

Rapid 3D measurement

Alcoa Howmet's foundry layout department has cut turbine blade inspection times by up to 70 per cent by using optical measurement. *Machinery* reports

Major improvements to the inspection process at Alcoa Howmet's foundry in Exeter have been delivered by the introduction of a GOM ATOS II optical measurement system (GOM UK, Coventry) and Geomagic Qualify computer-aided inspection software (Geomagic Europe, Stuttgart or www.geomagic.com).

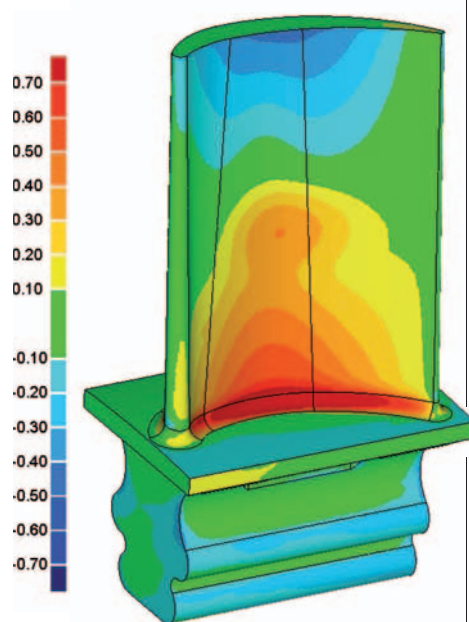
"What used to take us a week or more we can now complete in one day," says Steven Edwards, layout and toolroom manager.

He is talking about the proof inspection of newly cast turbine blades and other airfoil components; a process which has been transformed with the introduction of digital shape sampling and processing (DSSP – see box, page 88)

and computer-aided inspection software from Geomagic.

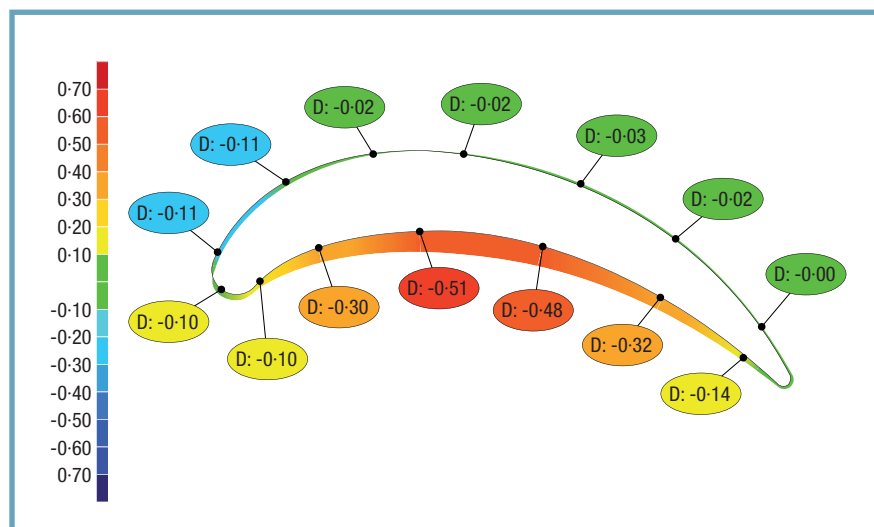
Alcoa Howmet is one of the two divisions that make up Alcoa Power and Propulsion, a major business unit of America's Alcoa Inc. Serving the aerospace and industrial power generation equipment manufacturing industries, Alcoa Howmet's products range from castings of super-alloy, titanium and aluminium alloys, to equipment and materials for the investment casting industry. The company casts turbine blades and vanes at its Exeter foundry for world-class companies like Siemens, Alstom, Rolls Royce and ABB, among many others.

The components it produces for these customers are cast using the lost-wax, or



investment casting process, and distortions are an unavoidable occurrence. Inspection is, therefore, key to Alcoa Howmet's ability to produce parts that meet all geometric tolerance conditions.

Colour coded 3D image, right, and, below, a 'whisker' diagram, both courtesy of Geomagic software which has helped cut turbine blade inspection times by 70 per cent for Alcoa Howmet, Exeter



DIGITAL TECHNOLOGY

Today that inspection process, both for first article and for changed parts inspection, relies mainly on digital shape sampling and processing (DSSP) technology. At Exeter, the DSSP technology used comprises a GOM ATOS II optical measurement system, which captures part geometry as a dense 'point cloud' or polygon mesh that precisely describes an object's surface and primitives, and Geomagic Qualify computer-aided inspection software.

