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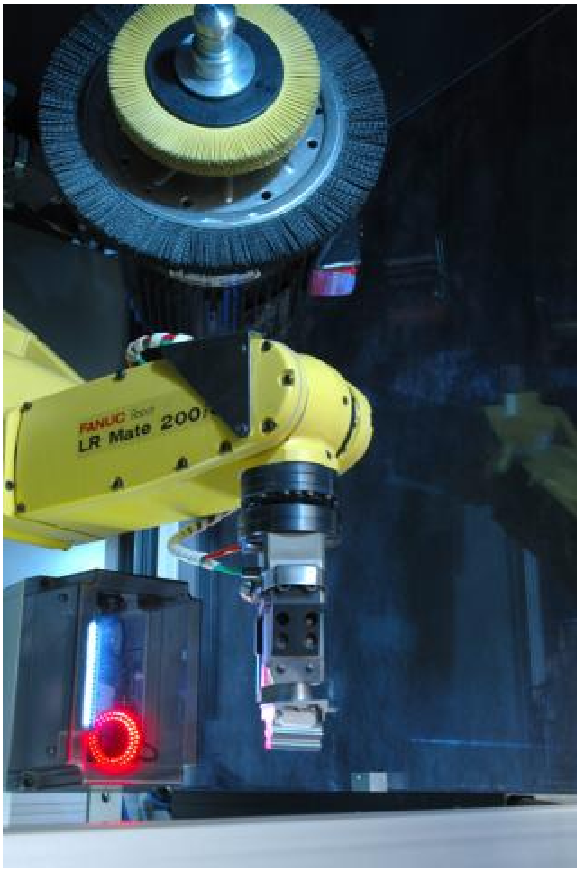
Organic Quality Control: The Natural Approach to Manufacturing

The quality landscape is changing. To deliver the high levels of quality required today, manufacturers are building quality control directly into their processes, rather than relying on a separate department to weed them out after the fact.

By James R. Koelsch, Automation World Contributing Writer

Inspection is built into the lean-manufacturing cell that Evana Automation designed for producing electronic actuator assemblies at American Axle.



Manufacturers have been quite keen on weeding out inferior products ever since the quality movement took root in the ’80s. Now, decades later, quality control has blossomed at companies like Detroit-based American Axle and Manufacturing Inc. At this tier-one automotive supplier, quality control is no longer seen as a separate task performed somewhere in another department or on an offline process. Rather, quality control is a natural part of manufacturing, integrated organically into the process.

Like most large manufacturers, American Axle is exploiting today’s automation to ensure that its processes build quality into each and every product from the outset. An example is the 21-step lean manufacturing cell that the automotive supplier received earlier this year from **Evana Automation Specialists (www.evana-online.com),** a systems integrator and custom builder based in Evansville, Ind. The cell built by this subsidiary of Phillips Service Industries assembles and tests electronic actuator assemblies for a line of automobile transmissions.

“Quality cannot be inspected into a product in its final state,” explains Randy Wire, Evana Automation’s general manager. “Rather, quality is the combined effort of incoming material inspection, verification of each process step, and to the extent possible, verification of the success of a subassembly." For him and his colleagues, automation and the appropriate monitoring techniques are the best means to these ends.

For this reason, his design engineers blended automated process monitoring and inspection into the automatic and semi-automatic processes in the actuator assembly cell at American Axle. This automation relies on in-process sensors, as well as on post-process inspection, to verify that the cell's stations perform the various riveting, pressing, dispensing, and other assembly tasks correctly.

For example, proximity sensors or photo eyes at each station verify that the operator has loaded the appropriate parts before the work cycle begins. "With the ever increasing variations in product assemblies, one of the most important aspects of quality control is ensuring that the proper component has been selected or introduced into the subassembly," notes Wire.

Sensors integrated into the processes then verify the assembly tasks themselves. In operations where one part is press fit into another, load cells and distance transducers on servodriven ballscrews monitor and report forces and distances. Likewise, fastening devices use sensors to monitor torque and angle to ensure that the screws are seated at the specified torque.

