cut, he says. Keeping lubricant at the cutting edge makes through-tool coolant even more effective.

• Better chip evacuation. Chips are small thanks to the rapid pecks. This ultimately produces more consistently accurate holes because chips no longer get bound up with the tool to distort the hole's shape.

• Consistently shaped chips, which lead to a more consistent drilling process overall.

For more information, enter the company name at **mmsonline.com/suppliers** or call M4 Sciences, 765-479-6215.

This final benefit might well be the most valuable, Mr. Bougher says. Manufacturers of high-value parts, such as aircraft fuel system components and orthopedic screws increasingly do not find their efficiency gains solely by running faster. The savings also come from engineering a process that runs with less human oversight. Doing this requires machining operations that perform predictably—cut after cut and hour after hour.

MAM's ability to control the chip contributes to this predictability, he says. What's more, users get this consistency and predictability essentially for free, because there is no need to reduce cycle time to make the cutting more consistent. ■

A Three-in-One Honing Station

BY MARK ALBERT

Combining roughing, finishing and gaging in one station is a distinctive capability of the ECO 80 dual-expansion honing system from Nagel Precision (Ann Arbor, Michigan). The system is designed for low- and medium-volume applications that require submicron bore sizes and mirror finishes. It can finish bore sizes ranging from 10 to 80 mm.

According to the company, honing systems typically require separate stations for roughing and finishing because each operation requires different grit sizes on the respective diamond honing tools. The dual-expansion system on the ECO 80 allows tools with different grit sizes to be mounted on the same spindle. Separate systems control the mechanisms within the spindle that expand the roughing or finishing tools. The expansion for roughing is driven by servo motors, whereas the expansion for finishing is hydraulically actuated. The finish honing operation commences automatically after the roughing operation reaches the pre-determined bore size.

An automatic tool wear compensation system can be integrated with pneumatic post-process gaging in one honing station.

An automatic tool wear compensation system links post-process gaging with the honing spindle. By gaging every part, bore size can be monitored continuously and submicron adjustments can be made to honing parameters to compensate for tool wear. The company says this approach is an improvement over manual compensation systems typically found on other equipment for low- and medium-volume applications, in which over- and under-compensation is a problem.

According to the developer, the tool wear compensation system is designed to further reduce non-cutting time while improving bore quality. Once inserted in the bore, the tool expands at a "rapid" feet rate of 220 microns per second at 45 percent of available torque until it reaches a pre-determined bore size close to the desired limit. It then switches to an expansion rate of 200 microns per second at 15 percent of available torque to avoid tool damage. Toward the end of the program cycle, the tool expands at only 2 microns per second at about 10 percent of available torque. The system constantly monitors both the tool expansion rate and percentage of available torque. The operator can reduce the tool expansion rate for tighter tolerances or increase the torque for faster cycle times. This approach is said to yield a more consistent bore in terms of finish, size and cylindricity.

For more information, enter the company name at **mmsonline.com/suppliers** or call 734-426-5650.

The ECO 80 honing system is designed for low to medium production runs.

According to the company, the post-process gaging system automatically checks the bore for form errors such as taper, hourglass, barrel shape, ovality and others. Automatic adjustments correct for the specific kind of error detected.

Company engineers customize matrices and tools to the user's material and bore geometry. The combination of correct tool selection and equipment settings is said to yield surface finishes below 0.05 micron Ra from a starting roughness of 1.07 micron Ra.

A gear-driven index table enables part loading and unloading during the finishing operation. Loading and unloading can be automated or accomplished manually. ■

Meter Tubes No Longer Manually Finished

BY PETER ZELINSKI

Computer controlled machine tools did not replace manual machining as soon as the more modern technology was invented. Rather, CNC and PLC control took over metalworking only after both were proven *and inexpensive.* In some applications, those conditions are still being met for the first time.

An article recently posted on MMSOnline

gives an example. Thanks to the innovation of budget-price honing, finishing the ID of orifice meter tubes for the oil industry is now moving to electronically controlled machines. The article on manufacturing these orifice meter tubes can be found at short.mmsonline.com/metertubes.

One of my favorite parts of the article is actually the nod it gives to the fine tactical sense of the operators who have historically done this work. Part of the value of the new honing system (from Sunnen) is how it improves the productivity and saves on the fatigue of these operators.

For more information, enter the company name at **mmsonline.com/suppliers** or call Sunnen, 314-781-2100.