NRK TODAY

TRENDS AND ISSUES IMPACTING METROLOGY & SPATIALANALYZER® VOLUME 6

Customer Spotlight: Perceptron

Perceptron provides automated metrology systems around the world to manufacturers of complex assembled products for in-process and near-line dimensional inspection. Perceptron sells automated robotic metrology systems primarily to major automobile manufacturers and suppliers. In early 2010, Perceptron adopted **SpatialAnalyzer® (SA),** specifically the SA Machine product, to cost effectively calibrate and compensate industrial robots to achieve the repeatability and accuracy necessary for inspection operations.

There are three main categories of robot calibration: Extrinsic calibration locates the base of the robot in the part coordinate system. Intrinsic calibration determines all of the link lengths, twist angles, joint zeros, link offsets, and stiffness parameters. Drift calibration adjusts some of the intrinsic parameters that drift over time by taking a subset of the calibration measurements throughout the process. SA Machine is used to do all of these calibrations in the Perceptron workcells.

How do Perceptron's clients benefit from SA Machine?

SA Machine compensates for the effects of thermal variation on the robot by effectively removing the impact of robot temperature changes on measurements. For example, when you first start using a robot that has been sitting idle, the robot will physically expand as it heats up from the thermal expansion of its links. As a robot continues to heat up, the change can be as great as 0.5 mm (0.020") or more, which can significantly impact repeatability of measurements. However, SA Machine can calculate and remove these thermal effects from the measurements so that the measurements are repeatable (typically within 0.10 mm, or 0.004" 6 sigma), regardless of changes in the robot.

When used with a laser tracker, SA Machine calibrates the robot by creating an accurate kinematic model. This allows Perceptron to report absolute accurate results in part space without requiring correlation to a reference device. For example, while an industrial robot is usually very repeatable (particularly after you compensate for thermal variation), it isn't inherently accurate. However, using SA with a laser tracker allows the user to calibrate the work envelope of a robotic measurement system directly into the part coordinate frame. This allows Perceptron to install an absolute accurate robotic metrology system and immediately generate results that are accurate to within 0.25 mm (0.010") without any offsets.

SA Machine reduces production line downtime because it is embedded into Perceptron's automated gauging systems. For example, once the system is installed and running, the temperature compensation data collection and adjustments are performed automatically in between measurement cycles. This avoids downtime and prevents bottlenecks.

Is Metrology a Value-Added Component?

Yes! Perceptron achieves value-added status by bringing automated metrology directly into the manufacturing process. By being part of the process and measuring very rapidly, 100% of production is measured, thus validating the dimensional quality of every part and providing insight into the manufacturing process. This insight gives Perceptron's customers the ability to pinpoint the root cause of variation, identify trends, and improve where necessary. Ultimately, this allows Perceptron's automated metrology systems to establish a strong ROI rather than be labeled the "cost of quality." ■

Aerospace Manufacturing & Metrology go Hand in Hand

The use of composite parts is integral to the future of aerospace manufacturing in order to build lighter, more efficient planes. While the operating costs of airplanes constructed of composite parts are lower, the manufacturing costs of such airplanes are typically higher. Composites—lightweight, strong, and durable—are more expensive than steel and aluminum, and metrology-assisted assembly is critical to making the manufacturing process cost effective. As composite parts become more extensively used, the role of metrology is becoming more widely recognized as a value-added component.

Generally speaking, metrology-assisted assembly with advanced metrology equipment and sophisticated software, such as **SpatialAnalyzer® (SA),** results in shorter production cycles and greater cost efficiency. This is especially true in the aerospace industry where composite parts are becoming more common. Compared to metal, composite is hard, unforgiving material; so accurate assembly adhering to very narrow tolerances is absolutely necessary to "get it right the first time." In addition to helping manufacturers avoid costly scrap and rework, the use of metrology software saves time and money by replacing hard tooling with 3-D models. Instead of being limited to fixed tooling structures, 3-D models can serve as flexible tooling, allowing users to react more flexibly to engineering changes.

