

► BY ALAN RICHTER, MANAGING EDITOR

# Digging In

A look at spade drills and when to apply them.

The spade drill's name derives from the shovel-like appearance of its blade, and "digging deep" is what it does. A standard blade is inserted into the drill body, typically made of 1018 or 1020 low-carbon steel, to create holes up to 8 diameters deep. Specials can be engineered to cut even deeper.

The blades are primarily made of HSS, including high-cobalt-content grades, and carbide. The vast majority are coated—in all the popular flavors. The types of holders vary, from stub to extra-long lengths, and they come with straight or spiral flutes. The holders also have an assortment of shank styles, such as tapered, straight and straight with a flange.

This article looks at the applications best suited for spade drills, as well as various types of spade drills on the market.

## Drill Selection

Drilling a hole is the most common metalcutting operation, but like most processes, options exist for cutting tool selection. When drilling, the basic choices are a twist, indexable-insert or spade drill.

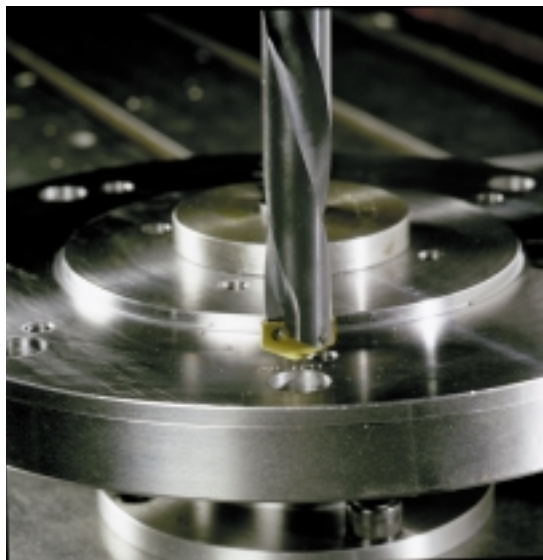
Although diameters range from 3/8" to around 8", spade drills in the 1/2"- to 2"-dia. range see the most action. And they can drill into any metal, according to

Lars Floderus, president of Madison Cutting Tools Inc., Providence, R.I. He distinguished between the older, universal-style spade blades, which are often reground, and the newer, longer-lasting ones that are treated as throwaway tools. Unlike their universal counterparts, modern spade drills have an overhang similar to an indexable insert, which allows for increased stability and faster drilling.

"The universal spade drill is not as fast," Floderus said. "And throwaway spade drills are two to three times faster than cobalt twist drills."

Jack Burley, product manager of rotating tooling for KPT/Kaiser Precision Tooling Inc., Elk Grove Village, Ill., concurred that spade drills cut faster than twist drills. He indicated that a spade drill's speed is up to five times faster than a comparable twist drill. In addition, the holes it cuts tend to be straighter, more consistent and have a finer surface finish than those produced by a twist drill.

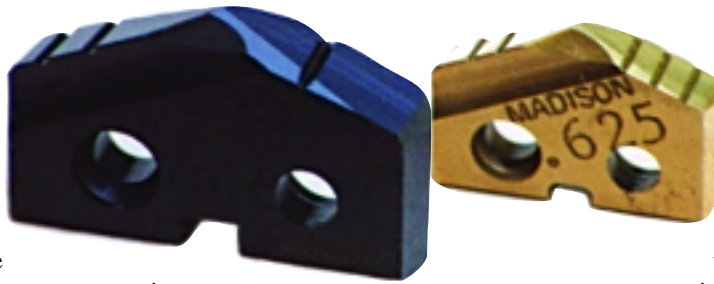
The reasons why relate to the spade drill's S-point geometry, through-the-tool coolant capability and replaceable blade with a higher hardness than a comparable twist drill. In addition, Burley explained that a spade drill performs the complex task of cutting and chiseling



Regal Cutting Tools

Spade drills are versatile tools for making holes up to 8 diameters deep.

the workpiece, which puts high compressive stress and axial thrust loads on the top of the drill, allowing for fast cutting. Plus, the form of the spade



drill's center point creates no eccentric forces and centers the drill. Once in the cut, the spade drill's margins, which are similar to a twist drill's, keep the tool centered, and the spade drill's web-point thinning minimizes end thrust to improve hole finish and straightness.

