NRK TODAY

TRENDS AND ISSUES IMPACTING METROLOGY & *SPATIALANALYZER* VOLUME 2

Big Projects, Bigger Solutions

Northrop Grumman Newport News Shipbuilding is world-renowned, for the scope of its operations as the largest dry dock in the world, and for the ships it builds for the United States military. With more than 21,000 employees, having the right tools and processes are critical. And one component of process that's changed in the past few decades is software applications.

Phil Caudill, the supervisor of the Dimensional Control Group, shared how the shipyard operated in the past. "At one time, we'd have measurement technicians become experts on a particular measurement system and its manufacturer's software."

Innovations to software can do more than change day to day work, it can also change the entire problem-solving process.

USS Ronald Reagan.

But then the process became more cumbersome. "With the measurement surveys increasing, becoming more diverse, and the addition of several new measurement systems, we needed to ensure any technician could use any measurement device, perform analysis, and report the results," Caudill said.

In general, the integration of portable metrology has had a huge impact on how large-scale projects are built, including the nuclear-powered aircraft carriers and submarines constructed at Northrop Grumman's Newport News Shipbuilding division. "Although not the largest of trades that work on the ships, the impact portable metrology has made over the years is significant. Portable metrology has been used to align everything from catapults, to missile tubes, to navigation systems," Caudill said.

It's also been used to determine neat cuts on super lift units, allowing the units to be prepared for joining in a remote location long before setting them on the ship. Caudill said portable metrology has grown to a point where it is now planned into the shipbuilding processes. It's relied upon to meet schedule and accuracy demands throughout the shipbuilding process.

Innovation at the shipyard occurs on a constant basis. "Technicians are now trained on one software that they use for almost everything measurement related. This change allowed each technician to become proficient and perform analysis on their data all while using one software," Caudill said.

That one software is called *SpatialAnalyzer* and it was implemented when Ron Hicks supervised the Dimensional Control Department at the shipyard. He said, "when I worked for Newport News Shipbuilding, I could really see how the universality of *SA* was important. People who ran the variety of software on each of the devices couldn't be used in other areas. Now that *SA* is the common software interface, it's easy to adjust people to other devices."

Bob Salerno, co-founder of New River Kinematics, the company that makes *SpatialAnalyzer,* said that the shipyard is one of the best examples of how having the right software can make a difference to how measurement and data collection are performed. ■

CMSC: The Industry Connects

While there will surely be discussion of metals versus composites at the Coordinate Metrology Systems Conference this year, metals may win out. Why? Because it's the Silver Anniversary of the CMSC, well-known as the best-attended annual industry event for Coordinate Measurement Technology Professionals.

This year, the annual CMSC crams three days full of industry topics, people and products into one place – Louisville, Kentucky. It's a time and place where booths, tables and hallways are filled with people discussing ideas, concepts, and theories with their peers. The educational atmosphere encourages attendees to network and learn about the latest innovations in the field of portable 3D industrial measurement technologies. Conference attendees hail from prominent science/research laboratories, and diverse industries such as aerospace, space hardware, antenna, automotive, shipbuilding, power generation, and general engineering.

Scott Sandwith, a member of the executive committee, said that the highlight of the show for him is all of the discussion that happens between industry professionals. "I love to see all the people coming together and discussing the work that they do every day. The innovations that the industry has made in technology are remarkable, and that's only enhanced by the exceptional people who work with it."

CMSC 2009 features whitepaper presentations by industry experts, advanced workshops and an Exhibition Hall packed with technology and service providers. Workshops feature user education and technical guidance, and Sandwith, also an applications engineer for New River Kinematics,

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Group Benefits of *SA* Licenses: One for All and All for One

When it comes to the bottom line, it's always nice to see the value you're getting from your vendors. And in this economy, it'd be even better to prove that company investments are well-spent. One of the ways to do that is to investigate a group license for *SpatialAnalyzer,* the industry leader in metrology software.

