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OCTOBER 2006

VOLUME 58 / NUMBER 10

Amazingly Small

Special Focus:
Micromachining

- More mini parts spur micro machine tools
- Wire EDM slims down

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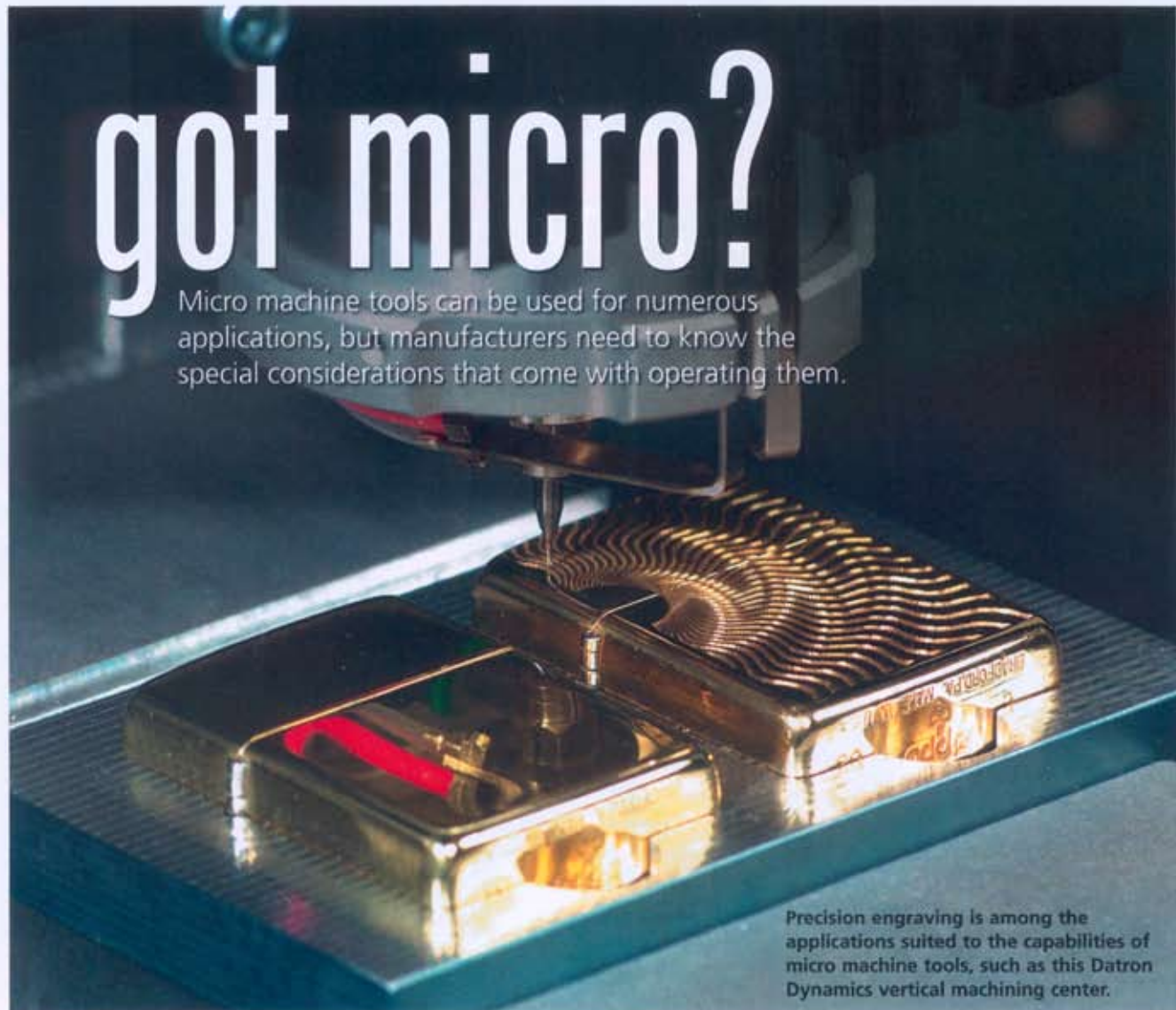
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got micro?

Micro machine tools can be used for numerous applications, but manufacturers need to know the special considerations that come with operating them.