"The spade drill's stability makes it possible to drill a hole up to 6 diameters with an unpiloted tool," Burley stated.

When it comes to producing shallow holes 1 to 2 diameters deep in machining center applications, a spade drill is not generally the first choice. "For shallow holes, spade drills can't compete with indexable-insert drills," Floderus said.

Floderus added that while spade drills generally run at lower speeds than

Spade blades are available in a variety of sizes and substrates, and they come with a broad selection of coatings.

indexable drills, they can match indexables' productivity because they can be fed at rates two to three times higher.

If the level of productivity is a wash, when should a spade drill replace an indexable? "An indexable-insert drill should be replaced by a spade drill when hole depth, hole tolerance, insert breakage or spindle horsepower is a problem," Floderus said.

### Horsepower Requirements

As a general rule, Floderus said the horsepower requirement for a spade drill is less than that of a comparable twist or indexable drill, because spade

drills produce smaller chips.

And the higher speeds needed for effective application of indexables brings with it higher horsepower demands.

You can expect a ½"-dia., HSS spade drill to require 1.5 to 3 hp, a 1" HSS spade to require 3 to 6 hp and a 2" HSS spade to require 7 to 14 hp, he said.

Floderus pointed out that the exact horsepower requirements can only be calculated using a mathematical formula that takes into account the particulars of a specific application and workpiece.

A simplified equation for determining horsepower, or tool power, as published by Allied Machine & Engineering Corp., Dover, Ohio, is:

$$\text{Tool power (hp)} = 0.6283 \times \text{ipr} \times \text{rpm} \times \text{Km} \times \text{drill dia.}^2 \text{ (in.)}$$

Where: Km is the material constant for the workpiece and refers to the specific cutting energy (lbs./in.<sup>2</sup>).

### Cool Comfort

When making holes with spade drills, dry machining is not an option. "You'll experience galling from heat generation and terrible tool life," said Burley. He added that if through-spindle coolant is unavailable, coolant glands, or inducers, should be used to provide a through-coolant capability.

Gene Delett, sales manager for Regal Cutting Tools, said that the company's taper-shank spade-drill holders allow through-the-spindle coolant delivery or supply coolant through the side of the holder with a gland. "With the gland in place, the coolant enters through the side and then through the center of the drill. Straight-shank holders also accept coolant feeding through the spindle or through a side entrance, where the coolant line is attached directly to the side port of the holder. The holder does not rotate in this setup," he explained. "The higher the pressure and more copious the flow the better."

Delett added that Regal's taper-shank spade-drill holder utilizes a bearing-type material in the gland, which allows drilling at higher spindle speeds with

## When a spade is not a spade

One type of drill with a replaceable tip that isn't called a "spade blade" is the indexable, single-carbide-insert drill from Yestool/Aloris-USA, Clifton, N.J. These through-coolant drills are offered in diameters from 0.315" to 2.000" and available in lengths of 3, 5 and 7 diameters. Smaller-diameter specials can be ordered.

According to Yestool/Aloris Operations Manager Peter Brushaber, each drill body accepts five different sizes of Quick Tip inserts. The insert is held in place by one setscrew through the side of the body, locking on the insert's stem.

Since the tips are locked in place with a setscrew through the side, they can be changed without removing the body from the machine tool. This reduces machine downtime, because the tool does not need to be reset after replacing the tips.

The company's drill bodies and inserts are not interchangeable with other manufacturers' bodies or tips.

"It's different than a spade drill," Brushaber said. "The inserts conform to the shape of standard drills, allowing higher penetration rates and longer tool life, and they impart a surface finish of 63 rms or better.



Only the tip wears, while the coolant flow and helical flute design clears the chips out of the hole."