The ATOS II system digitises a physical part by projecting different fringe patterns of white light on to the object's surface. These patterns are captured by

two cameras located at either side of the projector. As the object is scanned, the areas in which measurements have been recorded are displayed on a computer screen. The system monitors its calibration and the effects of the environment to ensure reliable measurement in industrial conditions. The captured data is then imported into Geomagic Qualify for the inspection process.

Geomagic Qualify takes advantage of digital shape sampling and processing to

enable fast, easy-to-understand graphical comparisons between CAD models and as-built parts. It saves time and increases accuracy for first-article inspection, trend analysis, 2D and 3D dimensioning and automated reporting. It has helped Mr Edwards and his team in Exeter to reduce proof inspection cycle times to typically one day from the week or more that it took with the previous touch-probe/coordinate measuring machine (CMM)-based methods.

The inspection process itself relies on

two inputs: 3D scan data of the inspected part and the original 3D CAD model of the part. Both are read into Geomagic Qualify, using industry-standard data transfer methods, or directly in the case of the data from Alcoa Howmet's Unigraphics CAD system. Datums and features upon which the inspection is going to be based are then created on the CAD model. The scan data is then aligned with the nominal CAD model using both the manual and the automatic alignment facilities provided by Geomagic Qualify.

Once the scan data and the CAD model are aligned correctly, the inspection process starts. This includes overall three-dimensional analysis of any deviation between the physical part and the nominal CAD model, with the results being presented as a colour-shaded plot of the part, showing deviation values (see page 87). Areas of the part that fall outside assigned geometric tolerances are also displayed for easy identification, along with geometric dimensioning and tolerance (GD&T) call-outs, 'whisker plots' of cross-sections and wall thickness analysis results (see page 87).

TURBINE SPECIAL

Alcoa Howmet also takes advantage of the specialised inspection capabilities offered with Geomagic Blade, an optional extension to Geomagic Qualify. Geomagic Blade focuses on the turbine machinery industry, providing specific functionality to enable the analysis of rotors, stators, impellers and specific internal blade features.

"With the Blade extension we can readily undertake multiple airfoil analysis by analysing and reporting on dimensions related to turbine segments, such as minimum opening, or throat, and minimum distance blade to blade, as well as other turbine-specific inspection requirements such as twist analysis and cross section and chord length measurements," says Matt Willacy, Alcoa Howmet layout engineer. "What's more, the software is easier to use and faster than our earlier system, and Geomagic is always willing to listen to our needs and

DSSP explained

DSSP encompasses the convergence of multiple technology advances. It describes the ability to use scanning hardware and processing software to digitally capture physical objects and automatically create accurate 3D digital models with associated structural properties for design, engineering, inspection and custom manufacturing.

Optical scanners have made it possible to collect millions of points in the time it used to take to record a few points. DSSP enables capturing the entire bounding surface geometry of a physical object – including product features, colours and even textures.

Gathering millions of points of data has little or no value, of course, unless the data can be processed easily into digital models with the quality needed for downstream applications. That's where software plays a critical role.

Point-cloud data that would choke a high end computing system five years ago is now easily digested by modern PCs. Gaps and noise in scanning data that used to take days to resolve are now corrected automatically in the best DSSP software. Conversion to polygons and NURBS surfaces, once requiring days of tedious work, can now be handled in minutes using a natural, intuitive workflow. Interaction between parametric CAD software and programs such as Geomagic Studio and Qualify is fast and intuitive.

One of the most promising aspects of DSSP is its ability to enable mass customisation – manufacturing one-of-a-kind products with the same efficiency and cost-effectiveness as mass production of one-size-fits-all goods. The medical market is a particular user of this capability for hearing instrument shells and orthodontic devices, for example.

Geomagic has received millions of dollars in funding from the US's National Science Foundation and the National Institute of Standards and Technology to further develop key DSSP technologies and apply them to industry. The technology is used on that most high profile of US endeavours – the space shuttle. Geomagic DSSP software has given NASA the ability to detect, assess, repair and validate a repair in the unpredictable environment of space.

As the shuttle nears the space station on the second day of flight, it rolls over to expose its underside. An optical scanner attached to a 50 ft extension of the shuttle's robot arm scans the underside of the shuttle's wings to capture damage.

Scan data is transmitted to Houston, where Geomagic software is used to create 3D models of the damaged tiles from the data. The models are then analysed to determine the extent of damage. To date it has not been necessary to require actual in-space repair.

to come up with new capabilities."

Reporting information benefits have also been won with the new system. In the past, this reporting procedure has always proved to be something of a bottleneck as the reports were time-consuming to produce and difficult to understand.

