Model-Based Inspection Gains Traction in QA

New developments in statistical process control (SPC) and point-cloud metrology software spur improvements in manufacturing quality

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The time-worn method of quality control typically focuses on using statistical process control (SPC) software to track and analyze the quality data coming from manufacturing processes. Still widely used in the automotive, aerospace and medical industries because of their stringent traceability requirements, SPC can be supplemented with point-cloud data for creating quality maps from the 3D CAD part models proliferating today in manufacturing. The latest metrology software packages that employ point clouds from scanned part data leverage the part manufacturing information (PMI) and geometric dimensioning and tolerancing (GD&T) of the part model to produce rich, accurate quality reports directly from CAD data.

Whether manufacturers use SPC software or point-cloud metrology, or a combination of the two, both methods help manufacturers improve their manufacturing processes. They give builders user-friendly charts and graphs to help factory operations managers quickly determine how to best produce parts without defects. That, of course, reduces the need to repair components and scrap parts.
Automating Quality Control

The latest offerings in quality control software include an automation solution combining Web-based SPC data from InspectionXpert Corp. (Apex, NC) and the Model-Based Definition (MBD) capabilities of the CAD-based Verisurf X9 software from Verisurf Software Inc. (Anaheim, CA). Verisurf and InspectionXpert announced their intensified collaboration on an automated quality control solution, QualityXpert from InspectionXpert, in February at the Control show in Stuttgart, Germany.

“We’ve been integrating with Verisurf on the InspectionXpert side for years. What’s new is we’ve actually built a full-blown Web-based quality automation system,” said Jeff Cope, founder and chief technical officer, InspectionXpert. “I describe it is as a Salesforce.com for quality engineers. What Salesforce did for automating the sales process we are doing for automating the quality process, and specifically the inspection process, although we’re rapidly adding other functionality. We have a real-time, interactive environment, where the machine operator can actually do inspection at the source. So instead of doing your inspections later, after you’ve already produced the part and are inspecting in a refrigerator room, you can inspect right at the machine.”

With the QualityXpert software, users can easily run SPC analysis or use point-cloud inspections using only a Web browser, he added. “Whether we import the measurements into Verisurf or into an iPad, users basically just need any HTML5-capable device. We do the SPC right in the browser, and render the CAD right in the browser,” Cope said. “We generate real-time quality alerts so they know if they’ve made a bad inspection or if their process is drifting. The key thing is it’s GD&T. We provide the SPC, and Verisurf does the point-cloud analysis.”

Verisurf’s X9 update adds important automated features that speed the inspection process for customers using point-cloud data, noted David Olson, Verisurf director of sales and marketing. In January, Verisurf began shipping the X9 version, which added the 3D solid-modeling application Verisurf Solids, previously an add-on module. The new software also includes new automated functions, including a “Do It” icon, to run a macro for quick alignment, registration, analysis, and reporting. “We’ve automated the entire point-cloud analysis and reporting process,” Olson said. “The technology is now automated and easy enough to use for a machinist or a quality technician with only a few days of training.”

A multi-tenant, cloud-hosted Software-as-a-Service (SaaS) solution, QualityXpert has balloon callouts on models that give users more information including PMI and GD&T data. “The geometry alone isn’t sufficient. There are annotations that call out what the geometry means,” Cope said. “It’s also not just having the PMI, you need to know which PMI. In your model, you might have 300 0.05-profile-of-a-surface callouts. Which one of those 300 profile-of-a-surface symbols are we talking about? Companies are demanding more.”

In addition, the AS 9102 standard for Aerospace First-Article Inspection (FAI) also requires that aerospace manufacturers follow stringent reporting guidelines. “Anyone making an aerospace part has to generate an AS 9102 report,” Cope said. “What the traditional CMM reporting consisted of was the measurement results—the expected value, and the location of those, called out on a balloon model.”

In many instances, manufacturers need to measure and report data on details of manufacturing processes that aren’t found in traditional CMM reports, he said. These reports can include data on material requirements, like the percentage of chromium content by weight or on process specifications, such as whether a part is anodized or hardened. “We pull in
the CAD from Verisurf, and the PDF file from a process company, and then we balloon the drawing with 3D tolerances or prints,” Cope said. “It could be a TIF file or any major CAD format, and we combine all that into our solution.”

Leveraging SPC Data

Taking manufacturing data to the cloud, offering global access to supply-chain data, is a big trend in SPC software today, said Shaun Wissner, marketing communications specialist for PC-DMIS and DataPage+ SPC software, Hexagon Manufacturing Intelligence (North Kingstown, RI). “Another is automatically linking environmental data to root-cause analysis, like if the temperature of the lab goes out of spec, the software will automatically flag the inspection report.”

