cover story

➤ BY BROOKE C. STODDARD

The Replacements

How do replaceable-crown drills stack up against the alternatives?

Solid-carbide drills are brittle and expensive. HSS drills are tougher and less expensive than solid carbide, but they don't last as long. Indexable-insert drills are cost-efficient, but they usually have to be followed by a reamer or a boring tool. Brazed-carbide drills need rebrazing. So why not set a solid-carbide crown, or tip, on a steel body and reap the advantages of carbide cutting edges and steel bodies? This, of course, is the idea behind replaceable-crown drills.

This hybrid drill is meant to combine the cutting accuracy and speed of carbide drilling with a less expensive steel body and, in the bargain, do away with two time-consuming and expensive processes: resetting a new drill and reconditioning a drill's cutting edges. These tools are said to offer the precision of brazed carbide drills while increasing productivity and lowering operating costs. The solid-carbide crowns are available in precise size increments and incorporate self-centering geometries that allow the user to meet tight diameter tolerances.

Iscar Metal Inc.'s CHAMDRILLJET features two coolant holes extending to the cutting edges.

Iscar Metals

Quick Changes

Time and cost savings are the main advantages of replaceable-crown drills, said Fredrik Sundström, drilling product manager at Seco Tools Inc., Warren, Mich. Since introducing the drills about 7 years ago, "we wanted

to compete against HSS and brazed drills," he said. "The advantage was in eliminating regrinding and recoating. In time, we have seen this drill working so efficiently that it also competes with solid-carbide drills. The steel body is more forgiving than a solid-carbide drill."

The "time" argument is that the body does not have to be removed from its holder. The crown is removed from the tool body and a new crown is secured. If the operator wants to incrementally increase hole sizes, he leaves the drill body in the machine and changes the crown. Several crown sizes fit one body.

Seco Tools

Seco Tools' CrownLoc replaceable-crown drill employs a pull rod through the body that screws into the bottom of the crown, then pulls the crown securely into the body.

There are various means of attaching a crown. Sumitomo Electric Carbide Inc. uses two screws that go through the face of the crown into the body. Seco Tools employs a pull rod through the body that screws into the bottom of the crown, then pulls the crown securely into the body. Iscar Metals Inc. and Ingersoll Cutting Tools both use a key that grips and then twist-locks the crown onto the body.

According to Sundström, a tip change takes about 20 seconds and requires no resetting. He added, however, that the interface must be cleaned with compressed air to prevent tool body damage.

Mike Gadzinski, training manager at Iscar Metals Inc., Arlington, Texas, estimates a crown change takes 30 seconds, compared to 10 minutes for a solid tool. "The automobile industry is really embracing this technology because of the decrease in downtime," said Gadzinski.

Iscar Metals

Iscar Metal's replaceable-crown drill uses a key that grips and then twist-locks the crown onto the body.

Cost Savings

Manufacturers also boast cost advantages. Because only the crowns are made of carbide, the crown/body assembly is cheaper than a solid-carbide drill. Replaceable-crown drills are more expensive than HSS ones, but perform better. Because many crowns can fit a single body, there are fewer tool bodies to buy.

Sundström said that the cheapest way of making a hole is still with indexable-insert drills, but added Seco Tools does not compare its CrownLoc series to indexables. "Indexable-insert drills are fast metal-removal tools, but they nearly always have to be followed by a reamer or boring tool." Replaceable-crown drills typically do not have to be followed by a reamer or a boring tool.

Added Sundström: "With solid carbide, you might have one drill in the machine, but also one in stock, one at the [regrinder's station], one on the way back from him, and one on the way to him. It all adds up. With a replaceable crown, you just keep the crowns in a drawer; when one wears out, you replace it with a new one."

Seco Tools does not recommend reconditioning crowns. Since the crown will not be reground, the operator can wear the tip past the point where he would normally stop to regrind a solid-carbide drill.

Gadzinski agreed that replaceable crowns should not be reground, adding that reconditioning involves high labor charges. In addition, he pointed out that "a reground [and, where applicable, recoated] bit may have only about half the life of a new one. If a machinist were unaware whether the drill he was using was reground or new, he would stop using it once he had reached the average life for a reground one, not a new one. If the drill bit were new, half of its useful life would be wasted." Alternatively, if a reground crown were mistaken for new, it might be run past its useful life and damage the part.

According to Sundström, a tool body can be refitted with new crowns at least 15 to 20 times, depending on the application. Each crown lasts about 120 minutes when machining steel, assuming proper clamping and coolant-application techniques are followed (Seco Tools recommends internal coolant).

Differing Opinions

Dan Murphy, regional sales manager for REM Sales Inc., Hoffman Estates, Ill., a distributor of Tsugami machine tools, said replaceable-crown drills are a good niche tool. He recommends indexable drills for large holes and solid-carbide for small ones. For holes in between, if it were high-volume work, he might choose solid-carbide or brazed in conjunction with a regrinding program.

