➤BILL KENNEDY, CONTRIBUTING EDITOR

THE STRAIGHT Story

When the application is appropriate, straight-flute drills outperform twist drills.

The effectiveness of today's straight-flute drills undercuts traditional assumptions about the indispensability of spiral-flute drills. In some applications, a straight-flute drill is a better choice than a twist drill.

Modern straight-flute drills were preceded by die drills: short, stiff tools with beefy tips for drilling hard steels. Run at a slow spindle speed and light feed rate, the die drill's strength and rigidity enabled it to make straight, round holes.

Die drills worked because the materials they were engineered to machine typically produced short chips. Chip control is still the key issue in the application of straight-flute drills, which work best in materials that don't generate long, stringy chips. These include cast iron, powder metal and medium- to high-silicon (6 percent or more) aluminum.

Guhring

Straight-flute drills operate best in materials that don't make long stringy chips, such as cast iron, P/M and medium- to high-silicon aluminum. Shown is a Guhring RT150GG straight-flute drill poised above a cast iron engine block.

However, new machine tool and coolant-delivery technologies, as well as enhanced tool geometries, have expanded the application range of straight-flute drills. Tim Johnson, director of engineering and applications for H.A.M. Precision USA, Pewaukee, Wis., said, "The old way of thinking is that you need a helix to pull the chips out, and that straight-flute drills are only for aluminum and cast iron in short—2 or 3 diameters deep—holes." But, he continued, thanks to the higher coolant pressures developed today and higher spindle speeds, a straight-flute, through-coolant tool is extremely effective at breaking and evacuating chips.

In the right applications, straight-flute drills offer significant performance advantages over drills with spiral flutes. Bob Hellinger, national sales manager for standard tools, Guhring Inc., Brookfield, Wis., said, "The beauty of these drills is they cut rounder and straighter holes, and they cut faster than a standard cobalt or high-speed-steel drill."

Hellinger cited a case where a Guhring RT150GG 0.394"-dia., straight-flute drill replaced a twist drill in an operation on aluminum. The twist drill ran at a 50-sfm cutting speed and a 0.005-ipr feed, while the straight-flute drill ran at 800 sfm and a 0.007 ipr. Cutting time with the straight-flute drill was about a tenth of that with the twist drill.

Part of the improvement is based

on the drill's basic design. A straight flute provides a direct path for the chip to exit the hole, said Jay Kopecky, inside application representative at CJT Koolcarb Inc., Carol Stream, Ill. However, the drill's cutting edge lacks a positive rake angle and, thereby, has minimal ability to turn and break chips, especially when drilling stringier material.

Faster is Better

Speed, specifically enough of it, is another factor in the successful application of straight-flute drills. "The faster you cut, the smaller the chips are going to be," Johnson said. He noted that straight-flute drills achieve high productivity through faster spindle speeds rather than higher feed rates.

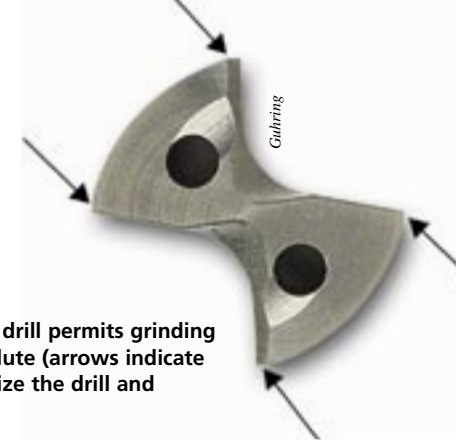
Many high-performance, high-penetration twist drills feature fairly large hones on their cutting edges, requiring that the feed rate at which the tool enters the work to exceed the size of the hone if the edge is to cut the material rather than simply push it. While in certain applications and materials the edge hone works well, Johnson said, "those tools typically operate at higher feeds and at slower speeds than straight-flute drills."

Johnson mentioned an application at carmaker Saturn where the drills initially were applied at a cutting speed of about 500 sfm. He said: "They decided to do a little testing and see how fast they could run. They saw tool life improve the faster they went. They were in the cut a shorter period of time and were more effective at removing chips. They were able to get solid-carbide, uncoated tools up to 1,000 sfm, while seeing extremely good tool life and hole quality as well."

With the proper combination of coolant pressure and cutting speed, straight-flute drills can be effective in materials that don't necessarily produce short chips. Johnson described an application in 1144 stress-proof steel where straight-flute drills are "working exceptionally well. The chips are breaking up nice and small, and we're not getting any built-up edge issues."