For additional information on YesTool/Aloris-USA, call (973) 772-1201, visit the company's Web site at [www.aloris.com](http://www.aloris.com).

less tool wear than when using a traditional inducer gland with O-rings. "Our inducer gland slides over the end of the drill—providing a press-fit—so there is no leaking," he said. This type of coolant gland is especially beneficial when running carbide inserts at very high spindle speeds.

When choosing between carbide and HSS blades, Floderus recommended carbide only when the machine tool is sufficiently rigid and has enough horsepower to allow for the higher drilling speeds required by carbide. Deep or interrupted holes drilled with carbide may require the use of a bushing, or a holder with guide pads or a chromed back pilot to ensure the drill doesn't vibrate or shatter.

### Other Styles

Speaking of carbide, solid-carbide spade drills are available. Lindy Tool Co., a manufacturer of these drills, says they are for drilling  $\frac{3}{32}$ "- to  $\frac{1}{2}$ "-dia. holes 2 to 3 diameters deep in difficult-to-machine metals. According to the president of the Waukegan, Ill., company, Dave Linderholm, other applications include drilling out broken taps, bolts and HSS drill bits, as well as drilling glass and rock.

The solid-carbide drills run at a lower spindle speed than other types of spade drills and generate tiny, fine chips. The pressure requirements also differ. "A solid-carbide spade drill likes more pressure rather than less," Linderholm said. "Otherwise, the tool dulls quicker."

He noted that his company's solid-carbide spade drill's face has an included angle from 10° to 18°, so there's always a negative rake on its face, which helps when drilling hardened materials. "Therefore, the down-cut is less shocking to the tool," Linderholm said.

Solid-carbide spade drills can be used on any type of machine, from a

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**Allied Machine & Engineering Corp.**  
(330) 343-4283  
www.alliedmachine.com

**KPT/Kaiser Precision Tooling Inc.**  
(827) 228-7660  
www.kptkaiser.com

**Lindy Tool Co.**  
(800) 823-2887  
www.lindytools.com

**Madison Cutting Tools Inc.**  
(401) 333-0400  
www.madisoncuttingtools.com

**Regal Cutting Tools**  
(800) 435-2948  
www.regalcuttingtools.com

Bridgeport to a CNC, and will produce very precise holes, said Linderholm. He added that the tools are still popular in the specialty automotive industry, but demand has diminished. "I used to sell tens of thousands of solid-carbide spade drills years ago, but the market went down during the last few years."

Most spade-drill blades are not indexable. Typically, they have a flat bottom that sits in the holder and are either thrown away or resharpened after the cutting edge becomes dull.

However, Floderus pointed out that Madison offers an indexable-type spade drill insert that sits in a V-shaped pocket. The company's Duodex inserts are ground in an eccentric mode, with one side slightly trailing the other, and are designed for "punching" a hole. They are for applications where cost per hole is more critical than tolerance and finish, Floderus said. In contrast, Madison's Accusize inserts are ground with both sides equidistant from the centerline.

Like other kinds of rotating cutting tools, spade drills are available for performing multiple operations in a single pass, such as chamfering and counter-boring. "For example, we can provide a special step holder that supports a throw-away spade drill blade at the

point and an indexable insert at the step," said Regal's Delett.

Nonetheless, Floderus said most of the spade drills sold produce straight holes as opposed to making combination cuts.

### Market Conditions

Spade drills are big in the automotive, off-road equipment, valve and heat exchanger industries, said Delett. He indicated that twist drills are still the market leader, especially for making small-diameter holes, with indexables in second place. But that could change. "The versatility of spade drills could make them more popular than indexable drills," Delett said.

Floderus agreed that the newer spade drills can often replace the more costly indexable drills, which require two, three or more inserts. "Spade drills save 30 percent in tooling costs compared to other drilling systems," he said.

But achieving these savings is often a matter of education. "A lot of people haven't caught on to the new spade drills' benefits and associate them with the universal-style spade blade," Floderus said. "As more people realize their cost and productivity advantages, spade drills will continue to take business from other drilling systems."