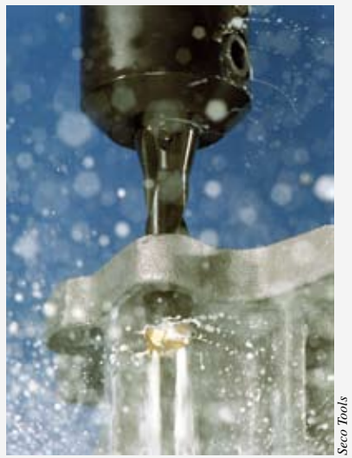
"But for medium-size holes," he said, "replaceable crowns offer versatility without a large investment. And you don't have to worry about a regrinding program. There's the niche, when you need better performance than HSS but not enough volume to justify a solid-carbide or brazed-carbide drill."

Murphy also likes replaceable crowns for CNC Swiss-style machines in applications where hole size is critical. He indicates the drill once, then replaces the tips as many times as necessary, reducing downtime.

But Kirk Gordon of Gordon Engineering Corp., an Audubon, Pa., supplier of CNC drill grinders, inspection systems and custom equipment, is a dissenter. "It's like putting a really hot engine in an economy car," he said. In his view, rigidity is essential when drilling with a carbide tool, and a steel body is not rigid enough. "High-performance points need to be supported,

Top choice for pinion manufacturing

Dave Mickelson, process engineer, Michigan Production Machining Inc., Macomb, Mich., counts himself on the "pro" side of the replaceable-crown drill debate. He noted that his company is using 14mm to 24.5mm CrownLoc replaceable-crown drills from Seco Tools on lathes in 19 manufacturing cells. They are applied primarily for making drive pinions used in carriers for transmission housings for the Big Three automakers. The high-volume production process operates nearly continuously.



Seco Tools

MPM Inc. applies CrownLoc drills for making drive pinions used in carriers for transmission housings.

The replaceable-crown drills run on CNC machines and are used to semifinish holes in 4118 or 1045 steel bar stock. In some cases, MPM leaves only 0.006" of material per side for finishing. In this application, the bar stock is turned on a lathe while the drill remains stationary, with the hole being made in the end of the workpiece.

"We've had a very good experience with the CrownLoc drills," said Mickelson. "I'm running the drills at feeds and speeds 25 to 30 percent faster than Seco Tools' highest recommendation, and it seems the faster I push these things, the better my tool life. They've outperformed everything else we've tried."

"Some of our parts range in length from 20mm to 60mm, and even with the longer parts, where I'm really blasting through the material, I'm not seeing any drill walking; they hold center nicely," he said.

Before fully converting to replaceable-crown drills about a year and a half ago, Mickelson used a variety of drills for this application, including spade, insert and solid carbide. "The other drills failed prematurely, and when we did get one to work within the parameters the tool builder gave us, when we started creeping up on speed, we would see the drill walking off center, leaving no material for finishing and other headaches."

Another benefit is that MPM has not had to use high-pressure coolant to evacuate chips using the replaceable-crown drills. "We do one blind-hole, and even on that the chips evacuate pretty well."

Mickelson has found that, barring a crash, the tool bodies seem to last indefinitely. "I haven't seen any channel wear on the bodies," he said. "On other drills I've used, the chips wear away the flutes and tear into the through-coolant holes, but that hasn't happened with the CrownLocs."

He is also satisfied with the crown life. "On the smaller drills, I'm getting 6,000 holes and with the larger drills, like the 24.5mm, I'm getting 2,000 holes while really blowing through the material," said Mickelson. "Another nice feature is the serrated lock-up device on the back of the tip that intermeshes with the body itself (see top photo). It takes all the guesswork out of replacing tips."

No tool setup is needed after replacing a tip. MPM purchased torque wrenches from Seco Tools to lock the tips in place after replacement. "We've taken tip replacement out of the hands of the setup guys and given it to the operators, who have been successfully changing their own drill tips for the past 6 months," said Mickelson. Each tip change takes 2 to 3 minutes.

Based on Mickelson's experience, Larie Smith, manufacturing engineer for MPM, has begun using a 15.25mm CrownLoc replaceable-crown drill on a low-hp machine to make a 3 diameters-deep blind-hole in a steel part. The drill operates at 2,500 rpm and 450 mm/min. and is producing 3,000 parts per crown, about double the production achieved with the previous tool, according to Smith. MPM is considering using replaceable-crown drills in other applications as well.