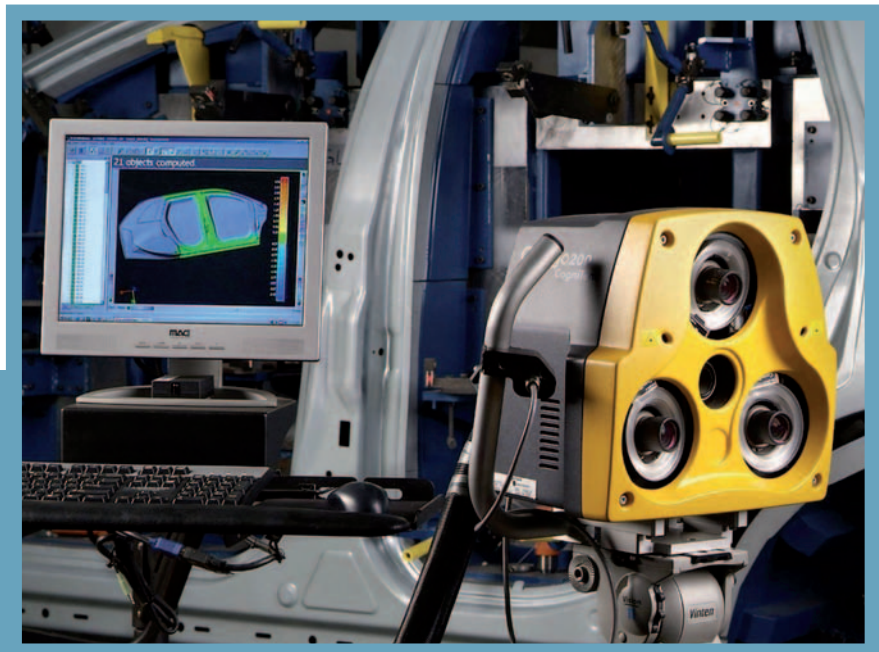
"The use of Geomagic Qualify has not only speeded up the actual inspection process but also the production of the reports," Mr Willacy explains. "They contain both graphical representations of the inspected part, such as colour-shaded deviation plots, etc, as well as actual numerical values, so they are much easier to understand than the reports we used to produce."

Images for the reports are created by saving required views during the inspection set-up procedure. Reports are

then output automatically and can be in a number of standard formats, including HTML, PDF and Microsoft Word. Alcoa Howmet, Exeter, currently outputs them as PDF documents which are then printed off for use by the product engineers. However, Mr Edwards has plans to install the free Geomagic Review software on all engineers' PCs to give them easy access to

reports by downloading them over the network. This will enable the engineers to further analyse the part and interrogate the results.

Something else that speeds up the process is the ability to produce inspection templates within Geomagic Qualify. These templates are customer-specific and are produced by saving the



Hexagon Metrology approach

Hexagon Metrology last year acquired Israel-based CogniTens, a company which has developed image capture technology and related processing software. Its focus has been on the automotive industry.

CogniTens is described as the leading provider of comprehensive dimensional measurement solutions, focused on improving common engineering and manufacturing processes in the automotive industry.

CogniTens dimensional measurement solutions assist car manufacturers and suppliers in: improving product quality; reducing engineering and production costs; accelerating vehicle ramp-up and launch; and speeding up the time-to-market.

Applications range from prototype part inspection, die build and tryout validation, to replacing hard checking fixtures for automotive parts and assemblies with virtual gauging technologies.

CogniTens products were designed for robust operation directly on the shopfloor and the company's OptiCell and Optigo data collection units are claimed immune to common production line conditions such as vibrations, ambient light and temperature changes, and they support measurement of untreated small to very large parts and assemblies.

All output data can be easily exported to various reverse engineering, dimensional inspection, and other software products such as: Geomagic, Polyworks, Metrologic, Tebis and Rapidform.

On show at MACH 2008 (Birmingham NEC, 21-25 April) will be the Optigo RE model (pictured) which also doubles as a 3D digitisation system for reverse-engineering applications and 3D modelling.

inspection workflow created the first time a part is inspected. The same workflow is then applied to subsequent inspections at the touch of a button and a separate report for the new part is produced, again automatically. This use of inspection templates means that set-up time is reduced to a minimum.

"There's no doubt that the use of Geomagic Qualify and the Blade extension has had a major beneficial impact on the time it takes us to complete first-article and subsequent inspections," says Mr Edwards. "As a result, we are able to provide a faster service to our internal and external customers at the same time as ensuring that the final product we deliver to them is of the highest possible quality, consistently." □