Because budgets are due now for purchases planned in the future, it makes sense to look at expenditures in the long term. And don't forget maintenance and upgrades, which can sneak up if you forget to calculate them in your initial budget. One easy way to take the long range view for your portable metrology needs is the Group License Program from New River Kinematics (NRK), which makes *SpatialAnalyzer.*

Don Savoie, Western Region Sales Manager for NRK, often has to lay out the plan in two or three year increments using a Group Investment Analysis. That's a comparison of current cost versus new planned purchases and/or upgrades of *SA* functionality.

"The three primary costs compared are maintenance, new license purchases and upgrades to an existing *SA* license and we customize the numbers comparison for our clients. The driving factors are the current number of *SA* licenses, cost of maintenance and an understanding of a customer's requirements over the next few years," he said.

The immediate benefit of acquiring a group license is that all current *SA* licenses then fall under one annual agreement, in effect, extending the maintenance agreement. The future benefit would be that annual maintenance costs will be at the reduced *SA* group pricing, which could be as much as 30% - 40% savings, according to Savoie.

NRK is known for its customer service, and regularly trains operators at their headquarters, as well as on-site for many of its clients. One advantage with a Group License is that clients can bundle discounted annual training programs with their annual maintenance agreement. This can help clear potential budget hurdles in seeking separate funding for routine training.

Continuous education is important and helps to maintain productivity at its peak performance. To support this, free on-site annual update meetings are offered to group license customers. When NRK publishes a new version of *SA*, these releases are available to all customers covered under the annual maintenance program. An update meeting helps group customers to derive maximum return on their investment in *SA*. The meetings cover a variety of topics, including a review of new *SA* functionality, Q&A for customer specific areas of interest, and how-to techniques.

When looking for ways to get the most for your money, eliminating budget lines is always a bonus. "With a Group License, a customer could add the cost of a week or two of training at a discount to their annual maintenance agreements," Savoie said.

And as business grows, a company under the Group License agreement has the ability to save even more — they can purchase additional licenses or upgrades at significant savings. Planning for growth is an important step for the overall bottom line, and so is standardization, another goal that *SA* helps its clients to achieve.

The Group License Program helps standardize *SA* as the metrology solution for all portable measurement technologies. *SA* makes it easy for users to build, inspect, and reverse design parts and tools because it provides a simple common interface for each of the technologies. "Once a user can run a job with a Leica tracker they can also run the job with a FARO, API or even a Metris Laser Radar. This capability enables measurement groups to share equipment and therefore choose the combination of measurement technologies that best fits the measurement job - without having to retrain operators," said Savoie. And as anyone in manufacturing knows, standardization saves on all fronts: labor, software investment, training, information analysis and distribution.

"The group license afforded us the ability to adopt *SA* as our standard metrology software …"

Jeff Watkins, Dimensional Control Manager for Northrop Grumman has seen benefits from the group license program.

"As a group license holder for nine years, we've derived many benefits from *SA*. We have saved a substantial amount of money on new license additions and annual maintenance. In addition, the group license afforded us the ability to adopt *SA* as our standard metrology software for portable measurement instruments and analysis," he said. He added that *SA's* capabilities and common interface greatly improves productivity and minimizes the training requirements when adding new measurement technology and personnel.

Clearly, there are financial and operational reasons to investigate the *SA* Group License Program. Are there any intangible features of the Group License agreement for clients?

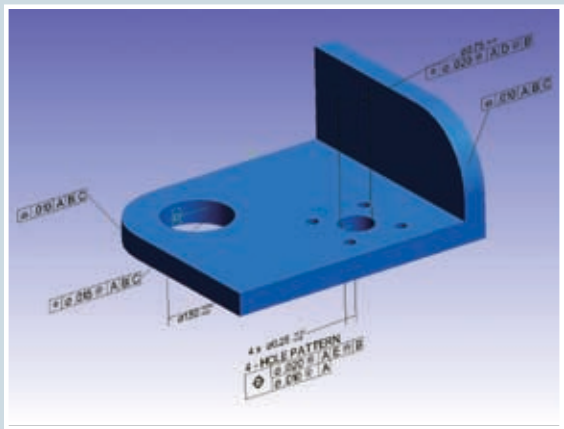
Well, Savoie admits there are a few. "Because larger groups will be providing more feedback, they will inevitably have greater influence with their input on new product features and functionality," he said. And this can be an even greater advantage if a client is looking for a customized solution. Within the industry, NRK is known for its responsive culture, and willingness to problem solve. So the more people using *SA*, the greater the potential that feedback will eliminate even the smallest of issues for their future. ■