Of course, inspection is necessary, too. For example, as a robot dispenses a gasket material along a complex profile, a laser displacement sensor ensures that the robot lays enough material. And tests in the cell's last stations check the final assembly's seal and ensure that the electronics and mechanics work properly.

The in-process verifications and final tests on the electronic actuator assembly implement a fundamental tenet of lean manufacturing: Don't produce bad product, and don't pass along bad product. "Any failed assembly process along the way requires acknowledgement by the operator and requires quarantining the failed assembly so it cannot be introduced downstream," says Wire.

The sensors and tests also provide real-time data for the cell's supervisory control and data acquisition (SCADA) system. Not only does the system give the necessary real-time feedback to the programmable logic controllers (PLCs) overseeing the stations, but it also provides the quality department with the data that they need. It stores the results of the final test of each product for traceability, trend tracking, and other quality studies.

Are QC departments endangered?

Although the integration of test and measurement automation into manufacturing processes has reduced the need for in-process inspectors, it has merely refocused the activities of quality control departments. It has not reduced the need for them as standalone departments, according to Wire.

"They take the lead on establishing the overall control plan and providing guidance on exactly what measures must be taken during the assembly process to ensure the final product meets customer requirements," he explains. "Quality control departments are vital to any manufacturing process and will remain so for the foreseeable future."

Other automation vendors concur. "As systems become increasingly more intelligent and maintenance free, the QC department's role will continue to be to provide auditing functions to confirm output quality," says Dan Cejka, product manager for tightening and welding systems at **Bosch Rexroth Corp. (www.boschrexroth-us.com)** in Charlotte, N.C. "But the QC department's support will not be integral to the assembly process, because the auditing and data collection will be automated."

Like Wire at Evana Automation, Cejka points to the automated feedback coming from sensors embedded in production tools. Even handheld assembly tools, such as the Nexo line that his company offers, come with torque, angle, and other sensors that not only help to optimize the work itself, but also support data collection for statistical process control and traceability. "In most, cases these sensors document the assembly process completely, and there is no need for [manual] quality checks or worker intervention," says Cejka. Some sensors can transmit this data wirelessly.

>> A QC Lesson From Lean Manufacturing: Click here for more information.

Onboard sensors and controls also give some tools the ability to self-calibrate. On nut runners, for example, this ability ensures that each bolt is tightened properly and the measurement is accurate. "Without this technology, the QC department would need to check both the tool and the outgoing product regularly," notes Cejka. With the technology, quality control needs to check the tool once a year to comply with standards promulgated by the International Standards Organization in Geneva.

Cejka credits these capabilities to continuing advances in fieldbus technologies that are expanding the speed and quality of interconnectivity between automation devices. "This allows multiple technologies such as fastening tools, drives, controls, and hydraulic systems to exchange large quantities of performance data in real time," he says.

Standards drive QC integration
Integrating quality control directly into manufacturing processes is strategic in the auto industry, where 100,000-mile warranties are fast becoming the norm. The task, however, can be quite a challenge on larger, more complex production lines, such as the one producing the new GF6 six-speed, front-wheel-drive transmissions at General Motors Corp.'s Alexis Road Powertrain plant in Toledo, Ohio. GM plans to make 2,200 of these transmissions per day on this time for its small vehicles, such as the Chevy Malibu and new Chevy Cruze.

To simplify the task of integrating quality into production, the automaker adopted a strategy of standardizing software to make adding inspection devices to the line much like adding a printer to a laptop computer. Its engineers developed the concept with help from the **Siemens Industry Automotive Group (www.usa.siemens.com/industry)** in Troy, Mich., an arm of the automation vendor that provided the line's controls, radio-frequency identification (RFID) tracking system, and Profinet communications network. The development team also included third-party software provider **Elite Engineering (www.eflexsystems.com)** of Rochester Hills, Mich., which overlaid its Flexible Assembly Configuration System (FACS) on the Siemens hardware and software.

