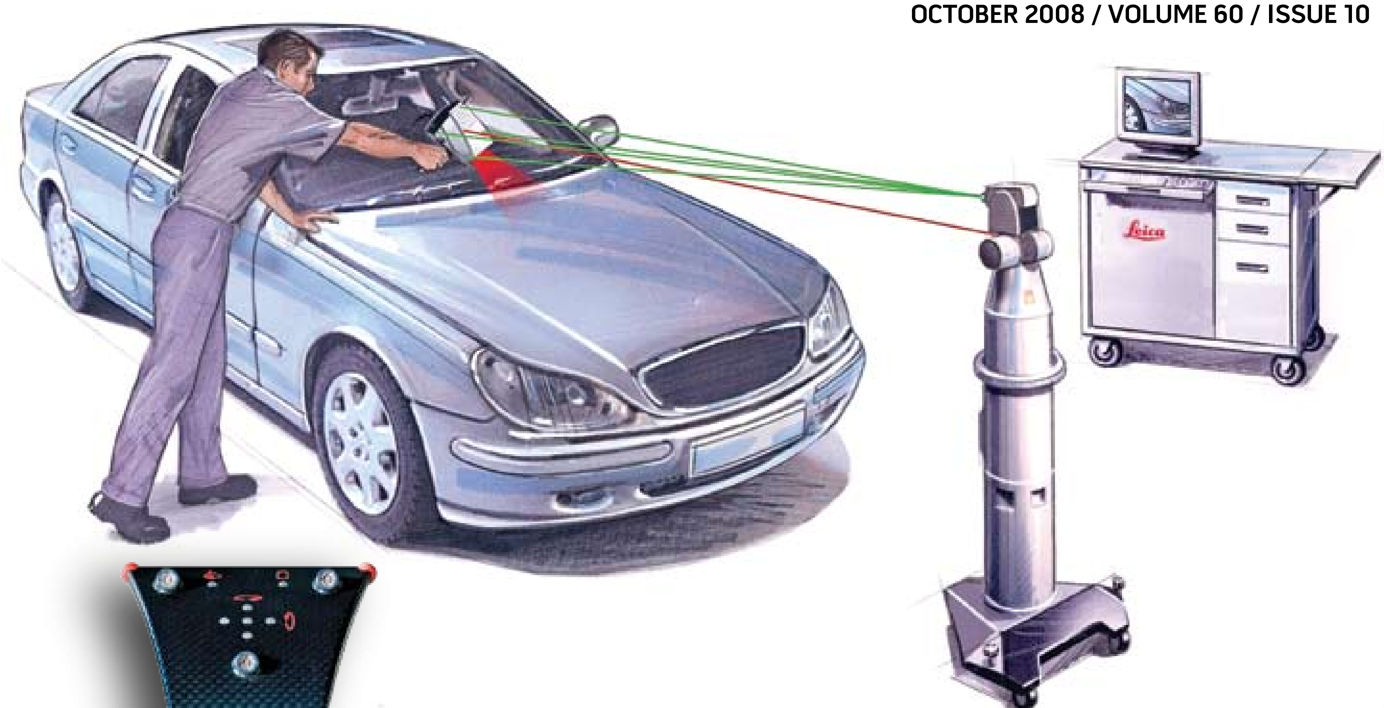
OCTOBER 2008 / VOLUME 60 / ISSUE 10



Hexagon Metrology

The Leica T-Probe, used in conjunction with a laser tracker, is a hand-held wireless device with a 15m radius.

Mobile Metrology

By Daniel McCann, Senior Editor

Portable coordinate measuring machines provide unprecedented flexibility, plus cost savings.

On a mid-August morning, Jeff Brehm, vice president of metrology for Computer Aided Measurement Services, St. Louis, hopped in his truck and headed southwest on I-55 for about 20 miles to Pevely, Mo., home of aerospace component manufacturer United Engineering Co.

United Engineering hired Brehm to measure a first-article wingspan for a new Gulfstream jet. When he started in metrology 25 years ago, such a project easily might have consumed 2 or 3 days. But included in his truck's cargo was a Leica laser tracker, which Brehm knew would enable him to wrap up the job and be home by nightfall.