When it comes to measuring large-scale parts like those used in aircraft manufacturing, portable metrology instruments offer convenient, user-friendly solutions. Software like SA can integrate multiple instruments, as well as synthesize and optimize data

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Metrology & Proton Therapy for Cancer Treatment

Proton therapy is a type of particle treatment that uses a beam of protons to treat cancer, most frequently localized, isolated tumors. Compared to standard radiation treatment, proton therapy delivers a high dosage of radiation that is very focused on the diseased tissue. Not only does this method necessitate fewer treatments, but also produces fewer side effects and leads to less damage to healthy surrounding tissues.

East Coast Metrology (ECM) recently undertook the challenge of aligning a proton therapy system for McLaren Proton Therapy Center in Flint, Michigan. The facility is comprised of a synchrotron, switchyard, three patient rooms, and gantries that revolve around the patient positioning system within the patient rooms. How does proton therapy work? The protons travel around the synchrotron's ring, which increases their energy to between 70 and 250 million electron volts (a voltage high enough to place protons at any depth within the patient's body). From there, the protons exit the synchrotron and travel down the switchyard where they are guided to one of the treatment rooms. The 45 ton gantry that revolves around the patient positioning system directs the beam precisely to the appropriate place on the patient's body.

"SA software was critical to the success of this project."

With an accuracy requirement of 0.1 mm (2 sigma) to design, install, and measure the control network, synchrotron, switchyard, gantry, and patient positioning system; ECM performed measurements using over 50 laser tracker positions, several total station set-ups, and multiple digital level survey loops. The project also required connecting measurements through three narrow passages and the use of over 50 control points on the floor and walls to tie everything together. Using **SpatialAnalyzer® (SA),** measurements were performed after completion of initial building construction, 90 days later just prior to systems installation, and after the many tons of radiation shielding had been installed. Other challenges facing ECM included increasingly restricted visibility to alignment features and the fact that the new building was settling (particularly after the shielding weight was installed).

After ECM prepared a comprehensive alignment plan, they used SA to:

- perform control network design
- bundle multiple instrument measurements
- automate component measurements using SA's Measurement Plan scripts
- construct relationships to optimize fit-ups between features
- graphically display measurements, points, instruments, sight lines, and uncertainty clouds.

ECM's experience with SA coupled with their knowledge of both Leica and Faro equipment was crucial for the success of the installation at McLaren Proton Therapy Center. Ray Ryan of ECM says, "SA software was critical to the success of this project."

In order for proton therapy centers to deliver effective treatment that leads to better patient outcomes, their proton therapy equipment must be accurately installed. What is the key to accurate installation? High accuracy metrology. ■

Control: International Trade Fair for Quality Assurance

May 8-11, 2012 will be the 26th annual Control International Trade Fair for Quality Assurance in Stuttgart, Germany. The 2011 Control show saw over 24,000 attendees from 72 different countries and 820 exhibitors from 27 different countries. Considered the world's leading quality assurance trade show, Control includes all technologies, products, subsystems, hardware, and software solutions that relate to quality assurance. 2012 promises to be an even more popular and widely attended show as quality becomes increasingly more relevant in the manufacturing world. New River Kinematics will exhibit **SpatialAnalyzer® (SA)** this year at Control for the fifth consecutive year. NRK's international presence continues to grow as metrology itself continues to expand worldwide. ■

SA Remote

SA Remote is the official iOS app that allows real-time viewing of 3-DOF and 6-DOF spatial data from **SpatialAnalyzer® (SA)** and allows remote control of the SA Laser Tracker interface. Available for free download at the Apple App Store, SA Remote can run on your iPhone®, iPod® touch, or iPad®. Here at New River Kinematics, we've found that an iPod touch makes the perfect SA Laser Tracker remote control.

Very popular amongst SA users, SA Remote is already saving people time and effort on the job. Scott Leedy, 3D Engineer at Applied Aerospace Structures Corp. (AASC), began using SA Remote as soon as the app was released. It especially came in handy when Leedy's team needed to level a tool that was too large to adjust while keeping the computer monitor in sight. Using SA Remote with an iPod touch, the technician was able to watch the numbers in real time at each adjustment location—a job that would normally require two people. Leedy says, "We keep an iPod touch with SA Remote on each of our three systems and use them for remote triggering as well."

