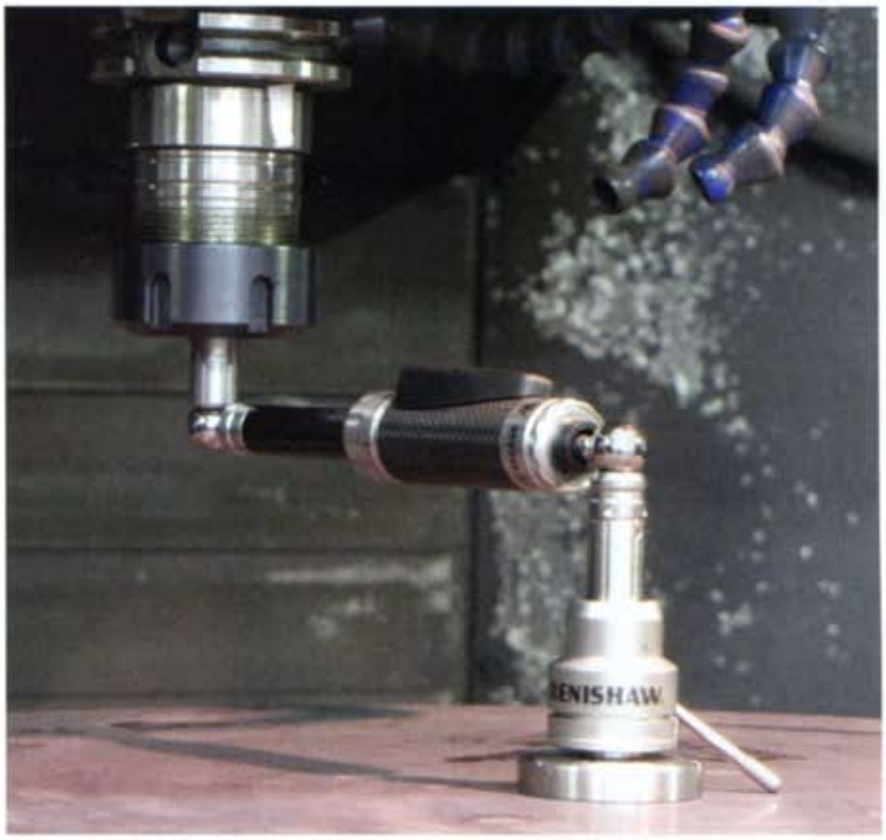
Edited by Eric Brothers

Ballbar training increases accuracy, extends machine life

A semiconductor industry supplier uses Renishaw's course to understand its machine tools' performance and train OEM service techs.



Silfex uses ballbar calibration to qualify metrology, calculate time maintenance, implement TPM and SPC, and forecast machine life.

Ballbar testing is nothing new to Wayne Ross and Jacob Hebbeler at Eaton, Ohio-based Silfex who have used ballbar analysis to maintain and enhance the accuracy of the plant's 50+ machines for more than a decade.

But, even ballbar users can still learn a few new tricks.

After upgrading to a QC20-W wireless ballbar and taking Renishaw's Advanced Ballbar course, Total Productive Maintenance (TPM) manager Ross and production machinist Hebbeler now use captured ballbar data to evaluate production accuracy, "super tune" machines to better-than-factory accuracy, and get longer life out of components. Ballbar tests have also changed the way the company proves out machines, schedules maintenance, and evaluates new equipment needs.

"We've done ballbar testing for years, but until we took the advanced ballbar course we weren't making full use of the results," Ross says. "Now we're using the ballbar to qualify metrology, time our maintenance decisions, implement TPM and statistical process control (SPC), and even forecast machine life."

UNCONVENTIONAL PROCESSING WITH CONVENTIONAL EQUIPMENT

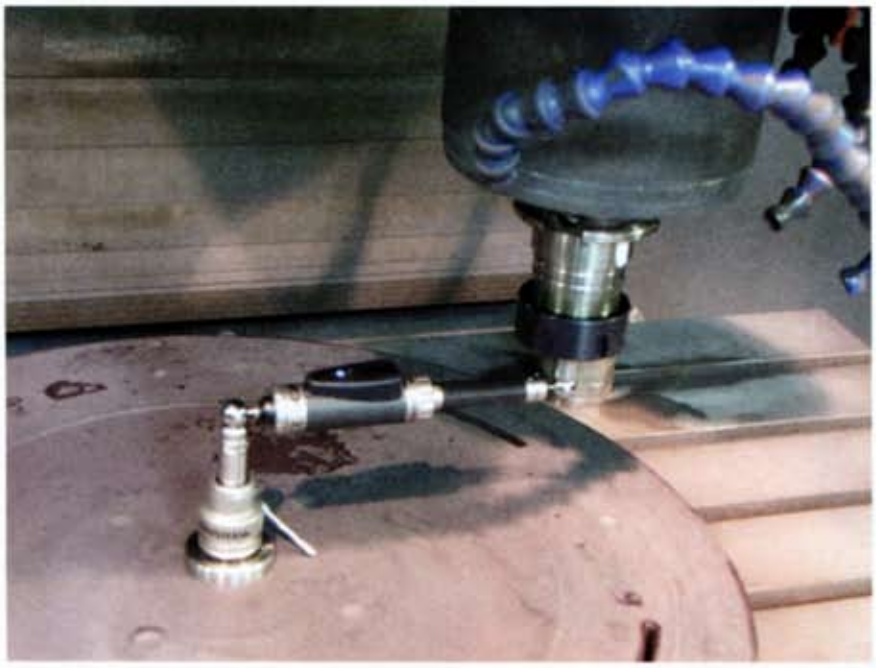
Silfex's lathes and vertical machining centers (VMCs) – primarily Haas and Mazak – use specialized tooling to grind and polish silicon and quartz for the semiconductor industry. The 300+ employee company, a rapidly growing division of Lam Research Corp., makes consumable parts for etching of computer chips.

