▶ BY GREGORY FARNUM

Open to Debate

Pros and cons of monoblock tooling.

Monoblock tooling addresses the needs of high-speed, close-tolerance machining.

Insert technology seems to evolve faster than the weather changes. Cutting tool manufacturers constantly are introducing new insert materials, coatings and geometries. It's enough to make the rest of the tool assembly seem somewhat staid by comparison.

Lately, however, monoblock (or integral-shank) tooling, in which the tool shank and cutter head are made from a single piece of steel or carbide, is sparking renewed debate on the basic approaches to tooling. Proponents say monoblock-style tooling meets many of the key needs of high-speed, close-tolerance machining. Opponents say it's a backward-looking technology, expensive and fundamentally unnecessary.

Larry Powell, product manager for spindle tooling at Seco-Carboloy, Warren, Mich., is definitely among the proponents. He thinks it is a product that is right for the times, but he knows the market will have some questions.

According to Powell, skeptics will ask, "'What's the big deal with monoblock?' Endmill holders, tap chucks, etc. have been around for a long time and are thought by many to be commodity items. [To them], one rotating toolholder is as good as another."

That may have been the case "before machine tools cost a million dollars, when spindles rotated under 6,000 rpm and part tolerances were in microns," he continued. Now, though, customers and machine tool builders are demanding better tooling.

"Carboloy expects to be responsible for everything from the spindle to the cutting edge," Powell said. "When we are not, the high-performance cutting tools we manufacture can underperform due to running in toolholders that were not designed nor manufactured for today's high [spindle speeds] or high-performance machining techniques."

Powell said Carboloy's monoblock products, which are being introduced to the North American market, are closely matched to the tolerances the machine tool builder holds for its spindles and to the cutting tool's operating data. "We do not expect our solid-carbide drills to perform optimally unless runout is controlled and minimized. Balance becomes important when trying to hold close-tolerance bores—even at traditional cutting speeds, let alone at speeds over 8,000 rpm."

BIG Kaiser Precision Tooling Inc., Elk Grove Village, Ill., is another company bringing monoblock-style tooling to market. "We are introducing a new indexable endmill called Fullcut Mill," said Jack Burley, the toolmaker's vice president of engineering. The Fullcut Mill will be available with two shank versions: straight and integral. Both can be run at high metal-removal rates, especially the integral-shank version.

While sharing some of the company's test results, Burley noted: "Our extensive testing and research found that [our] straight-shank tools offered much higher metal-removal rates than our competitors, but these numbers increased substantially when we tested our integral-shank tools of the same cutter geometry. Also, the improvements increased as the spindle size decreased."

The diameter of the cutter and total gage length also make a difference, Burley added. "For example, we measured tool deflection when cutting the same diameter with four different tools. The first tool was assembled with a straight shank and a BT 40 milling chuck and had a measured deflection of 60µm. The next tool was an integral BT 40, our shortest gage length of 3.4", and deflection measured only 20µm."

However, Burley went on to note that most real-world applications require a longer tool length to reach into pockets and, therefore, BIG Kaiser will offer a 1"-dia. CAT 40 with gage lengths of 3", 5" and 6".

He added that depending on length, integral-shank tools cost between 30 and 75 percent more than straight-shank tools.

Test results: integral vs. straight shank

Integral-shank tool, CAT 40: Full-slot milling, ¾" diameter, running at 500 sfm, 0.004 ipt, 3-tooth cutter (30.56 ipm), 4140 steel, axial depth of 0.35", mrr = 8.11 $in.^3$/min. No vibration.

Straight-shank tool: All parameters the same as for integral shank, except maximum depth could only reach 0.215" before vibration occurred, mrr = 4.96 $in.^3$/min.

Conclusion: Integral-shank mrr in this test was 60 percent higher than straight-shank mrr.

—BIG Kaiser Precision Tooling

A Different View

Not everyone is convinced that monoblock tooling is the greatest thing since sliced bread.

"With all the indexable and solid-carbide tooling and advanced holding systems—like milling chucks, shrink-fit holders and hydraulic chucks—on the market, why would a customer use a high-priced, dedicated, long-lead-time tool?" asked Lee Flick, director of manufacturing and engineering for T.M. Smith Tool International Corp., Mt. Clemens, Mich. "Monoblock tooling is costly and supply is problematical.

"We have found that using shrink-fit holders and milling chucks with solid-carbide tooling provides 95 percent effectiveness, compared to monoblock tooling, yet the cost of the monoblock tooling is more than 300 percent higher. Add in the high cost of trying to repair or regrind monoblock tooling and the cost per part starts to skyrocket," said Flick.

He added that there are applications where customers choose to use monoblock tooling, "but those applications are so specialized that less than 1 percent of the market will spend the money to purchase them."

Regarding the issue of supply, Flick described monoblock tooling as a "special," meaning that the customer is required to work with the manufacturer directly. He said there is no effective distribution of these types of tools, because every customer's demands are different and it takes a high level of engineering that most distributors cannot provide or support.

"Monoblock tooling," Flick concluded, "went out with stone tablets and square wheels. There are more cost-effective products on the market today that not only replace, but in many cases outperform, specialized monoblock tooling."

A spokesman for Briney Tooling Systems, Bad Axe, Mich., agreed with Flick. "The key advantage of shrink-fit tooling is the ability to quickly change cutting tools. The user is able to use a variety of cutters with a single standard toolholder shank and to change cutters in a timely way, keeping sharp edges on the workpiece."