Precision engraving is among the applications suited to the capabilities of micro machine tools, such as this Datron Dynamics vertical machining center.

Datron Dynamics

From cell phones to medical implants, manufactured products are continually becoming smaller and more complex. Of course, the parts that comprise the products are shrinking, too. While it's clearly inefficient to turn out tiny parts on a machine that was designed to produce, say, engine blocks, small-part making isn't simply a case of acquiring a micro machine tool and turning it on.

A look at three different brands of machine tools engineered to make small parts found large differences among them. For example, while the machines weighed from 400 lbs. to 5 tons, the heaviest machine has the smallest X-Y-Z work envelope. Dis-

cussions with the machine makers revealed how they build their machines to meet specific applications and also touched on some of the challenges of small-part machining in general.

Good Things Come in Small Packages

Michael Ogilvy is vice president of sales and marketing for Vertical Inc., Woodbury, N.H., the company founded in the design of Robert W. Ogilvy and Light Machine Inc., an early producer of teaching CNC machine tools.

The company's top machine for industrial applications is the Model 8000 3D vertical machining center, which features a 39" x 49" table and

12" x 12" x 6" Z-axis movements, respectively, weighs 400 lbs. and has a 40" x 40" envelope.

Designed for the company's machine shop around the world parts-factory, Vertical's perceptions about micro machine tools are the same. "We do a lot of coordinate milling and work in programming centers, and what we find is that in those machine shops, when they have one of our tools, they usually look at other machines as well," he said.

However, smaller machines can be used for other work, such as rapid prototyping. According to Ogilvy, 3D is an increasingly popular application for smaller machines. While

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back from the Far East. The work entails cutting out knife handles from a sheet of aluminum and involves drilling and tapping holes, milling pockets and beveling edges of 124 handle halves from a 36"×24"×1/8" sheet of aluminum. Tolerances are ±0.001" for details and ±0.0005" on some hole locations. Cycle time for a sheet is about 3 hours, during which the machine runs untended. Currently, the process runs three shifts, 5½ days a week.

"This is not something very flamboyant, like drilling microholes in jet engines," Schnecker said, "but the untended machining is part of the attractiveness for using micromachining in an industrial environment."

According to Schnecker, a major issue in micromachining is maintaining the tiny tools required to produce small part features. "Chip load and other things aside, the smaller the tool, the more sensitive it is," he said. "It's all about the rpm. The higher the rpm, the less likely you are to break a tool." Schnecker said Datron machines are designed around a 3-hp, 60,000-rpm spindle, and the relatively high horsepower enables the spindle to maintain high rpm while cutting.

In addition to marketing machine tools, Datron Dynamics also produces a selection of micromachining tools for high-speed applications, with fewer flutes to afford more room for chip evacuation. Schnecker said: "We use the rpm and the centrifugal forces to make sure we fling the chip away. If you have a 3"-dia. flycutter and you catch a chip, that flycutter won't even notice. If you have a 0.020"-dia. drill or a 0.040"-dia. endmill, you catch a chip and the tool immediately snaps. The smaller the tool, the faster you have to go to make sure you fling the chip out."

Beyond the challenges of actually machining small parts, Schnecker said that "most customers struggle to hold them; workholding becomes an intrinsic part of the whole micromachining work flow." He noted that the lower cutting forces involved somewhat moderate the need to maximize

rigidity, but gripping tiny parts remains a problem. Because many of the company's customers cut sheet products, Datron developed a vacuum workholding system called Vacuumate. Schnecker said the system enables a shop "to just put a piece of acrylic or aluminum down, cut out all the parts, turn off the vacuum and the parts are lying there to be grabbed."

The specialized nature of small-part machining is requiring machine builders to provide machining solutions beyond the machine tool itself. In addition to workholding, for example, Datron can provide robotic workhandling systems to simplify work flow. In a typical application, a robot picks parts from a tray and moves them to pneumatic grippers on the machine's 4th and 5th

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axes, where they are positioned for machining. When the cycle is complete, the robot removes the parts from the machine and places them in a finished parts tray.