Brock Peterson, Alignment Engineer at AASC tells a similar story, "One of our Aircraft products requires getting under the work piece and scooting around on the floor. The tracker and workstation are both 15' away from the piece, but with SA Remote I am able to set the measurement mode and target names without having to get out from under the work piece."

Interested? Visit the Apple App Store to download SA Remote for free today. ■

Electroimpact & SpatialAnalyzer®

Founded in 1986 and headquartered in Washington state, Electroimpact is a key supplier of major aerospace companies around the world. Focused on building large machines and tooling, Electroimpact specializes in integrating factory automation and tooling to deliver custom production solutions to their clients. Electroimpact's products, among others, include CNC drilling machines, wing panel and spar machines, and aircraft assembly fixtures.

Electroimpact adopted **SpatialAnalyzer® (SA)** seven years ago because they liked its analytical capabilities. Most notably, SA's sophisticated uncertainty analysis tools and the flexibility it offers in bundling instruments and networks appealed to the engineers of Electroimpact. Today they use many of SA's analytical tools to model complex uncertainty interactions and prepare for measuring needs before they are on a customer's site. They also use SA to model and present different metrology solutions, which allows them to predict measurement performance and validate recommended solutions during the proposal process.

Large Multi-Axis CNC Machines

When it comes to large multi-axis CNC machine compensation, SA comes in handy in more than one way. Large CNC machines present a unique challenge for efficient and accurate volumetric compensation, particularly in aerospace applications where extremely tight tolerances are required. Electroimpact has employed several methods including the use of SA to improve the efficiency and accuracy of the compensation process.

SA's Measure Stable Point Capability & Measurement Planning

The engineers at Electroimpact use several technologies to reduce machine compensation time, including SA to automate the machine compensation process. For example, SA's measure stable point capability can be used to automate measurement triggering during the machine compensation process. Using this capability, SA takes a measurement every time the tracker detects that the target is stable, thus saving time and eliminating the need for manual triggering by an operator. For more sophisticated measurement sessions it is advantageous to close the loop of communication between the tracker PC and the CNC machine. This was done by using SA's Measurement Plan custom scripting language in conjunction with a bespoke C# program. For advanced Measurement Planning uses, they've utilized SA training which accelerated the learning process with Measurement Plan implementation. Regarding technical support, engineer Rob Flynn finds the assistance he receives from New River Kinematics to be "consistently excellent." "SA support engineers have often gone beyond the call of duty for us by providing support at odd hours, showing up on site to provide direct support, or by investing real engineering time into solving a problem," he says.

"SA support engineers have often gone beyond the call of duty…"
Rob Flynn, Engineer

SA's Uncertainty Analysis Tools

In the case of testing and evaluating potential metrology solutions for machine compensation, Electroimpact brings SA's uncertainty analysis tools into play. When multiple tracker stations are necessary, SA allows users to propose instrument locations, establish target locations, and simulate measurements and compute the uncertainty of those targets. This simulation process saves time by eliminating the trial and error process and ultimately helps engineers rationalize how many trackers should be used, where each tracker should be placed, and predict the measurement sessions uncertainty. Flynn considers uncertainty analysis to be "an essential part of any engineer's toolbox for machine compensation." ■

NRK Metrology Institute – Expanded 2012 Course Schedule at Locations around the World

SpatialAnalyzer® (SA) is an amazingly powerful and robust software package. To ensure that SA users are getting the most out of SA and have an opportunity to participate in regularly scheduled training, the NRK Metrology Institute now offers an expanded schedule of SA training courses. This will include for the first time a multitude of classes around the US, as well as opportunities in Europe and Asia. Realizing that it isn't always easy for everyone to travel to NRK headquarters in Williamsburg, VA, the goal is to give users the opportunity to attend a class closer to home.

