

► BY BILL KENNEDY, CONTRIBUTING EDITOR

# Bigger and Better

Toolmakers offer productive, application-focused ways to enlarge existing holes.

**H**olemaking is the most common metalworking operation, so it follows that holemaking is frequently the focus of productivity improvement efforts. An obvious way to cut costs and speed throughput when making holes is to remove a lot of material in a hurry. This article covers selected tool offerings and application recommendations developed to match shop needs when it comes to enlarging existing holes.

## Many Parts, Little Time

For some shops, maximizing speed and quality is the primary goal. Removing material fast and reducing cycle times are especially crucial in the high-volume arena of automotive manufacturing. Powers

The Opening Drill line of hole-enlarging tools from Allied Machine & Engineering removes a large amount of material quickly with relatively low cutting forces and minimal stress on the machine tool.

and Sons LLC, Montpelier, Ohio, is a designer and manufacturer of steering and suspension components, systems and assemblies. The company machines forged steel parts primarily for trucks, including Ford 150 to 550 models and vehicles from Chrysler, General Motors, Volvo and International Truck. "We don't have many jobs that are 5,000 pieces," said Michael Manon, manufacturing engineer

for Powers and Sons. "We are talking hundreds of thousands of pieces, most produced in two-shift operations. Certain areas are running three shifts." In a true understatement, he added, "In our business, cycle time is important."

Powers and Sons spends a good deal of time enlarging holes. "They may be forged holes that we are going into to remove a lot of material, or they may be solid forgings that we have to drill

through, then go in from the opposite side to open up," Manon said. The parts are primarily made of 1040 steel, but 1541 hardened material (242 to 284 HB) is used in applications that require more strength. After roughing, the holes usually are finish bored to tolerances of 0.004" or tighter.

To enlarge the holes, Manon applies fixed-pocket inserted Coremaster core drills from Manchester Tool Co.'s OTM division, Wapakoneta, Ohio. The drills are offered in nine diameters, from 0.825" to 1.303". The larger-

tion in cutting speed compared to those made with 1040 alloys.

However, machining speed must be balanced against tool life. "We've got to be able to maintain tool life and cost per piece. I can't sacrifice high dollars in tool costs for cycle times in machining," he said.

The tools enable Powers and Sons to remove "extra material that we can't take out unless we use several other tools. You'd have more tool changes, less cut time and higher tool cycle times," Manon said.

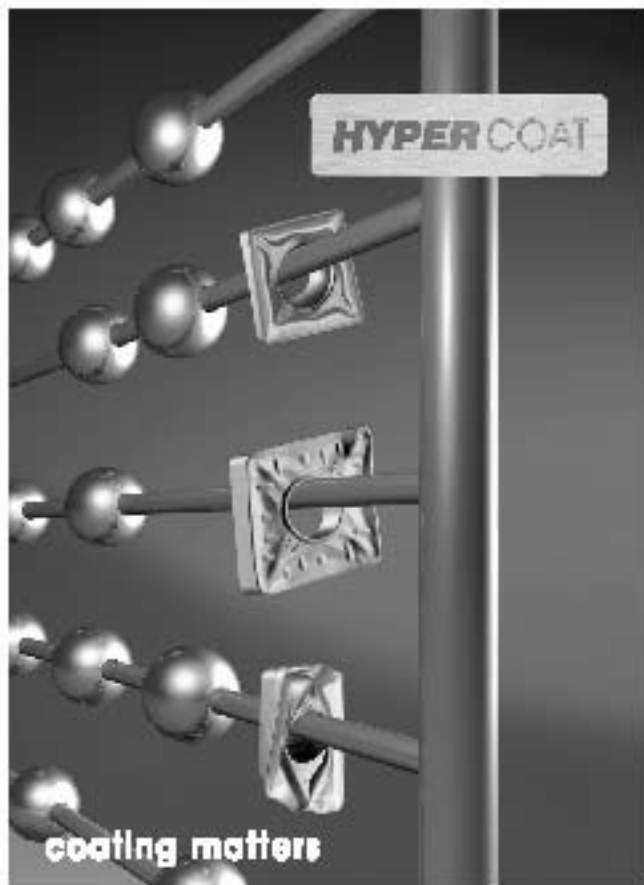
Bob Erickson, an OTM engineer, pointed out that the two-insert design of the tools enable them to correct holes that are out of position because of the vagaries of the forging or casting process. Unlike boring bars, the two-insert design of the tools is "2-flutes effective," Erickson said. "It's not going to follow the hole; instead, it's going to drill in a straight line. If the hole is 0.060" from where it ought to be, the core drill doesn't care—it puts the hole in the right spot."