Small Parts, Tight Tolerances

To make sure, the critical surfaces

of all a product demands that each part be made to high precision. For Richard, more machine change for Wilson Means, this said, "It's just a matter of setting up the machine to do for a precision critical part, such as the steering control inputs that are used in a vehicle. The tolerance on the hole and there are other features and surface finish requirements." He



The Wilson Means wire machining center includes features such as a direct threading spindle designed to eliminate toolholder-induced vibration and enable the machine to produce precise, small parts, such as medical instruments, semiconductor devices and optical lenses.

Richard says Wilson's definition for micro-machining is the machining of a part or parts in which each outer diameter is .0100 in. or smaller in size or that has details of 0.005 in. or smaller.

Wilson's response to the need for such precision is the Super20 CNC. With a diameter of 11.410" and a length of 11.280 in., it has a 12" of available work length. It has 12" of travel in both directions. The machine can be modified to provide processing accuracy of .001 inches and repeatability of .002 inches.

According to Richard, the most common problem operators of high-precision wire machines with Wilson's Super20 CNC is that of tool break. The Super20 is designed to make longer parts. Considering the effectiveness of the Super20 CNC technology, he pointed out that the machine doesn't take much time to change tooling. "Usually, it's a 15 min. or so 15 min. that the operator gets in, and the machine does a job," Richard said.

However, he added that the real challenge is preparing the wire for cutting. "The wire is fed into the machine before the tooling gets in. The wire is fed in the

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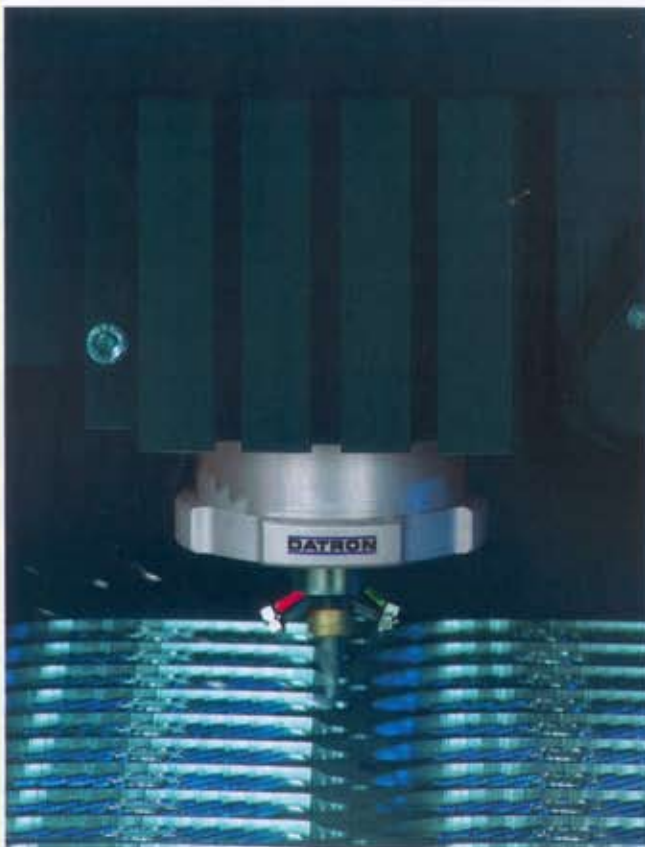
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This application, performed on a Datron Dynamics VMC, involved drilling and tapping holes, milling pockets, and beveling edges of 124 knife-handle halves from a 36"×24"×1/8" sheet of aluminum. This photo shows how combining microtooling and micromachining on a large bed enables multiple parts to be ganged and machined unattended.



got micro?

handbook with all the speeds and feeds for different cutters. However, when you get into what we call 'high-performance machining,' we don't follow the same rules anymore about speeds and feeds. It's a different approach. Twenty-five years ago, when I started out, you set your feed rate until you broke a tool and then backed it off one notch, and you felt good." He added the situation is different today. "Basically, all you can do is go from experience and general guidelines, then tweak it from there."

Finding the right micro machine tool for a small-part job starts with consideration of the part to be made, including its geometric configuration and the precision required. Then, by considering the capabilities of the variety of micro machine tools available, a shop can find the best way to turn out small parts in the required volume and precision. Δ

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