How GD&T is Changing Metrology

GD&T, or Geometric Dimensioning and Tolerancing, has become an industry standard as well as a different way of describing tolerance. Rather than the traditional reference frame, GD&T emulates the constraints of putting something together, based on the kinds of spatial relationships of the parts. It includes symbols, rules and even vocabulary for communication among engineers. It's the ultimate way that they "get on the same page," because in the past, there were differences in interpreting drawings and that caused errors.

It's been proposed and circulated by different organizations, but in the United States, it was ASME, the American Society of Mechanical Engineers, that formalized the standards for GD&T. The code was revised in 1994 to clarify the standards even further. A similar international standard is put out by the International Standards Organization, or ISO. These codes create the framework for how the industry implements them.

Bob Salerno, co-founder of software company New River Kinematics, explained that in GD&T, the relationships are the most important. "It's like how kinematics is the science of spatial relationships, and GD&T is a way of describing them," he said.



One of the most exciting changes that has recently occurred is the development of methods for directly coupling the designer's intent, as described through GD&T, to the inspection process. This effectively allows designers and measurement technicians to communicate exactly what is critical about a given part. It also puts the designer in control of the process and relieves the person doing the inspection from having to understand how this part mates to all the other parts.

The implementation and continued adaptation of GD&T has brought engineering and production a long way in the past 36 years since the code was adopted, and that is expected to continue as it's adopted more universally. ■

Innovations for Exploration at NASA

Working for NASA has some unique challenges that are assisted by developments in portable metrology, and the software program *SpatialAnalyzer*. "Everything we make is one of a kind, so we've got to get it right. These are billion dollar projects," said Henry Sampler, an optical physicist for NASA Goddard in Maryland.

Right now, Sampler is working on two projects: the James Webb Space Telescope that will replace Hubble in 2014, and the Lunar Reconnaissance Orbiter that will soon be mapping the surface of the moon. Each of these projects needs the precision metrology that *SpatialAnalyzer* brings to the process.

The goal of the LRO project is to find good landing sites on the moon, as well as locating topographical features and resources. This is done through creating an atlas of the moon through different cameras mounted on space craft. The images get stitched together, and Sample says that's where *SA* comes in.

"You have to know how the cameras point relative to the instrument, so that we can tell where we are in relation to the sun, the earth, and the stars. I've made a model of the LRO, with all of the bore site vectors relative to each other, which helps the science group to get their bearings," Sampler said.

In *SpatialAnalyzer,* Sampler creates a model, including all the pointing measurements that have been collected, describing the instruments orientations. "It helps prevent errors, and I used to send pages and pages of data and info to my altitude control guys, now I send a visual model through *SA*," he said. Sampler also said that his *SA* shortcuts save time and that it's easy for him to share data with his team through *SpatialAnalyzer*, especially using the FREE *SA* Viewer download. In working on the Hubble Space Telescope Project, the crew used *SA* to fit measurements to the model allowing us to verify that the instruments would fit in when replaced on the Hubble Space Telescope.

A mock-up of the Orion space capsule heads to its temporary home in a hangar at NASA's Langley Research Center in Hampton, VA

Over at NASA Langley in Virginia, *SpatialAnalyzer* is also advancing innovation. Richard Chattin, a Senior Technician in the Material Processing and Precision Measurements Section, works with metrology devices everyday because his department works with composite modeling development. They are using Leica laser trackers for measurements on the Orion space capsule, specifically the 4-bay crew module.

"We had several trackers with different software, but now we are using *SA*, which has better support and can be used on all of the equipment," Chattin said. He also said that the reports generated in *SA* are more sophisticated. "It's very powerful software, and I know I haven't even scratched the surface. I'm looking forward to sitting down and learning more about all the functions," he said.

