Foundry in Fine Form after 3D Laser Verification from GKS

Company
The well established foundry and pattern shop makes cast parts, mainly aluminum and magnesium, for the aerospace industry.

Challenge
The foundry had been making castings for an aerospace company for many years. In the normal lifecycle of foundry tooling, parts need to be refurbished to make sure the castings remain within the acceptable quality standards of the customer company. Equipment must be replaced or updated. After the refurbishing process, the new cast parts also have to be requalified to verify their correctness and quality.

Before CAD models became ubiquitous in parts manufacturing, blue-lining was used to inspect and QA castings. This was an especially labor-intensive, tedious process that could take up to 10 weeks to complete for one part, idling the production line during that time. The casting was sprayed with blue dye and set on a precise layout table (such as granite). Lines were scribed in the dye at specific heights, then gages and instruments were used to manually measure the features' dimensions and locations. The measurements were compared to the 2D drawing and a report of discrepant items was generated. After that, engineers needed to decide which of the discrepant items were due to processing of the casting (called assignable cause) and which had to be corrected in the tooling.

In an effort to streamline their verification process on this project, the foundry contacted GKS Global Services, a leading supplier of 3D laser scanning services for over 25 years, to perform 3D laser scanning on castings made with the refurbished equipment as a faster, more accurate means of inspection.

Larry Carlberg, GKS Service Bureau Manager, noted, "Because of my personal experience with foundry and pattern-making work, I realized that this type of inspection application of high-speed non-contact laser scanning would expedite this foundry's production of parts exponentially. We can scan a part in minutes and generate a color-coded inspection report that provides much more information about the part's acceptability than the slow, old-school blue-lining technique can do in weeks. If a company wants to remain competitive, it becomes imperative that it adopt new time- and money-saving technologies such as laser scanning into its inspection process."

Although the part had been in production for 20-30 years, a CAD model was first made in 2008 by manually inputting the dimensions from the 2D drawing. The CAD had never been verified against the physical part.

The 3D laser scanning process by GKS would provide the means for the foundry to perform the following important inspection procedures:

1. Check the casting against the CAD model to see whether it meets the criteria of the aerospace company, so they will accept the parts made by the foundry.
2. Validate the computer model (CAD) compared to the drawing (which was created years ago). Manual input of the 2D dimensions created the chance for human error to creep in. Laser scanning removes that error.
3. Compare the old casting to the refurbished casting. Equipment that has been used successfully during its lifetime eventually fails and needs to be refurbished.
4. Verify the target fixture in 3 planes (limit the 3 degrees of freedom)

Solution

The casting involved in this project was about 19 inches in diameter with a gearbox in the center. Both sides were scanned to capture all of the external 3D geometry. Complete capture of the internal cavity was not attempted because there was limited access to cored features. Rather an ultrasound technique was used to determine the thickness of the metal in the multiple cored passageways and gear box. The features could easily have been captured by cutting the casting similar to conventional layout methods, but that technique is unnecessary when using ultrasound technology.

GKS scanning engineers laser scanned the original casting and the new casting made from the refurbished equipment in only 2 hours per part with the Surveyor WS-2030 CMM equipped with a high-precision non-contact SLP-500 scanner manufactured by Laser Design. Non-contact 3D laser scanning is a complete measurement method; it captured everything on the surface of the objects, including free-form shapes and fine details. It also captured some internal features such as the core entrance and exit from internal features and the gearbox geometry. This aspect is very useful since it corroborates other inspection techniques such as ultrasound checks for wall thickness.

3D laser scanning technology works by projecting a line of laser light onto a surface while cameras continuously triangulate the changing distance and profile of the laser line as it sweeps along. The laser line passes back and forth over the area until the complete surface is captured. Irregular shapes are measured just as easily as prismatic ones, and they are instantaneously replicated digitally on-screen. The scanner measures very quickly, picking up tens of thousands of points per second, and generates huge numbers of data coordinates in a point cloud. Several scans are made to capture the entire part and then the point cloud data files are rotated into the same reference frame and assembled into an exact 360-degree representation of the scanned part.

Since laser scanning is a non-contact measuring method, there are no variations in practices or techniques from operator to operator, or pressure differences that may generate different readings in traditional touch-probe measurement. Laser scanning allows extremely consistent capturing of parts' geometry by removing the human error factor.

Results

The point cloud data was compared directly to the CAD to verify the part's acceptability. Also, the scan data was used with inspection software to compare dimensions to the 2D drawing for validation. The point cloud data from the old and new castings were overlaid to identify discrepant areas as well. Discrepant areas are identified by item number referencing the 2D drawing; out of the over 700 possible items, less than 5% were out of tolerance. These items were compiled in a color-coded inspection report. The gradations of color show the extent to which the area is out of tolerance when compared to both the CAD model and the 2D drawing: areas that are larger than spec appear in blues and purples; areas smaller appear in yellows and reds.

Since all the dimensions in the scan data are available in the inspection software program, the foundry engineers could easily work through the differences in each version and determine which one was correct. "Through this verification process, most of the errors will go away," commented Carlberg. "The errors attributed to after-cast processing will have an assignable cause. In some cases, the error may be due to some gating left on the casting, resulting in excess or oversized area. In other cases, the part may have been over-benched so too much material was ground off creating an undersized condition. Sometimes warping may occur when the molten metal cools, and the foundry uses force to straighten it, which may also cause distortion. Once all the assignable causes are addressed, then the molding equipment can be corrected, or alternately, the parts can be approved as is and shipped to the customer."

The scan data showed that the physical parts were not identical to the CAD model and that the CAD model was not identical to the 2D drawing. However, once the 34 discrepant items were looked at in more detail, there were only a few insignificant errors amongst them, none of which affected the quality of the part's performance. Based on the scan data, the foundry engineers could quickly be certain that the new refurbished equipment met the criteria of the 2D drawing and more importantly, the standards acceptable to their customer, the aerospace company.

The digital scan data also allowed the foundry engineers to correct the CAD model so that it matched all the dimensions of the drawing. After this thorough 3D laser scan of the casting, future inspections will be fast and efficient. Gone is the incredibly time-consuming blue-lining verification process which could take up to 10 weeks and idle the production line. "Now parts can be qualified in just hours and at regular intervals by simply laser scanning a sample casting and comparing it to the stored CAD model," explained Carlberg. "For example, if the aerospace company requires every 10th casting be checked for quality, the part can be scanned in minutes, then verified with the CAD, and production can resume on the same day. Engineers have documentation of the part showing the color-coded scale of tolerances in dimensions. The scanning setup is saved as a template so the next time they inspect the same part, everything is ready to go, making the whole procedure very fast."

Another major benefit of this type of inspection is that it takes the human error out of the qualifying process. Laser scanning is very repeatable and very accurate. Reliable results show areas that need attention and make it easy to take corrective actions only where necessary. As many foundries' equipment ages, this laser scanning requalification process can be invaluable for staying competitive in today's marketplace. GKS's expertise in the field saves time, money, and guarantees quality parts for customers.

About GKS Global Services

GKS Global Services has been a leading provider of dimensional inspection, 3D laser scanning and long range scanning services for over 27 years. GKS also offers development and design services, rapid prototyping, complete contract manufacturing services, and equipment rentals.

For additional information about how GKS Global Services can improve your manufactured product, save you money and decrease your development time, call 952-884-9648 or visit http://www.gks.com.