In that case, drill alignment determines hole position. "When you fix-

### Larger Holes, Less Stress

Other shops' choice of hole-enlarging tools may be based at least partly on the economic realities of their particular situations. Although many manufacturing sectors are booming, a cloudy economic outlook and competitive pressures are causing some shops—especially smaller ones—to be cautious in their outlays for capital equipment. As a result, many shops

face unproductive alternatives when it comes time to make larger diameter holes, said Rob Brown, product manager for holemaking and grinding products supplier Allied Machine & Engineering Corp. (AMEC), Dover, Ohio. "They have a 15-hp machine and have a job to drill a 3½"-dia. hole," he said. "That machine is not designed to do that kind of work. To do a large-diameter hole on a light-duty machine,



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**Powers and Sons uses CD 938 Coremaster core drills from OTM to open up 10.63mm- to 12.09mm-dia. cored holes (right) in forged and heat-treated 1541 steel idler arms. In a single pass, the drill takes the holes to within 0.5mm of finish size. The final diameter of 24.49mm, ±0.03mm (left), is then bored.**

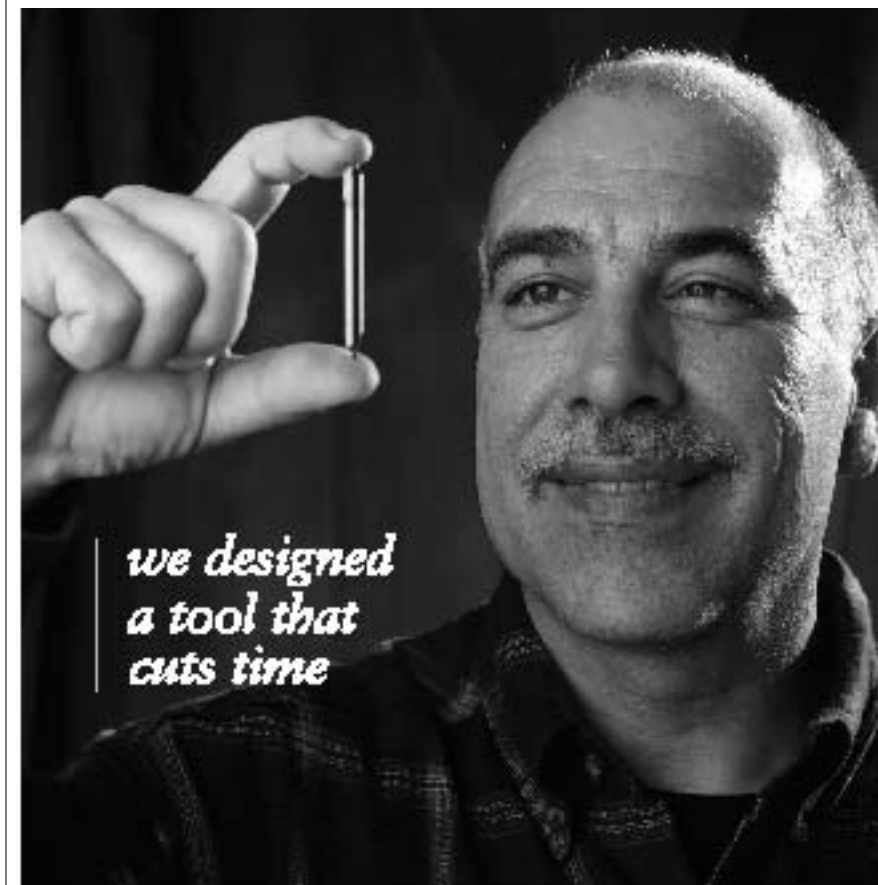
diameter drills can remove as much as 3/8" of material per side. OTM also offers 17 adjustable-cartridge Coremaster drills in diameters from 1.36" to 3.06". Cartridges can be adjusted up to 0.075" per side, providing 0.150" adjustment capability on diameter.