For manufacturers looking to maximize their investments in SPC software solutions, Wissner noted that “the best way is fortunately the most obvious, just mine the data. Many times we see manufacturers collecting and then simply passing on data as a customer requirement with no further inquiry, almost a go/no-go strategy. If, however, there were process thresholds and key identifiers determined for a particular production run, SPC could be used to cut sample rates and use more efficient inspection methods to decrease inspection backlog.”

In Hexagon’s latest DataPage+ SPC software, the WebReporter includes all of the software’s previous reporting tools that are now available in a standard Web interface accessible from anywhere, Wissner said. “Automatic report delivery and mobile notifications are real time and money savers for a lot of our customers. Generally though, SPC is all about the numbers so ensuring we are keeping up with the standards, and making the data easier to consume for the end user, are our key technical motivators.”

Automotive users widely deploy solutions like the Quick SPC software from Marposs Corp. (Auburn Hills, MI) for improving processes and to comply with quality-control
standards from the Automotive Industry Action Group (AIAG; Southfield, MI), noted Matteo Zoin, Marposs Testar Division product manager. Marposs’ diverse range of metrology solutions include displacement sensors, bench gages and other measurement tools, Zoin said, that can help manufacturers track key $C_p$ and $C_{pk}$ data for complex quality control.

The new wireless manual iWave2 gage uses Quick SPC, part of the company’s Merlin class of metrology software. Measurement values can be transmitted via Bluetooth to a gage computer located within 10 m of the device. The iWave2 gage has a measuring resolution of 0.0001 mm, and it’s programmable for standalone use via Android phone/tablet or PC. When used with Quick SPC, the gage offers an on/off switch commanded by guided sequence, calibration history, and simultaneous zeroing of multiple devices.

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With the Quick SPC and Merlin software, users can quickly perform statistical analyses on-screen with simple graphics showing the measurements of parts, Zoin said. “The operators can’t make a mistake on the production line, and the combination of the iWave2 device and the software enables an operator at a big automotive supplier to quickly check parts on a production line, saving time and avoiding errors,” Zoin said.

**Monitoring the Process**

For many manufacturers, keeping manufacturing processes in line will require using SPC in concert with other metrology software in the factory. Manufacturing managers leverage SPC with Delcam’s PowerInspect on-machine verification software that monitors machine tool performance to identify if processes are changing or encountering high tool

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wear, noted Michael Stones, product marketing manager, Delcam (Birmingham, UK).

“Tool wear results in a loss of dimensional accuracy and defective parts. Higher cutting speeds and temperatures challenge accuracy even further,” Stones said. “Measurement data from machine tool probes can help you maintain machine performance. By measuring critical dimensions after each cutting cycle and monitoring variations in the measurement data with statistical process control analysis, you can identify trends in variation, ‘process drift.’ With this knowledge, you’re able to update your machining coordinates before tool wear causes a nonconforming part. Minimal rework will improve your shop’s performance, and greater process control will facilitate unmanned, lights-out machining.

Machine tool probes can be used to ensure constant production quality, Stones added. “You can monitor tool wear without the usual downtime associated with off-machine measurement. Surface inspection data also allows you to identify and predict maintenance requirements. By measuring before finish machining, you can adapt the final process to prolong tool life and maintain an optimal surface finish.”

One of the biggest payoffs for SPC is preventing a manufacturer from making “bad” or “out-of-tolerance” parts, said Josh Old, application engineering manager, Capture 3D Inc. (Costa Mesa, CA). “Many manufacturing processes create tool wear. This occurs when the tool begins to change over time through usage,” he said. In the metalstamping process, for example, the die itself can begin to wear over time from the continuous process of the sheetmetal being pressed into the die to form the desired shape, he added.

“These changes typically occur over periods of time and not all at once. Through the use of SPC reports, the manufacturer can see the trend of the stamped part start to move away from the desired shape, but catching it before the parts are actually out of tolerance,” Old said. With this information, the manufacturer can address the tooling issue before they ever make bad or out-of-tolerance parts.

The InspectionXpert OnDemand for CAD software supports 3D Model-Based Definition (MBD) and traditional 2D print-based inspection planning.
parts, preventing situations of nonworking parts, customer dissatisfaction and even potential recalls of products.

Mapping the Future

Metrology packages for 3D scanning and point-cloud-based inspection are gaining in popularity, as manufacturers look to take advantage of CAD model data for improving manufacturing processes. “We all do it the same way. The process is scan your point cloud, align and best fit your scan data to a CAD model, and then analyze those points to the CAD model and create a report,” said Verisurf’s Olson. “The color map you create shows deviations from the CAD nominal, comparing to an ideal state.”

Most developers of 3D scanning equipment offer their own software, but an advantage of using a third-party package like Verisurf is that it interfaces to all brands and models of 3D scanners, Olson said.