He added that shrink-fit toolholders provide all the rigidity of an integral-shank tool. So, the user has tool-changing speed and flexibility with the benefits of better surface finish, longer tool life and less machine tool wear. An additional advantage is that shrink-fit toolholders can be precisely preset.

Like Flick, Scott Tilton, milling product manager for Ingersoll Cutting Tools, Rockford, Ill., also views monoblock tooling as a special rather than a commodity-type product. But, he takes a more nuanced view of the subject.

"Ingersoll Cutting Tools has built monoblock-style tooling. My take on the subject is that I'm neither for it nor against it," he said. "In some cases, a monoblock system is a great engineering choice."

Tilton added that when Ingersoll

Pros and cons of monoblock tooling

PRO: Improved tool-assembly rigidity.

PRO: Generally, improved tool life.

PRO: Reduced "small parts" inventory.

PRO: Consistency of setup is less dependent on tool-component cleanliness because there are far fewer mating surfaces in the complete tool assembly to keep clean.

CON: Monoblock tooling costs more.

CON: Damaging a few insert pockets in one area of a cutter means sending the entire tool assembly out for repair.

CON: Individual cutters or tool components cannot be dimensionally "ground to suit," so indexable-insert cutters must feature an adjustment mechanism.

CON: Monoblock tools are specials.

—G. Farnum

builds monoblock-style tooling, typically it is for straddle milling automotive steering or suspension parts. Straddle milling is a high metal-removal technique that consists of stacking two or more mills on an arbor to cut more than one surface of a part at the same time.

"The driving factor in straddle milling is rigidity," he said. "We need the best weight-to-rigidity ratio possible. Dedicated monoblock tooling can provide this rigidity. Also, the nature of automotive steering and suspension work lends itself to long production runs, which works well with dedicated tooling."

According to Tilton, monoblock tooling makes the most sense in high-production environments, where the tooling and machine tool are dedicated to a specific application for long periods of time.

The following companies contributed to this report:

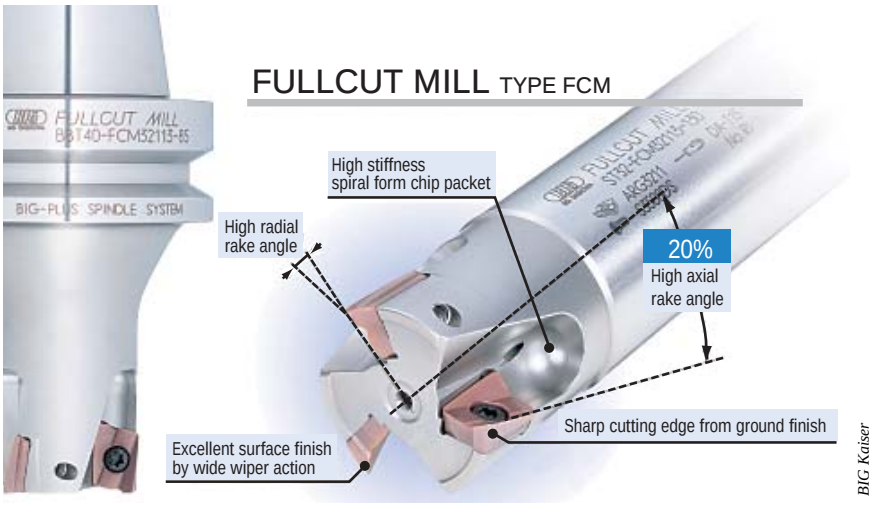
BIG Kaiser Precision Tooling Inc.
(888) 866-5776
www.bigkaiser.com

Briney Tooling Systems
(800) 752-8035
www.brineytooling.com

Ingersoll Cutting Tools
(815) 387-6600
www.ingersoll-imc.com

Seco-Carboloy
(586) 497-5000
www.carboloy.com

T.M. Smith Tool International Corp.
(800) 521-4894
www.tmsmith-tool.com



BIG Kaiser

Fullcut Mill indexable endmills from BIG Kaiser Precision Tooling will be available in either straight-shank or monoblock versions.

The Relative Price

Though critics frequently cite price as one of the drawbacks of monoblock-style tooling, Carboloy's Powell thinks the picture is more complex. "Traditionally, price has been the deciding factor for this type of tooling, because of the perception that all rotary toolholders are the same," he said. "Now, this perception is changing.

"Machine tool builders are voiding spindle warranties when poor-quality tooling causes premature bearing failure. Spindles are manufactured to much higher quality standards today and demand equally high-quality taper toolholders. Spindle speeds are faster, which aggravates any runout or unbalance the toolholder may have by the square of the increase in spindle speed," said Powell.

He maintains that cutting tool vendors have a major role to play in changing customers' cost-benefit perceptions. "Certainly, education is a key consideration in selling any quality product. If the customer is not aware of the proper usage of a tool, it is difficult to judge a good one from a mediocre one. Often, we see huge cost savings when we apply a cutting tool, because the tool we replaced was not applied correctly or was the wrong tool for the job."

Powell stressed that quality at a reasonable price is the way that manufacturers of monoblock tooling will succeed. "We must be priced competitively with respect to cutting tool manufacturers of equal-quality tooling."

About the Author

Gregory Farnum is a Detroit-based journalist specializing in industrial and scientific issues.