—Alan Rooks

The following companies contributed to this report:

Gordon Engineering Corp.
(610) 676-0266
www.gordon-eng.com

Ingersoll Cutting Tools
(866) 690-1859
www.ingersoll-imc.com

Iscar Metals Inc.
(877) 294-7227
www.iscarmetals.com

Michigan Production Machining Inc.
(586) 228-9700
www.michpro.com

REM Sales Inc.
(847) 649-1425
www.tsugamiusa.com

Seco Tools Inc.
(800) 832-8326
www.secotools.com

Sumitomo Electric Carbide Inc.
(800) 950-5202
www.sumicarbide.com

centered and driven by bodies that are strong and inflexible," he said.

Gordon is also wary of advertised cost savings. He agreed that, in theory, there should be savings, but suggested that the real cost per cutting edge can actually be higher with replaceable crowns than solid-carbide tools that are resharpened properly. He also believes that the replaceable crowns are not quite as effective as solid-carbide drills, saying in some cases, the slightly different geometries "water down" performance. And, he pointed out that standard replaceable crowns are generally not available below ¼", limiting their application.

"Bottom line," he said, "the replaceable-crown types just don't seem to me to make a lot of sense" compared to solid-carbide drills. Gordon cited the cost of buying a replaceable-crown drill, changing out worn tool bodies and replacing crowns instead of regrinding them, as well as the cost of "running slower and getting less precision, in terms of location, straightness, size and roundness of holes."

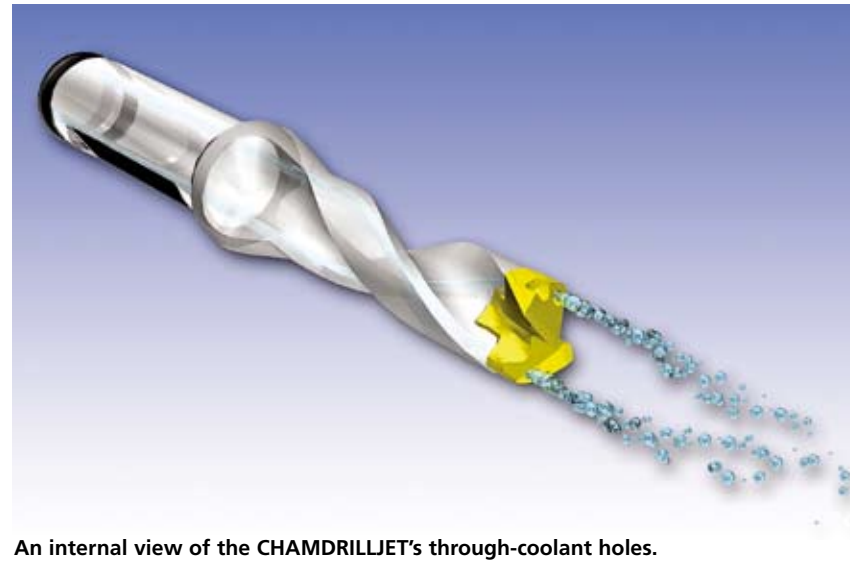
In Gordon's view, a good application for replaceable-crown drills is one with a novice operator. The operator couldn't be trusted to replace the whole tool, but he could replace the crown. Even then, Gordon said, an operator has to keep the body head clean and watch for wear or damage.

Murphy disagrees with this assessment. "The big problem is that people hate to throw things away," he said. "They also don't like to keep track of things. The lazy solution is to buy a more expensive tool and not worry about it." Instead, operators could put a macrocount into a CNC program for replaceable-crown drills and, after an appropriate number of changes, throw the body away, he said.

Murphy added that replaceable crowns are better suited for holes under 5 diameters deep, or even 3 diameters deep, and a solid drill is a better choice for deeper holes.

He doesn't promote replaceable crowns as a cure-all. "The application would be softer materials and low- to medium-volume lot sizes requiring a fairly shallow depth," Murphy said. "In those cases, replaceable-crown drills make sense. Also, if there are families of parts with several [hole] sizes, the drill bodies can cover a decent range with just a head swap.

"For harder materials, deep holes and very high-volume dedicated work, solid drills make more sense," he continued. "For one-offs and prototype work, HSS would be just the thing." △



Iscar Metals

An internal view of the CHAMDRILLJET's through-coolant holes.

Replaceable-crown specs

Ingersoll Cutting Tool's QwikTwist crowns begin at 0.2953" and broaden to 1.0197" to produce holes up to 8 diameters deep.

Iscar Metals Inc. offers crowns ranging from 0.295" to 1.017" for drilling holes 3 to 5 diameters deep.

Sumitomo Electric Carbide's recommended speeds and feeds for drilling steel with hardness ratings from 250 to 300 HB with a diameter around 0.64" are 260 to 360 sfm and 0.006 to 0.012 ipr, respectively.

Seco Tools' CrownLoc P geometry (for ordinary steels in the range of 250 to 300 HB) is meant to cut from 236 to 290 sfm with a feed rate of 0.009 to 0.011 ipr.

—B. Stoddard

About the Author

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