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Laser Scanning Improves Reverse Engineering and Inspection Tasks

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A wide range of moldmakers are adopting the emerging technology of 3D Laser Scanning in order to improve the accuracy and substantially reduce the time and cost of reverse engineering and inspection tasks. 3D Laser Scanners capture up to 50,000 coordinate points every second, drastically improving reverse engineering and inspection speed and accuracy. Using a laser scanner instead of a touch probe based digitizer or touch probe scanning device mounted on a machining center or CMM (Coordinate Measuring Machine) for reverse engineering / inspection can help a mold builder attract new business and therefore increase the proportion of time that these machines can be utilized for their intended purpose. Laser scanners also can dramatically reduce first article inspection costs for injection molded parts by graphically presenting on a screen exactly how the entire shape of the first article part compares to the design intent (CAD model).

Reverse Engineering and First Article Inspection important to moldmakers

Reverse engineering or digitizing a physical part is a critical task for any mold and pattern shop. Most customers say that they design all of their parts on a CAD system, however the reality isn't that simple. Many older parts were designed on a drafting board before the company started using CAD heavily and others were done on an older CAD system whose files haven't been converted over to their new system. In many other cases, the parts, molds or patterns were originally designed on a CAD system, but changes were made by hand to the mold or pattern after the design was completed the CAD file was never updated. Whatever the reason, nearly every mold shop is continually asked to duplicate or reverse engineer parts.

Many moldmakers use CMM's or CNC (Computerized Numerical Control) milling machine tools for reverse engineering. The problem with this approach is the amount of time required. It might take about 30 minutes to set up the machine and from that point on it works without a lot of attention. But parts have become so complex today that takes at least tens of thousands or sometimes even hundreds of thousands of points to create an accurate 3D model. Getting this many points takes hours or even days on a typical machining center or CMM. The contact digitizer probes used on these machines are also limited in the geometries that they can accurately reverse engineer. Some parts have undercuts or indentations that are too small for the probe to enter. There are also some parts with 3D contours that are so complicated that it would just take too long to accurately digitize them with point by point. The resulting coordinate points also have an offset calculation that is needed to vectorize the data that rarely gets calculated into the measurement accurately due to the constantly changing vector representing where on the touch probe sphere, that contact with the part was made.

Another critical measurement task for nearly every moldmaker is the need provide accurate measurement of prototype parts in order to evaluate the performance of the mold and process. Once

the engineers are satisfied, they set up the production operation and produce the first article parts. These parts are carefully measured and compared to the manufacturer's specifications. The problem with using a CMM for these measurements is that as the geometrical complexity grows, the number of points required for accurate measurements increases at an exponential rate. This greatly increases the amount of time needed to capture points one at a time on a CMM. Small high detail parts can be extremely difficult to measure without deflecting the part when touching it with a mechanical touch probe. Delicate, plastic parts like those of cell phones (as an example) easily deflect due to very thin walls and difficult to probe fine detail geometry.

Laser scanning offers major advantages

Laser scanning has demonstrated the ability to address all of these challenges. Laser scanning systems work by projecting a line of laser light onto surfaces while built-in arrays continuously triangulate the changing distance and profile of the laser line as it sweeps along, enabling the object to be accurately digitized in 3D. The laser probe electronics translate the video image of the line into 3D coordinates, providing real-time 3D coordinate data that gives the operator immediate feedback on areas that might have been missed. Laser scanners are able to quickly measure large parts while generating far greater numbers of data points than mechanical touch probes without the need for templates or fixtures. Since there is no mechanical contact by the laser scanner with the object, the problems of depressing soft objects, measuring small details, capturing complex free form surfaces are eliminated.

Laser scanners can greatly increase any moldmaker's reverse engineering capabilities. First of all, laser scanning takes far less time than a touch digitizer or scanner because, instead of collecting points one by one, the scanner picks up thousands every second. Laser scanning can reverse engineer parts that are so complex that they would be practically impossible one point at a time. It's like the difference between painting with a spray gun and a nailbrush. Instead of spending days to reverse engineer a complicated part, it can now be done in an hour or two. Second, this method produces a far more detailed and accurate point cloud, typically containing several million points that can be used to replicate into CAD models even the most complicated part to demanding tolerances. Laser scanning also does away with other limitations of a digitizer probe such as its inability to accurately define small features or to measure soft parts.