The tool used is a H.A.M. 294-0500 uncoated, through-coolant, 5mm-dia. drill run to a depth of 48mm at 185 sfm and a 0.003-ipr feed. Coolant pressure on the rotary dial machine is 1,500 psi. Johnson noted that the 1144 alloy has a high concentration of manganese sulfide, which enhances chipbreaking.

Success on such materials, however, requires high coolant pressures. "A good rule of thumb is about 600 psi and above," Johnson said, adding that "we like to see 1,000, 1,200 or higher."



The tip configuration of the straight-flute drill permits grinding of two margins at the periphery of each flute (arrows indicate margins); the four points of contact stabilize the drill and contribute to its accuracy.

In addition to chip control, BUE can be a problem with straight-flute drills, because the material being cut moves across the edge from the drill's center and is pushed to its corners.

One way to combat BUE is using a drill with a smooth finish. "We have fine finishes on most of our high-performance drills," said Guhring's Hellinger.

Coatings also help. As an example, Hellinger cited molybdenum disulfide, a coating used in many aluminum applications. "It's sort of like Teflon; nothing sticks to it. It's excellent in applications where you don't want to get built-up edge," he said.

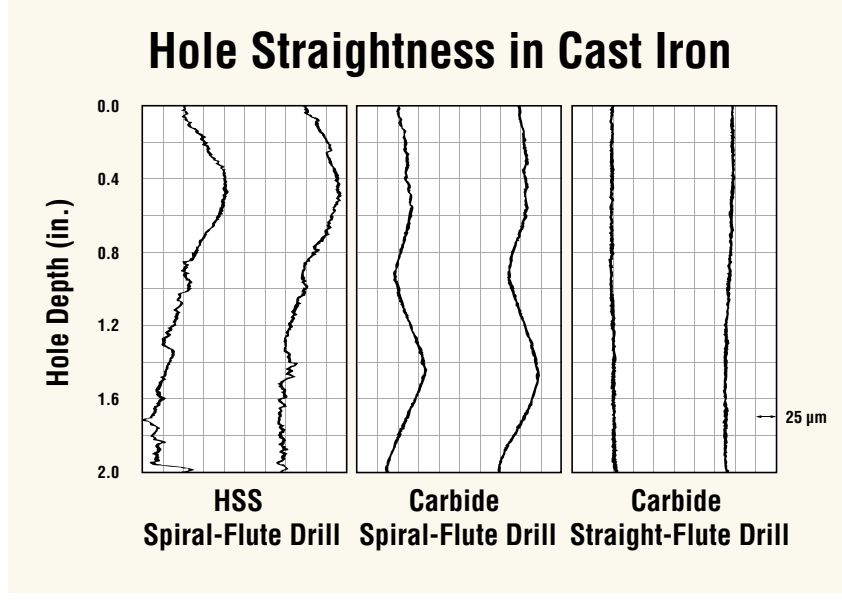
Getting to the Point

The tip configuration of a straight-flute drill permits grinding two margins at the periphery of each flute. The four points of contact stabilize the drill and contribute to its accuracy.

A large point angle also aids performance. Johnson said the 140° point angle of H.A.M. Precision's standard tools is similar to a split point, resulting in "very low thrust going into the hole." The large angle also ensures that the full drill diameter is engaged quickly, minimizing wander.

In many instances, it is best to create a starter hole with a pilot drill that has a point angle larger than that of the carbide straight-flute drill. Kopecky said, "You want the very center of the point, the chisel, to contact your starting hole first. Because of the brittleness of carbide, you don't want your cutting edges to contact first because that tends to crack the tips."

Another tactic involves using the straight-flute drill itself to briefly spot



When drilling a 10mm hole in cast iron, a HSS spiral-flute drill run at 98 sfm and 7.66 ipm with external coolant produced a hole of IT12 quality. A solid-carbide spiral-flute drill run at 295 sfm and 34.5 ipm with 440 psi/2.4-gpm through-coolant yielded a IT9 quality hole. A straight-flute drill run at 425 sfm, 33.3 ipm and featuring through-coolant at 735 psi/3.2 gpm created a hole with a quality of IT8.

the hole location before drilling. "Even a machined surface is not perfect," Johnson said, "and we just touch the hole to get the location. When you engage the chisel first, the tool doesn't have the opportunity to wander. We use the spot hole as basically a bushing, and then come back in and drill."


