

## QC10 ballbar a key quality and productivity tool in Rockwell Automation's Power Lean manufacturing

*QC10 ballbar used for both diagnosis and predictive maintenance to keep machine tools running and producing to specification.*

**Rockwell Automation Power Systems specialises in providing technologies and services for optimising power transmission performance and productivity. The company has turned its analytical and creative skills to developing an integrated process for continuous improvement of the manufacturing processes in its own plants.**

Named Power Lean, Rockwell Automation's program integrates the tools and methodologies of Lean Enterprise, Six Sigma, and Total Productive Maintenance. Focused on fast, bottom line results, Power Lean was implemented across multiple Power Systems plants. In one facility the program has reduced total inventory more than 20%, cost of quality more than 25%, cycle time by almost 80%, while increasing on-time delivery by 99% and productivity more than 35%, along with freeing valuable manufacturing space.

A key tool in the Power Lean arsenal is just that, a tool. "The Renishaw ballbar is an incredibly powerful tool for us," says Larry Sykes, Lean program manager. The QC10 ballbar gives maintenance technicians an internationally recognised standard for assessing the dynamic motion and positioning precision of machine tools and production machinery, he explains. "The ballbar gives us a preventive and diagnostic tool for making sure that our machines are capable of producing to required part specifications."

This provides vital benefits to both Six Sigma quality and Lean efficiencies. "Machine capability is critical when you're machining parts to tolerances in the tenths," says Bill Murphy of group maintenance. At the same time, ballbar tests generate trend data to help technicians implement predictive and preventive maintenance to keep machines functioning properly and part quality within spec.

The ability to do pro-active maintenance greatly reduced unexpected downtime to support the move to high-



Analysing the results of the QC10 ballbar test

throughput, lean work scheduling, says Sykes. Ballbar tests are done periodically for performance tracking under the predictive maintenance program, as well as when a machine problem is suspected. "The great thing is, ballbar testing is simple and fast, so you're minimising disruptions and downtime," stresses Sykes. "It only takes about 15 minutes to check out a machine."

Literally a telescoping bar with machined balls at either end, the ballbar attaches magnetically to socket devices mounted to the machine's spindle and bed. As the machine runs the ballbar through a sequence of programmed routines, a precision transducer tracks machine movements. Renishaw software converts the data into a polar plot of the machine's true movement. The software tracks machine movement to 0.5 micron, allowing precise assessment of machine geometry, circularity and stick/slip error, servo gain mismatch, vibration, backlash, repeatability and scale mismatch. The ballbar software not only provides diagnosis of specific errors in accordance with ISO 230-4 and ASME

B5.54 and B5.57 standards, but also ranks errors according to their overall effect on machine accuracy.

The 15-minute ballbar routine compares with circle/diamond/square tests previously used to check machine capability and accuracy. The features would actually be machined into a test piece, which would then go to Quality. It would check all the dimensions to make sure the machine was able to produce properly. If there was a problem with a feature geometry, however, the cause might not be obvious, notes Sykes.

By comparison, he says, "With the ballbar quick check system, you can evaluate a machine in 15 minutes and be able to tell if it can produce a good part. If there is a problem, the ballbar software gives us the ability to check through all the different possibilities, telling us which factor we need to address on the machine tool. Sometimes we're able to just make adjustments to parameters in the machine controller to offset some ballscrew issues in the machine."

Renishaw is constantly coming out with new and more powerful diagnostic capabilities, says Sykes. "We particularly like the trending abilities of the software." A machine history function enables monitoring of an individual machine through its life cycle to help predict and schedule future maintenance, he notes.

Responsible for that maintenance, Bill Murphy appreciates the ability to use the trend data to allocate resources. "We can prioritise the maintenance and make decisions on what needs to be done to extend machine asset reliability."

Another new software feature, the Ballbar Plot Simulator allows 'what if' scenarios by simulating machine adjustments, letting maintenance technicians view the effects on ballbar data before making any actual machine adjustments. "Today, if there's a problem with a part, we can run a ballbar test and either eliminate or target the machine tool," stresses Sykes.

The ballbar has helped Rockwell Automation take corrective maintenance to a higher level with Lean time savings. Sykes cites a CNC lathe with a damaged way that needed to be replaced. "Through working with the OEM and with Renishaw, we were able to capture all the accuracy information we needed and actually do the replacement and realignment of the way right here in the plant. Before, we'd have sent the lathe back to the factory for the repair, which could have taken a couple months. Our own maintenance people did the job on the shop floor in three weeks using the Renishaw ballbar."

Ballbar use spread to other plants of Power Systems after plant and Lean managers saw it demonstrated at a Champions Forum instituted under the Power Lean program. "The idea is to bring people from all the different plants to share best practices," says Sykes. "After we demonstrated what the ballbar was doing for us at one plant, it was quickly adopted by our other plants."

Power Lean's emphasis on searching out and sharing innovative tools and techniques has been such a success internally for Power Systems that Rockwell Automation decided to extend the sharing. It began offering the program to customers and other industries, even creating a four-week Power Lean Master Certificate Program with Clemson University. "What makes us different from consulting-type operations is that we are all manufacturing people," says Sykes. "The things that we teach we have actually implemented in our plants."

The Power Lean training program emphasises hands-on training, says Sykes, now a program manager. "It's two days of classroom material, then three days of actually working out on the shop floor implementing the things they just learned. They get the theory, then the hands-on application."