Laser scanners can also improve the process of inspecting prototypes or First Articles. Instead of just measuring dimensional lines, laser scanners capture the entire contour of the part. They import the resulting point cloud into software that automatically registers the as-built First Article to the CAD model provided by the customers with colorful highlights any differences out of tolerance. The Reverse Engineering Software (like Geomagic STUDIO®) provided with the scanner greatly simplifies the process of moving from point cloud to computer aided design (CAD) model, making it possible in minimal time to generate a CAD model of the scanned part that faithfully duplicates the original part.

The Inspection Software (like Geomagic QUALIFY®) can be used to compare original design geometry to the actual physical part, generating an overall graduated color error plot that shows in a glance where and by how much, surfaces deviate from the original design. Standardized, typical GD&T (Geometric Dimensions & Tolerances) of important part features and measures are provided with spreadsheet reports that are automatically generated from the scan data for repetitive part inspections. This goes far beyond the dimensional checks that can be performed with touch probes on CMMs. It provides a graphical comparison of the manufactured part vs. the CAD model, automatically performing first-article inspection, tool validation, wear analysis, object alignment,

and 2D and 3D dimensional analysis. The time to inspect first articles is substantially reduced while at the same time improving the accuracy of the process.

Moldmaker improves reverse engineering

A moldmaker that switched from a CMM to a laser scanning service bureau saves an average of one week per reverse engineering project by reducing digitizing and modeling time. The result is that the company's skilled employees can spend their time on more profitable machining jobs. In the past, Lawrence Mold and Tool Corporation, Lawrenceville, New Jersey, had to dedicate a skilled person for at least a week to reverse engineer and model even fairly simple molds or parts that customers wanted to replicate. This reduced the company's productive capacity. George Lesenskyj, President of the company, decided to try an outside engineering service bureau (Laser Design Inc., Minneapolis, MN – also, industry's leading manufacturer of 3D Laser Scanning Systems) to free up his employees to spend more time on customer projects. "I discovered that due to the speed of laser scanning, the service bureau that we used was actually able to do the job for less than what it cost to do the job in-house," he said. "Best of all, the service bureau frees up my people so they can dedicate more of their time to the precision machining and fitting aspects of the job.

"We were very happy with the results of this project," Lesenskyj said. "The Laser Design Inc. Engineering Service Bureau provided us with a CAD surface model of the part in Pro/ENGINEER format. We then had to blend out the surfaces and stitch them into a solid and then we were ready to start designing the mold. We saved at least a week on this particular part, and on more complicated parts that we have completed since then, the timesavings have been as much as a month. The accuracy of the file that we received was better than what we could have achieved with a CMM. In addition, switching to laser scanning means that we now have the confidence that we can reverse engineer any customer part or mold regardless of its complexity. All in all, the laser scanning service bureau approach has proven to be the reverse engineering method that best fits our business."

Automotive supplier boosts inspection capabilities

An automotive supplier reduced the time needed to inspect the first article of foam parts by 2/3 by switching from a coordinate measuring machine (CMM) to a laser scanner. Foam Design, Inc., Lexington, Kentucky, builds a wide range of foam parts, including inserts for headliners used to protect against injuries in the event of a collision. Inspecting these components with a CMM was a tedious and error-prone process because of the difficulty involved in making contact with the part while not depressing the soft foam material. A customer gave Steve Scrivner, Quality Manager for Foam Design, the idea of improving the speed and accuracy of the inspection process with a 3D Laser Scanner "The laser scanner has reduced the amount of time needed to lay out a first article part from about an hour to under 20 minutes," Scrivner said. "Just as important, the accuracy and consistency of measurements have been substantially improved because this noncontact measurement method eliminates the danger of depressing the part surface."

"First article inspection with a 3D Laser Scanner is substantially faster than with a CMM," Scrivner said. "In the past, our technicians had to move the probe along a line to see where the part matches while now they can simply paint the part and perform the comparison on the computer. The time required to inspect first articles has been substantially reduced while at the same time improving the accuracy of the process. Our customers love being able to the view the as-built part on the computer screen overlayed against their design. We also see the potential to use laser scanning for inspection and reverse engineering of some of the other foam parts that we produce and we plan to begin investigating opportunities in these areas in the near future."