Of course, NASA faces tough internal audit procedures and *SA* offers more efficiency, reporting options and ease of data review. Many of the contractors are now using *SA* and both Chattin and Sampler have been working with them to get up to speed. "It's changed the way we do things. Making sure that everyone is on the same page is important. The data we provide can be used by any engineer," Chattin said.

In the case of the James Webb telescope, parts of it are being constructed in decentralized sites because its part of an international effort. Mechanical engineers all over the world are working with *SA* to coordinate among partners. Sampler said that using the same software has improved communication and confidence—and helped prevent errors.

"I was looking at a model on *SA*, and it saved me on one of the fixtures because I was able to determine that the line ran right into a wall. Catching this early prevented an international embarrassment!" he said.

One of the big differences with *SpatialAnalyzer* is that the company that makes it: New River Kinematics of Williamsburg, Virginia, is committed

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SpatialAnalyzer Provides Total Solutions for Portable Metrology

Bob Salerno has been in the metrology industry for the past 20 years, and he's a problem solver. In his role as a mechanical engineer and co-founder of New River Kinematics, he gets a lot of calls from clients in the aerospace and shipbuilding industries for problem solving.

As the industry innovated rapidly, certain issues bubbled to the surface. "One of the reasons people call with a production crisis is that they are doing something like trying to get a part to fit, and can't find the reason why it's not working. Many times it's transferring data from one measurement environment to another," Salerno said.

Another challenge in the industry is the changing technological environment. "Instrumentation is always changing," Salerno said. "Ten years ago, laser trackers dominated, but now scanners are more common, and laser radar is finding more use." It can be a challenge to find solutions for all types of instrumentation.

Each of these instruments brings a different set of strengths and weakness, but the software they use can be universal with *SpatialAnalyzer,* a software product created by Salerno and his partner Joe Calkins.

The *SA* software package was designed with these industry shifts in mind. From the beginning, *SA* was architected from the ground up to be a metrology solution. Salerno and Calkins both have Ph.D.s in mechanical engineering, and that's why they understand what the user needs and how their instruments are used.

"When measuring a physical property like angle, distance or length, those observations get turned into coordinates. That's the real nugget of what we do, turn observations into coordinates," Salerno said.

"We know it's critical that our users understand the uncertainty associated with every coordinate. Tolerances are getting tighter, more than ever before. Our clients say, 'We need to know where this edge is, plus or minus 0.004 inches.' If you want to know that, you need a measurement system that not only provides the edge location, but does so with acceptable uncertainty," Salerno said.

For engineers in manufacturing, this can mean less rework and less waste. That's one of NRK's motivations, as well as being able to create more compatibility in the industry. That means that *SA* runs on arms, trackers and scanners, and that operators can be cross-trained to work *SA* on all of them. The data is compatible and so are the operators.

There's another benefit of cross training that's overlooked sometimes. "Having an operator know more than one instrument ups their creativity for whole systems. A tracker guy can bring his tracker tricks that he's known for years to using an arm. He might be able to innovate in a way that someone who was trained only on an arm might not think of it," Salerno said. Some users have never had instrument-specific software, so they use *SA* and pick it up right away, and become flexible workers.

And, that is one of many reasons that *SA* is becoming the industry standard for engineering in large volume projects. ■

International Metrology – Its Growth is No Mystery

Changes in the field of metrology have changed the way things are done all over the world. Nicolas Tanala, International Business Development Manager for New River Kinematics (NRK), shared some reflections on the changing market.

In Europe, there's a huge interest in understanding and adopting portable metrology because it's not easy to verify quality without it. Larger pieces can't be taken to a stationary metrology device, so portability is a critical feature. "Portable metrology is used more often to replace bulky jigs and also more integrated into manufacturing to save time and money. This is what we call 'Metrology Guided Fabrication,'" said Tanala.

SpatialAnalyzer, the industry-leading software for portable metrology in the USA, is extremely efficient in helping manage part assembly for clients all over the world. For example, Airbus, the European aeronautics leader, uses *SA* in their manufacturing process. Any change that Airbus makes causes ripples as they change their assembly process to be more decentralized.