"Before the tracker came out, we had computer-operated theodolites," he said. With that technology, metrologists typically spent a day setting up the equipment. The next day, "We'd fire up four different theodolite heads, which were basically like telescopes, and have an operator on each of the heads measuring. We would put a little target on the skin, everybody would take aim at the same dot and take a measurement, go to the next dot, take a measurement. It was a very painstaking process."

The aluminum wing skin at United Engineering measured 3" thick × 15' wide × 58' in length. Brehm first made sure the skin was flat and level "just like it came off a skin mill," he said. The wing skin's design had been incorporated into a CATIA (Computer-Aided Three-dimensional Interactive Application) model, which Brehm imported into the tracker's software so he'd have the proper alignments.

He then started measuring the part—scrutinizing the profile, pocket size, locations and sizes of hundreds of holes and edge trim on the outboard, inboard, fore and aft.

"The tracker is a laser interferometer, which basically makes distance measurements and uses horizontal and vertical encoders to get angle measurements," said Brehm. "The nice thing about it is that with the software we can actually make station moves, move that tracker around an object, utilizing at least three common points."

Nine hours after he started, Brehm had the data he needed and began to pack up.

Compared to previous technology, said Brehm, "Guys in the shop say using the laser track is almost like cheating."

PCMMs Highlight Flexibility

With their entrance into metrology in the early '90s, portable coordinate measurement machines (PCMMs)—from laser trackers to articulating arms and hand-held devices—have been an increasingly popular alternative to stationary CMMs. Prime among those attractions is the inherent flexibility of equipment that can be moved around shop floor or even travel across the country to measure parts large and small.

"PCMMs have changed the coordinate measuring industry," said Eric Lundquist, president of A.A. Jansson Inc., Waterford, Mich., a metrology consulting and equipment company. "In their initial introduction, they were used to measure large parts in loose-tolerance applications." Since then, their applications have expanded to include alignment verification for presses, machine tools, jigs and fixtures, reverse engineering and calibration of machine tools and robots.

While conventional CMMs are accurate and quick, they have their limitations, Lundquist said. They can't, for instance, perform reverse engineering or measure parts in the field. Moreover, he continued, "for many large applications, conventional CMMs were too expensive due to size. PCMMs addressed these constraints by being portable in nature and relatively small."

Brek Manufacturing Co., Gardena, Calif., a maker of airframe components, uses a PCMM to complement its traditional CMMs. "We have three CMMs," said Enrique Tenorio, applications manager. "But we use the Leica Absolute laser tracker if we need to measure a part on the machine or to verify a part when we cannot take that part off of the machine."

They also use the tracker for large machined parts, such as the 800-lb., 280"-long A380 wing spar. "To measure it, we load the model [for the spar] into the tracker, create an alignment on the part and start measurements of features that are important for our analysis," Tenorio said. "The tracker is efficient, user-friendly and provides us with much flexibility for inspection operations."

The Leica's accuracy is close to a stationary CMM. "We have done some tests and have seen only a slight difference between the two systems," Tenorio said.

Measuring 2' tall and weighing 48 lbs., the Leica laser tracker's measurement accuracy is guaranteed to 10μm up to 40 meters radially, said Dave Armstrong, Leica Systems product manager for Leica Geosystems, a division of Hexagon Metrology Inc., North Kingstown, R.I.

One of the more recent developments to be used in conjunction with the laser tracker is the Leica T-Probe, a hand-held wireless device for measuring deep locations, small holes and detailed areas. "It's like a CMM in your hand," said Armstrong. "It's a noncontact scanner that communicates with the laser tracker and has a 15m radius."

