement that may be 30 to 60 years old. That's a big reason why digital measurement methods are so useful. They help companies determine what design modifications are needed to preserve their legacy installations."

Tuned to Last

Sometimes the Dimensional Engineering team is called upon to validate the designs of turbine engines that have long been in use, as part of the equipment's scheduled maintenance.

The company recently helped fine-tune the performance of a steam turbine at a power plant in Odessa, Texas. The turbine was disassembled and the alignments of all stationary internal components were assessed and adjusted. The goal: to keep the turbine operating smoothly for many more years to come.

Particularly urgent was the need to ensure that all stators were precisely aligned as per the equipment's design. Taking digital measurements made this possible.

The Dimensional Engineering team used laser tracking to conduct an iterative process of measure, assess, and adjust from stage to stage to stage. They could work far more quickly – and be far more confident of their measurements' accuracy – than if they had performed this work purely by hand.

The recalibrated components were then reassembled to run with optimum efficiency. Self likens the work to automobile maintenance: "The better tuned the engine, the longer the car will stay on the road," he says. "In the same way, there's no reason a well-tuned turbine engine can't keep performing as it was designed for as long as the useful life of its parts."

According to Bonner, "This was the first time the OEM used laser trackers to perform a diaphragm alignment within a turbine engine. They were very pleased with the results."

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DIY Alignment

Meanwhile, for a major energy systems manufacturer in Ohio, digital data capture and analysis is helping the company's design engineers understand the effects of heat and movement on a gas turbine engine's performance as part of a manufacturer's study.

Their focus: skid-to-skid alignment. Per Bonner, "The designers must know 'How much will this cradle move?' and 'How much will the foundation expand?' when the engine revs up and gets hot." Dimensional Engineering's methods have helped the engineering team keep engine compressor skids aligned with turbine drive skids under varying conditions.

"In this case," says Self, "our assignment has been as much of a 'teach a man to fish' opportunity as a problem-solving challenge." He explains: "We've applied our skills and tools, and now we're teaching the client how to carry on with the work themselves."

Results are positive. A metrologist in the company's manufacturing engineering department attested to the effectiveness of the learn-for-ourselves approach: "Dimensional Engineering taught us many short cuts and tricks that would have taken us years to figure out on our own. They know our process better than anyone else. And with them teaching us their laser tracking and scanning techniques, we've not only improved skid alignment, we now know how to repeat the process for future units." ■

SOLUTION AT A GLANCE

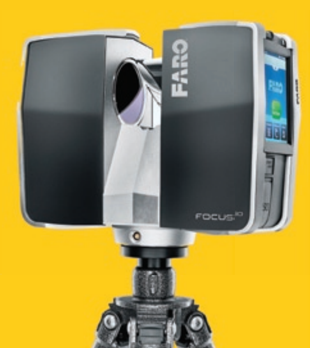
Using 3D Digital Data Capture and Analysis to Keep Turbine Parts Aligned

Save time. By replacing hand measurements with laser tracking and scanning, surface dimensions needed for inspecting and assessing turbine alignment can be collected in hours instead of days. Validating designs digitally further speeds the task.

Cut costs. The field engineering team can find and correct equipment problems digitally before making physical modifications. The solutions works right the first time. This can save millions of dollars by preventing interruptions in plant production.

Enhance precision. Capturing a complex engine's dimensions in digital mode helps document the entire turbine alignment project in a highly accurate, up-to-date, as-built 3D point cloud. The project is fully traceable and more easily repeatable.

Dimensional Engineering's preferred tools for capturing digital measurements of industrial equipment are the Vantage laser tracker, EDGE ScanArm, and Focus3D laser scanner from Faro Techologies, Inc. The company analyzes the collected data using PolyWorks®, the universal 3D metrology software platform™ from InnovMetric Software, Inc.



Old vs. New

How Capturing and Analyzing Measurements Digitally Helps Simply the Turbine Alignment Process ... and Delivers Bottom-Line Advantages

Need/Task	Old Way	New Way	Benefits
Data Collection	**Manual:** Measuring turbine parts and their alignment by hand is a tough slog, prone to errors and omissions.	**Digital:** Using the latest laser tracking and scanning devices helps automate and speed the measurements.	Measure more quickly, easily, completely, and accurately
Design Validation	**Cross Your Fingers:** Field engineers hand-measure parts and hand-modify their alignment ... and hope it all works properly.	**Virtual Build and Bolt:** Alignment changes are fully tested and proven out in software before making them in the actual turbine.	Get it right the first time
Project Documentation	**Binders, Loose-Leaf, and Sticky Notes:** Much can be lost when taking measurements and logging alignment processes manually.	**Start-to-Finish Traceability:** The entire project exists digitally in the point cloud. Data is precise, up to date, and comprehensive.	Repeat alignment tasks, when needed, in much less time than before
Process Improvement	**Downtime:** Turbines may need to be torn down to the smallest parts for measuring. Manual refinement and replacement can take weeks or more.	**Uptime:** Digital data capture and analysis is a largely "hands-off" approach. It can be done with little disruption to normal production.	Minimize shut-down time so as to optimize production yields

Passion for Precision

Since 2005, Dimensional Engineering, Inc. has helped quality-driven engineering teams solve urgent design and production engineering problems through the application of 3D digital data capture and analysis services. The company pioneered this specialized field and continues to be recognized worldwide as its leader.

Dimensional Engineering's clients are leaders in power and energy, process manufacturing, aerospace and aircraft, automotive, and defense. Some include ATP Oil and Gas, Boeing, Chart Energy & Chemicals, GE, General Dynamics, General Motors, Hawker Beechcraft, Johnson Controls, KUKA Assembly and Test Corp., Lockheed Martin, Maersk, Occidental Chemical Corporation, Quadrant, Raytheon, Rolls-Royce Energy Systems, Timken, Triumph Group, and Webasto.

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