Siemens verifies turbine blade geometry with 3D laser scanners

Siemens, a worldwide leader in power plant turbines, investigates laser scanning to monitor the production quality of casting blades. Powerful 3D scanning technology accurately captures the aerofoil surfaces of blades as well as their fine alignment notches. A single mouse click triggers the automatic geometry verification process that provides detailed insight on the basis of graphic part-to-CAD comparison. LC50 laser scanning and Focus point cloud processing are the cornerstones of a much faster and operator-independent digital inspection process.

LC50 @ Siemens (GE)

LC50 laser scanners verify blade geometry and alignment at Siemens to guarantee premium economy and long life in stationary gas turbines.

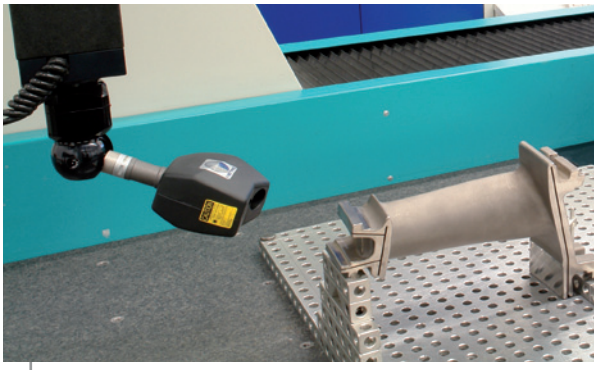
- Scanners accurately capture blades' aerofoil surfaces and fine alignment notches
- Automatic geometry verification process executes graphic part-to-CAD comparison
- Non-contact measurement is faster and requires little or no blade pre-alignment

Capturing the complex geometry of turbine blades

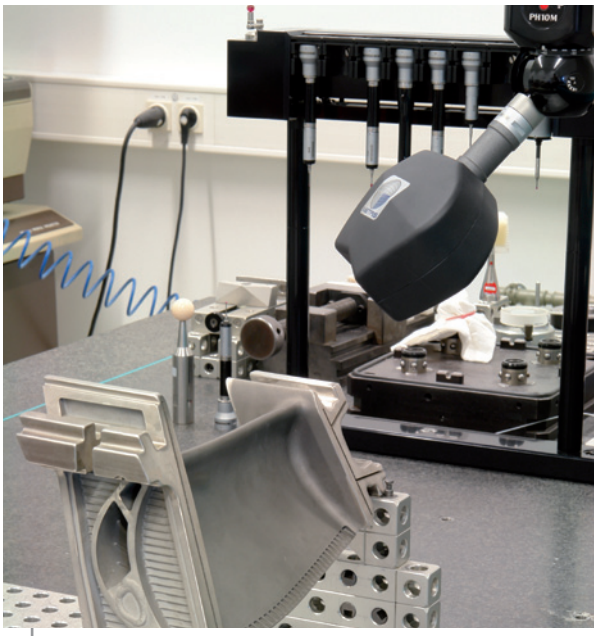
The quality of turbine blades in stationary gas turbine power plants is critical. As hot combustion gas expands through the turbine, it spins aerofoil blades to drive a generator that produces electricity. Air-cooled in its internal channel, turbine blades reach high rotational speeds and face temperatures up to around 1000°C. Turbine blades are designed for optimum aerodynamics and mass center location, and are made of advanced metal alloy castings to increase strength, resist extreme temperature, and avoid corrosion. Inaccuracies in blade geometry and positioning may cause energy conversion efficiency loss and untimely blade failure.

The complete amount of turbine blades that Siemens produces on a yearly basis are measured at different manufacturing stages. "Already 10% of this amount of blades are inspected through laser scanning," says Jörg Ziege, Metrology Manager at Siemens Fossil Power Generation in Berlin, Germany. "Our metrology engineers use 2 Nikon Metrology LC50 laser scanners to verify the shape of the aerodynamic blade surface and the dimensions of milled planes and flanges, drilled holes and alignment notches. We opted for laser scanning to efficiently and confidently capture freeform surfaces and geometric features. Compared to traditional tactile inspection, laser scanners capture much more point data in a shorter time frame, and embed measurement and analysis in an automatic digital inspection process. At the same time, non-contact measurement requires little or no blade pre-alignment, and eliminates probe compensation when scanning freeform blade surfaces."

Particularly important are the linear notches that correctly align a blade to the inner and outer rotor ring rails of a turbine wheel.



On average, a blade is inspected in a few minutes, including repeated scanning of its linear notches under different angles.



Linear blade notches determine the position of the blade relative to inner and outer turbine ring rail structures.

Ziege explains that these alignment notches are manufactured internally using electrical discharge machining (EDM). "Inaccurate notch locations cause blade misalignment, and increase the likelihood of blade failure problems in the future. To capture the fine alignment notches, the LC50 performs multiple scans under different angles. By capturing thousands of inspection points per second, Focus software is able to apply far more accurate line fitting to determine the positions of notch edges and verify the angles between notches."

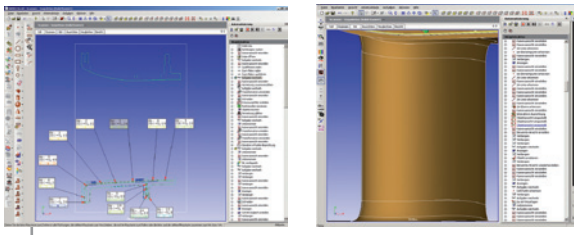
Automatic inspection providing deeper insight

To prepare a laser scanning inspection routine for a new blade type, Ziege's team sets up an inspection macro in Focus Scan software. This is a one-time effort that roughly takes half a day, depending on blade type and size. At the CMM, or off-line on the basis of blade CAD information, they define the straightforward travel paths of the scanner and corresponding scanner angles. According to Ziege, it is much easier to define scanner motion and orientation than to program the hundreds of individual touch sensor points for a tactile inspection job. In addition, laser scanning only requires standard holding fixtures, whereas traditional inspection methods demand costly dedicated positioning and fixation tooling.

Once the macro is defined, serial blade inspection is run on either one of the two CMMs in the metrology laboratory. "One click on the button is all it takes to launch the inspection routine," explains Ziege. "The scanner automatically moves around the blade, while capturing surfaces and features using a multitude of measuring points. On average, a blade is inspected in a few minutes, including repeated scanning of its linear notches under different angles. Since we deployed laser scanning, we reduced the inspection execution time. A short calibration routine is executed weekly to guarantee high accuracy."

> *"Requires little or no blade pre-alignment, and eliminates probe compensation when scanning freeform blade surfaces.*
>
> *Jörg Ziege, Metrology Manager for Siemens Fossil Power Generation*

Focus Scan manages the data that is acquired in real time, and Focus Inspection executes alignment, filtering and meshing entirely automatically. Also the predefined analysis work is executed automatically. Graphic displays of blade sections show geometric part-to-CAD deviation, and calculated dimensions indicate the exact width and orientation of alignment notches, for example. Ziege says that results and analyses are incorporated into digital reports that accompany the inspected blades when turned out to customers. "As laser scanning reports yield more profound insight, they are essential for us to ensure high production quality and minimize blade failure in the field. Reports indicate issues that we take up internally and with suppliers in our continuous effort to systematically improve the quality of Siemens turbine blades.



Thanks to automated inspection in Focus software, one click is sufficient to launch the inspection routine.