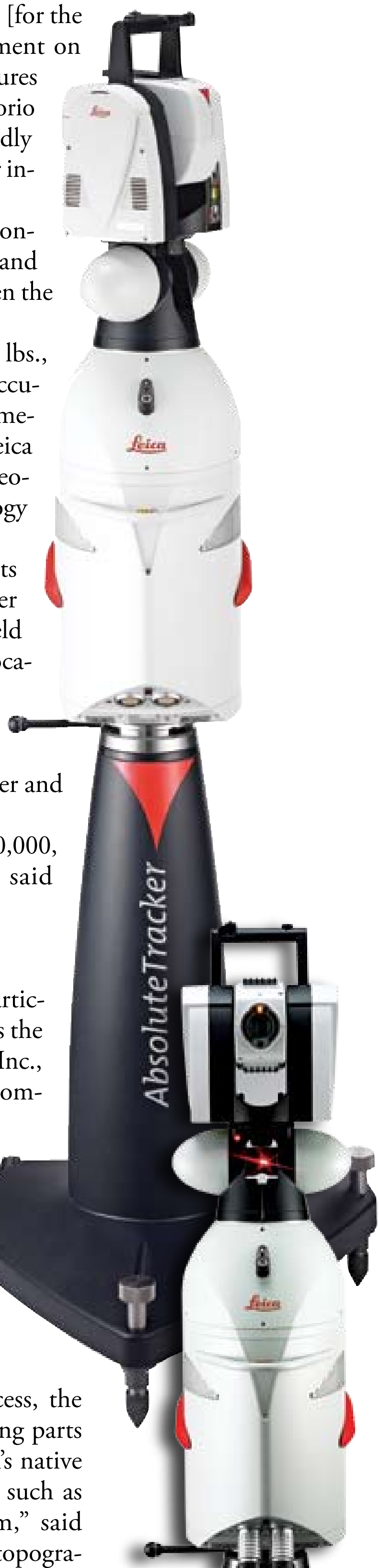
The Leica laser tracker costs about $140,000, and the T-Probe lists for $80,000, said Armstrong.

Articulating Arms

Another PCMM technology is the articulating arm. Among the latest models is the Laser ScanArm from Faro Technologies Inc., Lake Mary, Fla. With the ScanArm, companies can acquire both contact (point) data and point-cloud laser scans without the need to swap instruments, said Darin Sahler, global public relations manager for Faro. The device can perform inspections, tool certification, CAD-to-part analysis and reverse engineering of custom parts.

"At the very beginning of the process, the design phase, engineers can scan existing parts and designs, feeding data into the arm's native CAM2Q or other software platforms, such as Polyworks, Geomatic and Rapidform," said Sahler. "A scanner recreates the digital topography of a surface—fender, oil pan, door or tool—in files that are often 100 times more dense than those generated by contact instruments."

On the production floor, Sahler continued, users can attach the Laser ScanArm directly to machinery, then guide the touch probe along the surface of the object being inspected. The



Hexagon Metrology

Measuring 2' tall and weighing 48 lbs., the Leica laser tracker's measurement accuracy is 10μm up to 40m radially.

ScanArms' laptop computer then illustrates the 3-D measurement on-screen and records the data, essentially creating a 3-D blueprint.

"These files are converted by software in maps," continued Sahler, "wherein the software compares the file to the original CAD surface, then generates a topographical image on which the relative tolerances of the surface are color-coded in shades of green to blue to red."

The color-deviation maps help simplify what previously had required time-consuming measurement analysis, said Sahler. "If a problem is developing," he said, "you can see color shifts from one generation of map to another, and the production team can take corrective action before a problem becomes serious." The base price for the ScanArm is $71,000, and the scanning unit is accurate up to 0.0014".

A-Line Precision Tool

A worker at A-Line Precision Tool uses the FaroGage to measure hard-to-reach spots.

Hand-Held Gage

In addition to taking measurements, inspection applications are also an important use for one of Faro's products, the FaroGage. "It's like a robot arm," explained Rob Muru, president of A-Line Precision Tool Ltd., Toronto, which purchased one 2 years ago. "You set a probe on it and use that to touch the part [under inspection]." With a 48' working volume, the FaroGage, priced at $19,000, has an accuracy of 0.0002".

"We originally bought the FaroGage for a job on submarine search equipment. We were fabricating an aluminum frame; it was a tricky job that involved 950 measurements and a CMM wouldn't have been able to finagle in and around the part. We had to get some measurements on the fly in some hard-to-reach places."