H.A.M. Precision

H.A.M. Precision's Multi-Drill is a solid-carbide, TiAlN-coated, through-coolant, straight-flute step drill. It is engineered to drill, counterbore and chamfer short-chipping aluminum.

G-Rated

Kopecky noted that many refer to any straight-flute drill as a "G-Drill," which is "not necessarily the case." G-Drill is actually a trademarked name for a class of straight-flute drills from Accuromm USA Inc. in which the drill's trailing margin burnishes the hole.

By way of comparison, Johnson said, "typically, a HSS drill will give you about a 125-rms finish, a carbide helical-flute, high-performance drill will give you somewhere in the 63 range, a 3-flute reamer will give you in the 32 range and a G-Drill will be in the 16-or-better range—a burnished type of finish."

Tony Shinoda, an engineer at Accuromm, Lexington, Ky., said different Accuromm drills are engineered to produce different levels of hole quality. The company's G-Drill typically meets H9 hole tolerances, while its G-7 drills combine drilling with a reaming function to meet H7 standards.

For example, Accuromm reports an aluminum holemaking application in which a 0.394"-dia., straight-flute G-Drill, run at 330 ft./min. and 0.008 ipr, replaced a twist drill and improved hole-diameter tolerance from ±0.0032" to ±0.0012". At the same cutting parameters, a G-7 drill held a tolerance of ±0.0008".

The benefits of higher hole quality can extend to other steps in an operation. Accuromm notes that when holes are to be tapped, tight size control can extend tap life by about 50 percent.

Increased metalworking performance nearly always requires a narrowing of the application focus. Straight-flute drills are far from general-application tools. But in an increasing range of applications, they provide significant benefits in both productivity and final part quality. △

The following companies contributed to this report:

Accuromm USA Inc.
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Competitive Carbide Inc.
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Guhring Inc.
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Unquenchable productivity

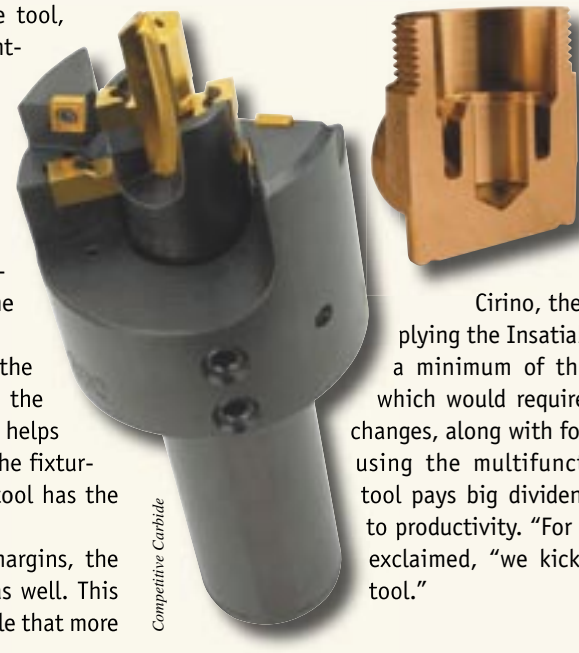
To produce all of a part's features with one tool, Competitive Carbide Inc. married its straight-flute G-Spot drill to a hollow mill. The result is the Insatiable G-Spot special.

"We're insatiable. We want the tool to perform as many operations as it can," said Tom Cirino, president of the Mentor, Ohio-based toolmaker.

The tool performs nine operations, including drilling, OD chamfering and spotfacing, ID chamfering and spotfacing, and OD turning to prep the part for threading.

Because there's a large contact area between the tool and part, as well as a four-point contact on the drill's diameter with the part, the two-piece tool helps to hold the part in place. This is in addition to the fixturing. "As much as the spindle has the tool, the tool has the part," Cirino said.

Because the straight-flute drill has double margins, the tool not only makes the hole, but burnishes it as well. This imparts a finer finish and produces a straighter hole that more closely meets the specified size compared to a conventional drill, which has a single margin where the cutting edge is.


Competitive Carbide

According to Cirino, the alternative to applying the Insatiable G-Spot is using a minimum of three or four tools, which would require up to three tool changes, along with four operations. And using the multifunction combination tool pays big dividends when it comes to productivity. "For cycle time," Cirino exclaimed, "we kick [butt] with that tool."

—Alan Richter