▶BY ALAN RICHTER, MANAGING EDITOR

Built By Design

A CAD-to-part comparison system allows first-article parts inspection on the shop floor and reverse engineering.

When tolerances are tighter than a couple tenths, a traditional, fixed-base coordinate measuring machine in a controlled-climate room is required to accurately measure the dimensions of relatively small parts and tooling. But when tolerances need to be held from 0.0002" to 0.001" or so, and the parts are large, such as fixtures and jigs for aerospace applications, measuring with portable CMMs right on the shop floor is often the way to go.

These portable metrology devices are typically bundled with 3-D CAM software—such as the CAM2 Measure from FARO Technologies Inc., Lake Mary, Fla.—for CAD-to-part comparison, as well as measurement and inspection. This type of software allows measured parts to be compared to design files or engineering blueprints.

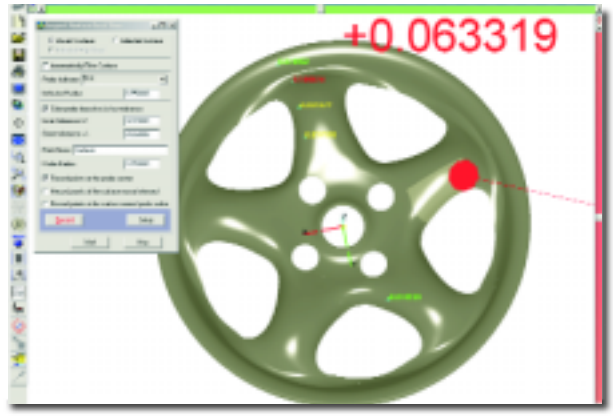
Darin Sahler, the company's global public relations officer, noted that FARO doesn't actively market the software as a standalone product, but end users sometimes purchase it when upgrading their systems.

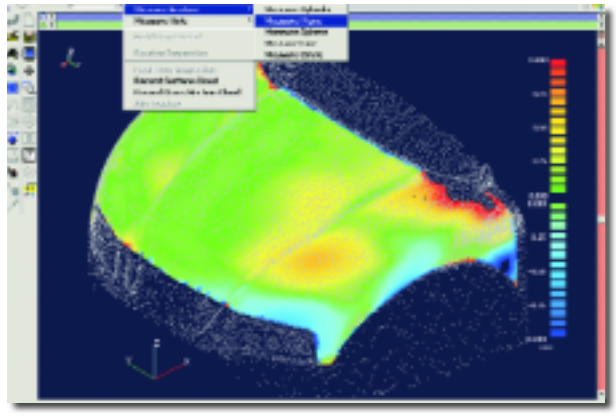
However, that type of software is tied to the portable metrology hardware from a specific manufacturer, said Arnold Free, vice president of business development for MAYA Metrix. The Montreal-based company is the developer of Build!IT, a software program that directly interfaces with all leading CMM systems to allow real-time measurement and comparison to CAD geometry. For example, Build!IT would allow portable measurement arms, such as FaroArms, to interface with data collected from a laser tracker from Leica Geosystems GR.

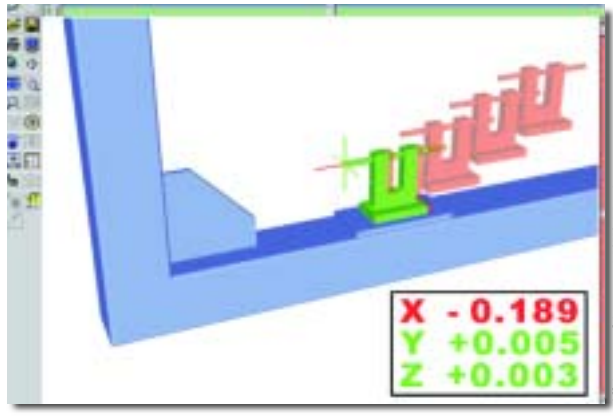
"We can drive a variety of equipment with a single software product and a single process," commented Free.

Puzzle Assembly

With its variety of stationary and portable CMMs, including measurement arms and laser trackers, Goodrich Corp.'s Aerostructures Group needs to be able to use all its metrology systems simultaneously, said Larry Brannock, senior engineer of quality assurance for the Chula Vista, Calif., company. He added that incorporating such software (in his company's case, Build!IT) lets it use hardware from various manufacturers and







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CAD-to-part software for measurement, inspection, analysis and tool building interfaces in real-time with portable CMMs from the leading manufacturers and has a surface-geometry engine with reverse engineering tools.

go directly from the 3-D CAD model to building the fixture and jig tooling. This saves money—lots of it.

