3D laser scanning advances tool creation

Multi-sensor CMM cuts 35 per cent from cost of remanufacturing implant forging dies

Laser scanning combined with touch probing on a Nikon Metrology co-ordinate measuring machine (CMM) fits perfectly with additive layer manufacturing (3D printing) practices at French rapid manufacturing service bureau, Applications Additives Avancées (3A). This modern metrology system is the key to reduced lead-times and lower costs in the manufacture of medical, aerospace and other mechanical components.

Located in a high technology industrial centre in Nogent, France, 3A was formed in January 2011 as a subcontract manufacturer of titanium alloy and cobalt chrome parts using electron beam melting (EBM) technology. The firm mainly services the medical sector, which presently accounts for 75 per cent of turnover, producing standard and patient-specific implants and prostheses as well as medical instruments. However, contracts are also carried out for the aerospace and motorsport sectors, as EBM is ideal for producing turbine blades, for example, and lightweight, multi-piece assemblies as single components.

To provide quality assurance support for these activities, specifically to ISO 13485 for medical devices, 3A has purchased a Nikon Metrology bridge-type co-ordinate measuring machine (CMM) with an 800 x 700 x 600 mm inspection volume. It was supplied with a Nikon Metrology LC15Dx laser scanning head capable of measuring regular and freeform 3D shapes to an accuracy of under ten microns, an order of magnitude less than the required accuracies of the parts being produced.

Pascale Marié, Sales and Marketing Manager at 3A, commented, "We are very happy with the scanner, which we believe is the most accurate on the market. It is the latest version from Nikon Metrology and the first to be installed in France.

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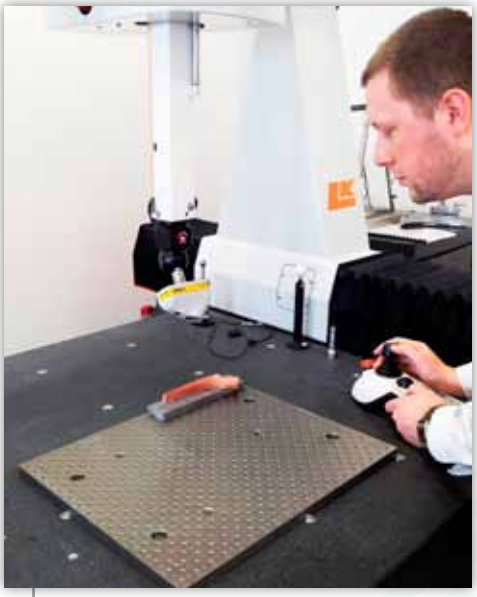
The electrode being automatically scanned.



Programming a scanning cycle for reverse engineering a copper electrode that is commonly used to spark-erode a forging die for femoral hip implant manufacture.

"Before buying the equipment, we were aware that touch probing was unable to provide effective control of the highly complex geometries, such as lattice structures, that we build in our Arcam EBM system. That is why we chose the LC15Dx.

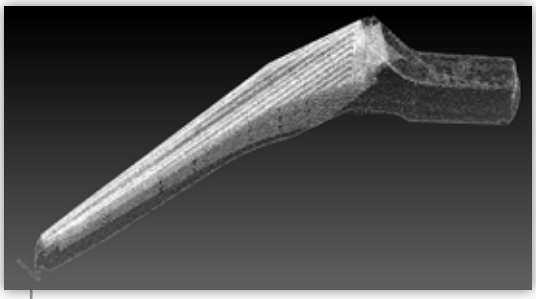
"For simpler 3D printed components, however, our engineers program the CMM to inspect the parts by touch probing, as it is faster and less costly in terms of operator time."