With the new one-click analysis of the “Do It” button in X9, Olson said users get fast, easy alignment and analysis of complex point-cloud data. But manufacturers need to consider several issues before adopting 3D scanning, he added, as the scanning process generates extremely large data sets with millions of scanned points, the scanners themselves cost about $20,000, and users sometimes can be better served employing single-point measurement solutions for their applications.

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“The world hasn’t fully embraced scanning,” Olson said. “There are industries that are reluctant to accept scanned data. The aerospace industry is very careful.”

Deciding whether to use point-cloud data really depends on the manufacturer’s end goal, said Hexagon’s Wissner. “Will you use that massive amount of data to reverse-engineer something or check for defects? On the other hand,
will you use the technology to increase inspection throughput, since a laser doesn’t have to stop and take discrete points? Point-cloud data and the laser, and white light sensor technology used to collect it, are so versatile that really the sky is the limit for how a manufacturer could choose to employ it,” he said.

“Now PMI is a different animal altogether. Where point-cloud data is free flowing and versatile, PMI data is rigid, based on rules and standards, and requires adept knowledge of these standards to properly employ," Wissner noted.

Hexagon has supported PMI for almost 10 years now with its stand-alone Planner software and Planner Tools inside PC-DMIS. “My advice to any manufacturer looking to start annotating their CAD with PMI would be to study ASME Y14.41 to get a handle on the proper implementation and then go slowly,” Wissner said. “PMI is a marathon, not a sprint.”

Capture 3D scanners use the trend package in the ATOS and GOM Professional software that shows not only trends in numerical values but also full 3D surface color mapping.

Hexagon’s subsidiary, New River Kinematics (Williamsburg, VA), offers point-cloud inspection with its SpatialAnalyzer metrology software. “SpatialAnalyzer helps our customers build strategic metrology plans that embrace and embed metrology practices throughout the entire production process,” said Patrick D. Welch, vice president, sales, North America, New River Kinematics. “Our technology addresses a broad array of measurement and inspection needs from providing inspection information via Model-Based Definition to providing a complex blueprint for the whole production process.

SpatialAnalyzer gives users a full set of tools for quality or process control, Welch added. “It all starts with how we collect data. SA collects the X-Y-Z location of each point and acquires important metadata. Using metadata, the end user now has the ability to examine the accuracy of the data as they collect it.” The software includes other capabilities, such as relationship fitting, USMN (Unified Spatial Metrology Network), TransTrack, pipe fitting, measurement plans and robot calibration, he said.

“When fully deployed, SpatialAnalyzer gives the end user all the metrology tools needed to monitor production and ensure making perfect parts,” he said. “SpatialAnalyzer offers the QC manager a suite of tools from virtually fitting parts as they are manufactured to a Factory Manager dashboard, which provides the status of each part. Using production staff to collect real-time data helps eliminate those head-
scratching moments at the end of the production process when it is discovered that something is wrong."

Mastering SPC software can be challenging, and point-cloud metrology tools can ease inspection tasks.

“Traditionally charts have been used to represent the data being captured and still are for many applications,” said Capture 3D’s Old. “The more data acquired, the more reliable the information, but also the more difficult it is to analyze and understand that data and to then make intelligent decisions. This process requires a tremendous amount of expertise and time, if you ever took statistics in college, you know what I mean.”

In the 3D measurement world, users can measure complete parts with millions of measurement points on each sample and then use color images of the part to show the changes occurring over time, he said. “Now management and engineers alike have a tool that they can both easily understand, communicate about and make well-informed decisions about, resolving a problem before it occurs.”

Capture 3D’s software partner, GOM (Braunschweig, Germany), developed a trend package included in its ATOS and GOM professional software, Old added. “Not only does the GOM software trend numerical values, but it also provides full 3D surface color mapping,” he said. “For example, we can produce a full 3D color map for Min/Max deviation, Arithmetic Mean, Range, Sigma, C_p value, P_p value, C_pK value and P_pK values. The trend feature also can generate an average mesh from a group of meshes or tell you the Golden Part or Mesh or the best manufactured part out of a group of parts. The ‘Golden Part, or Mesh’ is useful because there are times when a working part is actually better than the originally designed part and the manufacturer can use that as a benchmark instead.”

“The geometry alone isn’t sufficient.”

Using 3D scan data for inspection completely changes the way people manufacture their parts and brings a much higher level of quality over the older tactile metrology methods, Old said. “If you can imagine designing a part from the ground up and trying to fix quality issues for which you do not know the cause [root cause analysis], using a tactile measurement machine is like throwing darts at the part hoping you hit the problem area,” he said. “Lots of iterations and rework. With the ATOS Triple Scan, it is like shooting the part with a shotgun to find the problem. You see it all at once and you can find the issues much quicker with a higher level of certainty. Fewer iterations and quicker times to market. Once the part is ready for full production, manufacturers are using the ATOS Scanner in tandem with the SPC software to help monitor their processes.”

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