Change is a constant as manufacturing sectors see the value in improving their technology. That includes changes in materials as well. The A350 aircraft has a significant increase in the amount of composite material used. "Therefore, the entire way Airbus manufactures has also changed – that includes processes, tolerances, and material behavior. Due to *SA's* measurement plan, it's

particularly adapted to this automation, especially because of its ability to handle multiple portable instruments," Tanala said.

As even more changes happen in the industry, the ripple effect continues. The increased use of composite materials has brought new material suppliers into the fold of portable metrology by raising the bar for precision and compatibility with other components being shipped in from all parts of the world.

Besides aerospace, portable metrology is invigorating other industries by adding precision to their large-scale projects. Even the scientific community is adopting portable methods for particle accelerators, space shuttles and ground-based satellite dishes. Accelerator rings, a highly specialized enterprise, are a growing field for portable metrology. Tanala said because of the massive scale and highly sensitive experiments conducted on site, the need for accuracy and certainty is paramount. "When the client measures on this scale, there are a huge number of instrument stations. *SA* contains the USMN module, which allows the user to assess the whole network uncertainty and therefore to get the very best measurement accuracy in such a complex configuration," he said.

China, India and other emerging markets have more basic immediate needs—their priority is transportation, in order to continue growth. And the current direction is to create jobs and products by nationalizing the manufacturing of cars, trains and construction equipment.

"Emerging markets are starting to widely use portable metrology for large scale measurement. *SA* can help them to set up the best practices and avoid wasting money in heavy and expensive jigs. The priority, for any business, but particularly for emerging markets, is to make things simple, quick and accurate," Tanala said.

Rick Cole, NRK Sales Director, added his perspective to the growth in emerging international markets.

"Basically, anything that needs speed can benefit from more precision in the manufacturing process," Cole said. "Originally, the United States and Europe shipped products to emerging markets. But now, they can create those products on their own soil, but they still need technology to make that happen," Cole said. As a result, these emerging markets are becoming a huge consumer of metrology now. ■

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Innovations

to accommodating their clients. "If we call with a problem or question, they are there anytime. It helps that they are located nearby, and they have come on site for modification of equipment," Chattin said.

Sampler's been working for NASA for 30 years and he remembers a time when things weren't so easy with regard to software. "I wish I had this when I first got there. The technology has really changed since then – We used to have this rudimentary software, and then a copy of *SA* came with a Leica tracker. Whoever designed the software really knows what they are doing."

Sampler said he's not surprised to hear that it was designed by engineers who needed software for a project they were working on. "It's easy and does everything we want it to do. If we ask for adjustments, they make it happen," he said.

Chattin agreed, saying that, "The support staff is great. Having that mechanical engineering background helps, because they understand the lingo and there's not much explanation needed."

So, as NASA moves into the next millennium, the advances of measurement, engineering and software aid them in their journey. NRK is proud to contribute in those goals. ■

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The Industry Connects

thinks that's a crucial part of the conference.

"At the CMSC, education and sharing knowledge is so important. The conference brings together people who work together and people who may do so in the future," Sandwith said.

For example, NRK is hosting a presentation about "What's New in *SA*" with Joe Calkins, one of the company's co-founders. It's for users as well as those who might be curious about how *SpatialAnalyzer* might work for their projects. The presentation is Wednesday, from 4 to 5:30 p.m. and will include a question and answer session.

Calkins thinks highly of the conference and said, "We never miss a CMSC—not since we exhibited the first version of *SpatialAnalyzer* in 1996. It's the place to be in this industry and every year I look forward to learning something new."

Many of the exhibitors will feature metrology systems such as electronic theodolites, laser projection systems, laser trackers, laser radar, photogrammetry/videogrammetry systems, scanning devices, and articulating arms. The CMSC is a society of users, services and OEM manufacturers of close tolerance, industrial coordinate measurement systems, software and peripherals. The society's goal is advancement or development of any measurement system or software that produces and uses three-dimensional coordinate data.

Besides meeting for discussion about trends, industry issues and networking, this conference has many fun events planned around it. This year's event includes a tour of Churchill Downs and historic Bardsville. ■

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