Laser scanning helps reduce the cost of producing forgings

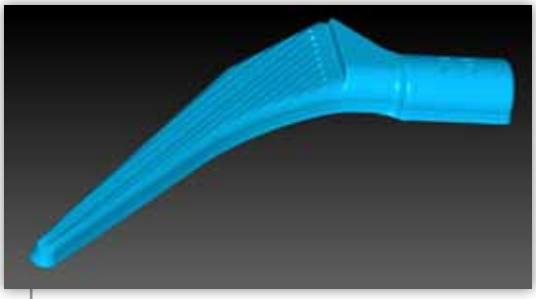
Ms Marie went on to explain that once the 3D scanning head was operational, it attracted a lot of work that had not been envisaged at the outset. For example, one customer that manufactures medical implants needed all of its legacy forging dies reverse-engineered to produce CAD files. Still in use today, the old die sets were originally either electro-eroded using copper electrodes or produced on a pantograph milling machine, so digital data did not exist.

Now, the customer sends to 3A either the two halves of a forging die or the pair of electrodes that produced them. The data for reverse engineering is acquired on the Nikon Metrology CMM using its LC15Dx laser head and Focus Scan software. Turnaround time for the complete reverse engineering process is rapid at two to three days. Scanning a part takes from around 30 minutes up to 2.5 hours for a highly complex resin die, thanks to the speed of data acquisition with laser scanning, which measures 70,000 points per second at intervals of 22 microns. There are hundreds of dies that need to be digitised so that CAD files are available as tools wear out, ensuring continuity of implant production.

The digital CAD models enable the customer to prepare metalcutting cycles so that the forging dies can be machined on modern, high speed cutting equipment in a process route that costs 35 per cent less and is considerably faster than when dies were spark eroded using expensive electrodes. The resulting financial advantage is significant, as the costs associated with forging die production are the single most important variable affecting the cost of forged products.



The resulting point cloud from the laser scanning cycle.



The virtual surface of the electrode after 3D meshing.

A second scanning application is the repair of existing tools. Once CAD models are available for a die set, it is possible to scan a used forging tool in order to accurately rebuild the two halves by repairing the metal in the places where they are worn. Those areas are machined and polished, after which further laser scanning allows the new profile to be referenced against the digital model. Any areas of concern can be highlighted using interactive or automatic deviation analysis with colour mapping and reporting within the Nikon Metrology Focus Inspection software package.

Low scan data noise results in smooth, high quality surfaces

Irrespective of whether the scanner is employed for reverse engineering, or is used to inspect parts against design intent in CAD models to control the dimensional conformity of EBM manufactured components or help optimise die refurbishment, the capture of accurate point cloud data is essential. This is where the LC15Dx scores, as the accuracy of measured results is comparable with those of tactile inspection.

Pascale Marié continued, "The point clouds resulting from scanning the freeform profile of a component are filtered and meshed into NURBS (non-uniform rational basis spline) surfaces that are grouped to create the CAD model.

"The smoothness and accuracy of the surfaces generated by the Nikon Metrology CMM, scanner and software is so good that the 0.1 mm tolerance required for subsequent forging die manufacture is easily maintained by our customer. Quality control over our own 3D additive manufactured components is similarly reliable."

Reflective surfaces are prevalent throughout 3A's operations in Nogent, as forging dies are hand polished to achieve high accuracy, while some implant surfaces, notably for knees and hips, are honed mainly to optimise the friction coefficient. Laser scanning is usually susceptible to errors when inspecting such reflective surfaces, but the LC15Dx with its high quality Nikon lens handles the conditions well. Unwanted reflections are neutralised by an advanced software filter while changes in ambient light are absorbed by an optical daylight filter. Only when it comes to parts with a mirror finish is manual intervention necessary for spraying the part with a matt coating prior to scanning.

The relationship between Nikon Metrology and 3A has progressed to such an extent that the additive manufacturing service bureau has agreed to act as a showroom and demonstration centre in Eastern France for the supplier's inspection solutions.

ABOUT 3A

Advanced Additive Applications (3A) is specialized in rapid manufacturing of metal parts with the ARCAM Electron Beam Melting Technology (EBM®), from custom-made products up to type series.

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ABOUT NIKON METROLOGY

Nikon Metrology offers the broadest range of metrology solutions for applications ranging from miniature electronics to the largest aircrafts. Nikon Metrology's innovative measuring and precision instruments contribute to a high performance design-through-manufacturing process that allows manufacturers to deliver premium quality products in a shorter time.