Central to the integration strategy was the development of consistent, and even identical, logic blocks for the stations throughout the line. Many of these blocks can be called drivers, according to Reinhold Niesing, Siemens' engineering manager for the GM project. "GM wanted to have a standard way for connecting quality devices like vision systems, for example, into their system," he explains. "We were able to create a true plug-and-play system."

Accomplishing this feat required more than just agreeing on a communication network or protocol. "Most devices can be integrated via a Profinet network, but even similar devices from different manufacturers present their data in different ways," says Niesing. "So, this system provides a kind of device driver that makes it possible to integrate control and quality devices into the overall system, regardless of who is the manufacturer is."

Developing these drivers for vision systems, for example, required GM to decide on a company-wide method for installing cameras, programming them to perform tasks, exchanging operating parameters, and reporting results. Once the camera is plugged in, the driver can automatically provide the control network with the necessary information to configure and add the device. The FACS software can then link it to the rest of the network and begin receiving inspection results according to the predetermined data formats.

"If you wanted to add a vision system to past systems, somebody would have to program that camera," says George Jewell, a former GM engineer who worked on the project, but is now a project engineer with Elite Engineering. "Whoever did programming would just program it the way that he felt was best and then write the results in somewhere on the RFID tag." Typically, most results would stay within the workstation and were not reported to a central repository for quality analysis.

On the other hand, the plug-and-play system not only reports the data beyond the immediate workstation, but also permits storing the images for root cause analyses later. The system also allows GM to reduce redundant programming and the risk of introducing errors. "Having this standard logic in place leaves fewer opportunities for false rejects or not catching bad parts," says Jewell. "You can identify problem more quickly, too."

For these reasons, GM is not only using the FACS software for integrating the machining, assembly, and testing of transmissions at the Alexis Road Powertrain plant. It is also using it to integrate quality into engine and transmission production at other plants in the U.S., as well as in Mexico, China, India, Thailand, Korea, and Canada.

Robot checks surfaces
Montreal-based AV&R Vision and Robotics has integrated vision into manufacturing in a different way. Rather than developing a set of standard drivers, as GM is doing, its engineers used a common programming environment to integrate vision-based inspection into a robotic deburring cell. The systems integrator developed the process for an aircraft-engine manufacturer as part of a lean manufacturing project to automate the refinishing of jet-engine turbine airfoils during routine service.

After a grinding operation refinishes an airfoil, an operator loads it into the deburring cell. A six-axis robot manipulates it over a tool to remove any burrs from the root of the blade, break the edges, and regenerate their radii. Without putting the airfoil down, the robot then presents it to a Smart Camera vision system from **National Instruments Corp. (www.ni.com)** of Austin, Texas for inspection. As the camera looks for defects on the critical surfaces, the software classifies them according to their shape and records its findings with the airfoil's serial number, which the camera also reads.

In the past, the process was a labor-intensive process because workers would deburr and inspect the radii and complex surfaces manually, using an assortment of deburring tools and hand gages. "We developed a cell that can automatically perform these two processes, ensuring that every part leaves the cell with the desired quality," says Michael Muldoon at AV&R Vision and Robotics.

To automate those tasks, the engineering staff used National Instruments' LabVIEW programming environment to develop the human-machine interface (HMI) and program the robot, the camera, and software doing the classifications and reporting. "If you program each of those subsystems in a different programming environment, you have to spend a lot of time on communications and synchronizing the systems," says Carlton Heard, product manager for vision at National Instruments. "Having everything in one environment just makes the integration a lot easier." he says.

"It also makes it easier to inspect parts while you're moving it or to use the camera as a feedback device to control the motion of the robot," he adds. In some cases, the camera can replace the encoder and provide the feedback for motion control.

Companies in this article:

Supplier:

- **Bosch Rexroth**
- **Elite Engineering**
- **Evana Automation Specialists**
- **National Instruments**
- **Siemens Industry**