"We are one of the few companies in the world that can grow defect-free, single-crystal silicon to a diameter of 460mm," Ross explains. "We do start-to-finish manufacturing under one roof, which is important because the semi-conductor industry requires 100% traceability on everything from the material source to the machined parts, and we have all of that under direct control."

The plant is environmentally controlled and equipped with multiple cleanrooms from class 10,000 to 100.

"One speck of contamination can wipe out a lot of computer chips," Ross stresses.

Processing the silicon includes wire sawing, waterjet cutting, milling, drilling, grinding, and lap polishing before inspection in metrology rooms with CMM and VCMM equipment. Parts then go to an on-site cleanroom for packaging. Production runs range from five to 100 pieces per setup and tolerances are typically ±0.0010", with some requiring ±0.0005".



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Grinding silicon creates an extremely harsh machining environment.

"We're using conventional machines to do unconventional processing and using ballbar diagnostics to stay on top of our machine capability in a high-wear application," Ross says. "We use the ballbar to diagnose ballscrew wear every six months, but usually get called to test machines before that. The advanced ballbar training showed us how to determine if we can make machine adjustments or if it's time to replace the ballscrews. This allows us to control downtime scheduling and maintain our accuracy as machine components wear out, rather than judging machine capability from the quality of finished parts.

"We run these machines hard, three shifts, five days a week, with quite a few long runs, and the grinding environment is tough on the equipment. I'm amazed at how accurate we can make these machines considering how rapidly the machining environment changes."

INCREASING CAPABILITY

Conducted at Renishaw in Hoffman Estates, Ill., the hands-on advanced training course allows participants to practice setting up and running ballbar analysis on different machine tools in a learning lab.

"I've been working with ballbars for 13 years and thought I knew my stuff," Hebbeler says. "We learned how to troubleshoot scale mismatch, which has helped us super tune our circular interpolation and extend the useful life of the mechanical parts of our machines. We also look at lateral play to gauge the condition of our linear guides."

"After the advanced class we concentrated on interpreting our numbers to see if there were more details we could control," Ross explains. "Jacob has gotten good at adjusting the backlash and reversal spikes, so we can get more life out of the ballscrews, which is our hedge until we can get a service tech in."

Silfex uses ballbar diagnostics to determine a machine's squareness, which is the prerequisite for analyzing backlash and reversal spikes.

"Many shops overlook the effects of the floor on machine level," Ross says. "We are lucky our concrete is substantial enough to support all the weight we put on it, and we check and adjust the machine level upon installation. Once we set the level we can diagnose reversal spikes, backlash, and scaling mismatch, which we didn't know how to do before the class."

They now handle machine leveling using a 0.0002" level, largely because they can hit specs that some technicians have trouble achieving.

After the training Ross and Hebbeler used their new knowledge to push the boundaries of machine accuracy.

"Our goal on squareness was 0.000050", and I decided we would try for 0.000025"," Ross says.

Based on their success with the ballbar, Ross and Hebbeler are expanding their machine diagnostics.

"The ballbar tells us about the foundation: the linear guides, the ballscrews, and the thrust bearings – the bottom end of the machine – that's where mechanical tolerances are established and it also confirms our metrology," Ross says. "We've also started using some vibration analysis, and that tells us about the top-end of the machine, which dictates finish. So, we are analyzing all the factors that affect our size and finish. We'd like to get into volumetric compensation testing with the ballbar. We currently test X and Y on VMCs, and X and Z on the lathes and have done full Y-Z testing in the past on a few machining centers. With volumetric testing we'll also hit X-Z, and I think we'll be able to get what we need in the 220° sweep the ballbar is capable of."

NEW PROGRAMS

Silfex is now using ballbar data to establish thresholds in relation to its various processes and determine process capability. "We now have diagnostics to back up what we think is happening with our machines," Ross says.