Powers and Sons employs the tools for roughing. "We have to remove a couple hundred thousandths on a side of a bore," Manon said. "We rough it out, get it out of the way; we don't really gage a dimension off it. We need to get in and out of the hole as fast as possible." As a result, the drill manufacturer's application parameter recommendations represent a starting point. "We will challenge the tool," Manon said. "We need to find out how fast the tool can get it done." He added that the hardened 1541 alloy parts usually require about a 30 percent reduc-

### A core drill can be a semifinishing or a finishing tool, depending on the tolerance.

ture the part, you fixture on the locating edges. If the hole should be 2" over and 3" the other way, that's where you put your hole," Erickson said.

He added that because the core drills have two effective flutes, they operate at two times the feed rate of inserted drills. The relevant formula is feed (ipr) = fpt × effective flutes. For example, he said, "If you feed 0.008 ipr with an inserted drill, you'd feed 0.016 ipr with a core drill." Erickson said a core drill can be a semifinishing or a finishing tool, depending on the tolerance. "When you are talking tenths, no," he said, "but if you are talking a few thousandths, a core drill is a fine finishing tool."



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Allied Machine & Engineering product manager Rob Brown (left) and R&D test engineer Bradley Gray discuss application testing of Opening Drill hole-enlarging tools.

heads feature two 180°-opposed inserts that are adjustable for radial diameter and axial height.

The heads provide three different approaches to roughing existing holes. In balanced cutting, both inserts are set at the same radial diameter and axial height. This arrangement produces maximum concentricity and permits higher feed rates because the setup has two effective flutes.

In a second approach, step cutting, one insert is set to a larger radial diameter while the other is set to a deeper axial depth. The deeper axial depth means the insert is slightly ahead of the other insert. Step cutting provides higher cutting capacity and can handle a larger stock allowance than balanced cutting, but a reduction in feed rate is required because the setup is 1-flute effective.

Zaya compared the ability of balanced and step cutting methods to handle stock allowance. It's possible to

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contributed to this report:**

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remove up to 0.300" on diameter when employing balanced cutting using a 3/8" inscribed-circle CC09, diamond-shaped insert to enlarge a hole in 1020 steel. Using step cutting, stock allow-

ance increases to 0.500". Applying a 1/2"-IC insert in the same material, 0.400" stock removal achieved in balanced cutting can be increased to 0.800" when step cutting.

Balanced and step cutting employ triangular, diamond or square inserts. Full profile cutting, the third rough-boring approach possible with the heads, uses trigon inserts—a triangle with an intermediate angle on each side. The cutting edge configuration gives the tool four cutting profiles, enabling the removal of large stock allowances in a single pass.

Comparing all three hole-enlarging methods, balanced cutting permits stock removal up to 10 percent of the final bore diameter. With step cutting, the percentage increases up to 20 percent. With profile cutting, the increase doubles again—up to 40 percent of the final bore diameter. Like step cutting,

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**'Boring allows you to have adjustability in the diameter you are cutting. That's the main difference between drilling and boring.'**

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profile cutting also is 1-flute effective in relation to feed rates.

Hole finish depends on many variables, including the material, fixturing, machine, spindle, age of the machine and spindle combination and tool cleanliness. "If you had a brand new machine with a great fixture and a brand new tool, you could probably achieve surface finish upwards of 60 to 70µin.  $R_a$  with just a roughing pass," Zaya said. That will be sufficient for many users, while others will complete the hole with a fine-finishing operation.

Assuming a rigid machine, tool-holder and workpiece combination, BIG Kaiser said its twin cutters can maintain repeatability of bore size within 0.0002", location and roundness within 0.0005" and bore tolerance 0.004" when a tool presetter is employed.  $\Delta$

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