In addition to Williamsburg, regularly scheduled classes will be held at locations including Dallas, TX; Detroit, MI; Los Angeles, CA; and Seattle, WA. Specific locations will be announced within a month of any given class, but typically a convention center or hotel near the airport will be used. International training opportunities will also be announced later in the year. For a complete schedule of upcoming training courses, visit www.kinematics.com.

There are three standard SA training courses currently offered:

Introduction to SA: Suitable for the new user or self-taught users who have been using SA for less than six months. It is highly recommended that all new users take this course so they can be sure they are getting the most out of their use of SA.

Advanced SA: Suitable for people who have been using SA for six months to two years, or users who have already taken Introduction to SA.

Measurement Plans (MP): Best suited for the most advanced users of SA who want to learn how to script out commands in order to automate specific processes in SA.

The NRK Metrology Institute is also busy ramping up to offer courses that are increasingly more robust with course materials (reading materials, presentation slides, video, etc.) that can be used for future reference. Classes are taught by Todd Burch, NRK Director of Training. ■

NRK METROLOGY INSTITUTE

VMT GmbH: Supplying the Tunneling Industry Worldwide

VMT GmbH, a survey technology company, was founded in 1994 to supply a wide range of custom solutions, services, and surveying systems to the tunneling industry. Headquartered in Germany, VMT undertakes tunneling projects all over the world, including current projects in the UK, China, Hong Kong, and Australia. One of their major products that is used worldwide is a specific system that guides tunnel boring machines in segment-lined and pipe-jacked tunnels.

When manufacturing large size concrete segments to be used for tunnel linings, precisely assembled steel moulds with stringent quality control measures are employed to ensure correct fabrication of the concrete segments. Increasingly narrow tolerances are required for segment dimensional accuracy; so a reliable, efficient measuring method is essential to determine the linear dimensions and angular properties of the moulds. Due to the fact that measurements are needed during the early stages of the fabrication process and usually take place at the mould supplier's plant, the project requires portable metrology equipment and corresponding metrology software.

VMT uses **SpatialAnalyzer® (SA)** with Laser interferometer systems to measure both moulds and segments. SA is used not only to drive the laser trackers, but to process the measurements, compare them to the original CAD models, and to use SA's spatial transformation capability for optimum fit analysis (SA's Best Fit and Bundling capabilities). Using 3D models allows for the detection of defaults that would have gone unnoticed during a mechanical inspection. This method also allows VMT to take multiple measurements and analyze them quickly enough to meet the requirements of a high speed quality control and quality assurance process.

Large size concrete segment fabrication for tunneling projects typically follows this sequence:

- Delivery of moulds
- Verification of moulds' geometric properties
- Production of segments
- Verification of segments' geometric properties
- If needed, maintenance/refinement of moulds' mechanical and geometric properties.

This process differs from previous fabrication management in that it allows for more attention and analysis of the geometric properties of the moulds and segments; not merely their mechanical integrity. Not only can VMT rapidly perform these measurements, but this type of quality control also allows VMT to react more flexibly to potential problems and more proactively prevent defects. Instead of identifying defects after a segment has been transported to the tunnel, VMT saves time and resources by identifying any problems before the segment leaves the fabrication plant. ■

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Aerospace Manufacturing & Metrology go Hand in Hand

from a multitude of sources. SA enables users to share equipment and therefore choose the combination of measurement technologies that best fits the measurement job – all with a common interface *and* the capability of running any number of measurement sensors simultaneously.

The past fifteen years has seen an expansion of metrology use throughout the manufacturing process, particularly in the case of aerospace. Today, metrology

"…absolutely necessary to get it right the first time…"

is widely used in production *and* is being adopted by design teams and other departments further upstream in the production process.

The growing acceptance and application of metrology-assisted methods in aerospace manufacturing has led to the integration of metrology in everything from production, to process control and assembly, to fully-automated inspection, and troubleshooting. This has basically brought metrology, and therefore quality, fully "into the fold" of the entire manufacturing process. When fully integrated in the manufacturing process, metrology and quality become not only value-added but required. ■

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