



Milling

Choosing the Best End Mill: Solid, Modular or Indexable?

Kip Hanson | Mar 21, 2023

The good news? CNC machinists have a lot to choose from when selecting an end mill. The bad news? CNC machinists have a lot to choose from when selecting an end mill.

Shopping for a milling cutter can be a confusing exercise. With dozens of brands and hundreds of geometries, sizes, flute counts, coatings, and substrates available, finding the best one often comes down to what you know or which company you trust most.

And while trust is a nice attribute to have in any relationship, relying on the “what you know” part of the preceding statement leads to lost opportunities.

Shops that stick solely to the tried-and-true miss out on the latest—and often greatest—advancements in cutting tool technology, a practice that can spell lower tool life and productivity. Sometimes, it spells the difference between profit and loss.

We'll touch on details like material-specific carbide grades and variable helix geometries shortly, but let's begin the topic of milling cutter selection by defining their three broad categories: solid, indexable and modular:

- **Solid Carbide End Mills:** As their name implies, solid end mills are ground from a single piece of material, usually cemented carbide, although high-speed steel (HSS) cobalt varieties are also available, as are solid ceramic tools for machining Inconel and other nickel-based heat-resistant superalloys (HRSA). Depending on your budget and application, solid carbide end mills begin the slide into cost-prohibitive territory somewhere in the ¾-inch to 1-inch diameter range, while HSS remains affordable (though less productive) up to a couple of inches or so.
- **Indexable Cutters:** Looking for a 6-inch diameter or larger end mill? If your machining center can drive it, they're available, as are similarly humongous face mills, shell mills, button cutters, and a host of other indexable cutters. All are equipped with precision-ground carbide inserts that are attached to a steel cutter body using screws or sometimes clamps. Unlike most solid end mills, indexable cutters often boast coolant-through-the-tool capabilities and are far more cost-effective at larger sizes. As a rule, however, they are not center-cutting like many solid end mills (although it's easy enough to ramp or helix cut in the Z-direction instead), nor are they as rigid (but still plenty strong for most applications).
- **Modular Milling:** Sometimes referred to as replaceable head milling cutters, modular end mills straddle the line between solid carbide's performance and greater expense (particularly at the upper end of the size range) and the convenience of indexable tools. They use a single piece of

carbide whose business end is identical to a solid end mill but has a proprietary threaded connection that screws onto a steel cutter body—and does so within seconds. Exceptions exist, but generally speaking, the sweet spot for these tools is in the ½-inch to 1½-inch range. And as with solid end mills, some modular heads can be reconditioned.

Workpiece Is Critical in End Mill Selection

So which one's right for your application? It's a great question, but it might be the wrong one to ask. Far more important than the milling tool's cost or how it's mounted are the workpiece material, shape, and tolerance; available spindle horsepower; machine rigidity; the number of parts to be machined; programming technique; and numerous other factors that help determine success during machining operations.

"For large indexable cutters especially, it's critical to understand your machine's horsepower and torque curves," says Scott Etling, vice president of global product management at Kennametal. "You want to select a milling cutter with a diameter and number of inserts that allow you to utilize the full power of your machine tool—within the limits of your fixturing, of course—so as to maximize productivity for the application."

Etling points to the company's Dodeka series of indexable milling cutters as one way to achieve that. "It uses one insert that fits into three different pockets. So by changing cutter bodies, you could use a 75-degree lead angle and apply it as a high feed cutter; switch to a 30-degree for a heavier depth of cut; or go with a 45-degree lead angle as a happy medium between each of these."

He laughs. "No one likes to hear it, but the answer with any cutting tool recommendation always comes down to something I heard long ago: It depends."

Opposites Attract

Corey Schwenke is less concerned with horsepower draw, although he agrees with Etling as to the variables and complexity of cutting tool selection.

As the product manager for solid round tools at Sandvik Coromant—meaning he's responsible for end mills, drills, reamers, taps, and exchangeable heads—Schwenke focuses practically all of his attention on the other (and generally smaller) end of the milling cutter spectrum: non-indexable cutting tools.

He's quick to note that, with the exception of taps, high-speed steel is a non-starter at Sandvik Coromant, an increasingly common standpoint among cutting tool providers (Kennametal included), given carbide's far greater tool life and productivity.

Schwenke also suggests that most shops do a good job when choosing between solid, modular and indexables. What they aren't always so great at is choosing the correct grade, flute count and geometry for the task at hand.

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Here again, cost and size availability are the primary drivers, and it's easy to make a blanket statement that solid carbide is king up to ½-inch diameter, indexables are a no-brainer above a 2-inch diameter or so, and that modular fills the gap between the two nicely.

Whatever the size or shape, Schwenke agrees that cutting tool selection depends heavily on the metal and the toolpath used to cut it.

“Our Plura line of solid end mills is available in variable helix and form control versions, and they are optimized for certain materials and sometimes even certain milling applications,” he says. “For instance, we have an application-specific 5xD [five times diameter] length of cut tool designed specifically for titanium, so if you have a feature with high thin walls as in many aerospace components, you can often complete it in a single pass.”

The Plura line also has grades and geometries for use in stainless steel, cast iron, and heat-resistant superalloys, Schwenke says.

Kennametal offers those options, too. And both companies provide modular or exchangeable head end mills—Kennametal offers the *Duo-Lock* line while Sandvik Coromant has its *CoroMill 316*.

Breaking the End Mill Status Quo

Those are just a few examples of the options available from these two leading cutting tool providers. Others have similar offerings. Ultimately, you’re in the best position to analyze your facility’s machining scenarios and decide whether the best options are solid, modular or indexable.

The point to remember is that if your shop is making tool selections based on what you know or the solution/vendor you’re most comfortable with, it’s probably time to ditch the status quo. Explore the options, talk to people such as Etling and Schwenke, and step outside your comfort zone. It’s the fastest way to improve.

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