"The last program we quoted for tooling was $7 million, and we actually came in at $3.5 million," Brannock said. "That's a 50 percent savings on what we said it would cost even when incorporating this process."

He explained that this level of savings is the result of not having to machine components so precisely in order to assemble them. "Instead of machining all the different pieces for a tool and assembling them like a precision jigsaw puzzle, we machine things a little less precise and then use the software to locate and set the parts at assembly," Brannock said. "That saves us a lot of time and money."

He added that the details aren't interchangeable when the tooling is machined more precisely. "If you make another one and put it in place, it's not where you think it should be," Brannock explained. "You have to go and tweak it anyway."

The software allows Goodrich to check the tooling as it's being built, he added, rather than assembling it and then having someone check it again. Most of the jigs and fixtures Goodrich builds measure 5'×7'×5', but some have dimensions up to 30'.

To measure the larger tooling, a laser tracker is required; measurement arms are more suitable for the smaller parts. Sahler said FARO offers trackers that reach up to 230' and arms with reaches, or measurement spheres, from 4' to 12', in 2' increments.

Up and Assembling

Unlike some of the more complicated modeling software packages designed for engineers, Brannock said he prefers a more intuitive CAD-to-part measurement system, one that is easier for tool builders to learn. "I'll sacrifice some of the features I want to keep the process simple," he said. "Then we're able to get more out of the people on the shop floor."

Learning how to use the software and the portable arms requires a 2-day training course, followed by a couple days of supervised equipment operation. "After I show the shop people how to use it, I give them the database and send them off," Brannock said.

Nonetheless, Brannock noted basic computer literacy is beneficial before trying to grasp even the simplest graphic-based package. "The problem is with some of the guys who have been here a long time. They know the little tricks of the trade that never get written down and are really good at assembling tools, but they tend to not have a lot of computer skills," he said. "I'm a programmer, so basic things I think they're going to know, they have no clue. And sometimes they won't tell you when you're teaching them, and then they get out there on the floor and are lost."

Goodrich Corp., Aerostructures Group

Inspecting the contour of a tail cone using a laser tracker.

Goodrich Corp., Aerostructures Group

Locating the details on a weld jig using a portable measurement arm.

Having the program provide that basic training is on Brannock's wish list. "I'd like to see some type of macro language where somebody who doesn't know anything about computers can come in and have the software lead him step by step through the measurement process, and it would be the same every time," he said.

Building Backwards

In addition to comparing CMM coordinates to the part's CAD geometry, Build!IT, for example, allows point-data collection for performing reverse engineering, said MAYA Metrix' Free. The software provides basic reverse engineering for performing less-complex design work or the collected data can be brought into a CAD system to create the part.

"If you have a mold or any tool that you have no CAD data for, or if it's been modified on the shop floor and you need to make a record of those

Goodrich Corp., Aerostructures Group

Reworking an assembly jib to engineering specifications.

The following companies contributed to this article:

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modifications, then by using a tracker or an arm, you can measure it, collect point data on it and fit surfaces, curves or cross sections through it," he explained. "You then bring the data back into your CAD system to reverse-engineer a part or create a permanent record of the modified tool."

Savannah, Ga.-based Gulfstream Aerospace Corp. is one company that applies its 3-D measurement technology to reverse-engineer and perform conformation-of-design intent, said Medie Still, senior manufacturing technology engineer. He added that "cloud point" data is gathered using a Leica LTD 500 laser tracker, which is good for scanning surfaces and acquiring jig points, and two 12'-sphere FaroArms, for non-line-of-sight and tight places.

"We need software that can interface with all of our 3-D metrology systems," Still said. "We also need to interface with CATIA, and Build!IT allows us to acquire data for our CATIA interface and use the engineering design models for inspection or root-cause analysis on the shop floor." (CATIA is an integrated suite of CAD, CAE and CAM software applications from IBM.)

Whether the software for 3-D metrology applications supports reverse engineering, measurement, inspection analysis or tool building, Still emphasized that repeatability and accuracy is a major issue with quality-assurance personnel.

"You need to ask," said Still, "does it perform, is it reliable and is the data acquisition consistent?"