Ten years ago, without the FaroGage, A-Line wouldn't have been able to do the project, said Muru. In fact, the gage unveiled some blueprint discrepancies that otherwise might have gone unnoticed. "We saw 50 or 60 conflicting measurements on the drawing that didn't make sense," Muru said. "We found that out on the FaroGage, which meant that somehow, whoever was making this thing before was either fudging the numbers or doing something [wrong]. The FaroGage verified measurements and machining that were not verified before. And [the client] didn't know anything about anything being out of whack."

A Nose for Problems

Discovering longstanding machining imperfections is not uncommon among PCMM users, especially with the technology's increasing accuracy. "We find issues, especially in tooling, that might have been causing problems for years and all of a sudden they pop up [while taking measurements]," said Brehm of Computer Aided Measurement Services. He said one manufacturer consistently made a jet fuselage joint fixture 1" too large. "It had been that way for 10 years, and we went in and fixed it," he said.

Improving products and reducing costs is a large attraction of the PCMMs. At Parallel Robotic Systems, Hampton, N.H., which produces hexapod-type robots for biomechanical applications,

How often should you calibrate?

WHILE EVERY MANUFACTURER would endorse the importance of maintaining well-calibrated measuring and test instruments, just how often that equipment should be recalibrated is an open question.

The International Organization for Standardization (ISO) 9000 requirements, which address the issue, state only that companies have to regularly recalibrate their measuring instruments and maintain a record of those inspections and adjustments, said Jim Ingram, owner and principal consultant of J. M. Ingram & Associates, a management and metrology consulting firm headquartered in Ogdensburg, N.Y. The ISO does not specify how often those calibrations be made.

"I've worked with more than 175 calibration laboratories in the last 6 years and one of the biggest problems I've run into is that the laboratories' customers don't know how to calculate a calibration interval," said Ingram. "In the 1970s, the average calibration interval was 6 to 9 months. Today, because of the continuing improvement of instruments, that interval is a year or two, according to many manufacturers' guidelines."

But, he added, companies should consider adjusting those time spans if their instruments are heavily used (10 times a day vs. once a month), if they're often operating in extreme heat and high humidity, and if they're frequently transported, which increases the chances of mishandling.

"Usage and past calibration history are the big factors," said Ingram. "It's up to the user to evaluate not only the most recent calibration report, but the previous three or five that they have on record. If history shows that the instrument has to be adjusted every time it goes in for calibration, they know they should schedule calibrations more often to ensure reliability. On the other hand, the instruments may be found to be very stable, thus allowing a longer calibration interval and costs savings."

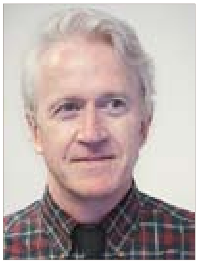
—D. McCann

workers routinely use FaroGages to determine the exact tolerances required for each project.

The gage, said Andy Chui, Parallel's manager of engineering, "allows us to find out the needed dimensions for our parts. So we save money when we can tell a machine shop they don't have to control for tight tolerances (on certain parts and locations)."

It's these types of returns on investment that, increasingly, are boosting the popularity of PCMMs. "Not only are PCMMs addressing the markets that conventional CMMs can't," said Lundquist of A.A. Jansson. "Their advancements have allowed them to compete in both the conventional CMM and the theodolite markets. Because of their improved accuracies, ease of use and versatility, they are becoming a preferred choice by manufacturers and inspection houses. They truly are the next generation of measurement." **CTE**

About the Author: *Daniel McCann is senior editor of* Cutting Tool Engineering. *He can be reached at dmccann@jwr.com or (847) 714-0177.*



contributors

A.A. Jansson Inc.
(248) 674-4811
www.aajansson.com

A-Line Precision Tool Ltd.
(416)-769-4557
www.a-linetool.com

Brek Manufacturing Co.
(310) 329-7638
www.brekmfg.com

Computer Aided Measurement Services
(314) 868-0868
www.cams3d.com

Faro Technologies Inc.
(800) 736-0234
www.faro.com

J.M. Ingram & Associates
(315) 393-0229
www.jmingramassociates.com

Leica Geosystems/Hexagon Metrology Inc.
(800) 343-7933
www.hexagonmetrology.us

Parallel Robotic Systems Corp.
(603) 926-7454
www.prsco.com