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Race to the Finish

Considerations when choosing a hard tool or brush for deburring holes.

By Susan Woods, Contributing Editor

Where there are drilled holes, there are burrs. The only question is how large the burrs will be, according to Dave Lopes, vice president of sales and marketing for Cogsdill Tool Products Inc., Camden, S.C.

If the drill is new and extremely sharp, the burrs will be very small as the drill enters and exits the hole. As the drill wears, it cuts less and pushes the material more, making the burrs larger.

While burrs are acceptable in some cases, most industrial customers demand burr-free parts. Classic deburring removes the razor-edge burr on a part, typically with either hard deburring tools or deburring brushes.

"Unless you are grinding, however, it is almost impossible to mechanically remove burrs without making some sort of small edge break," said Gary Brown, president of Heule Tool Corp., Cincinnati. "That edge break could be a chamfer or radius, but it is not really possible to say, 'I don't want any edge break.' "

Brad Hopkins, senior product manager for power brushes, Weiler Corp., Cresco, Pa., agreed. "Due to their compliant nature, brushes alter edge geometry only very slightly in comparison to hard tools, but the bristles will always 'ease' or radius the edges upon which they are working to some degree."

Heule Tool

The Heule SNAP carbide deburring tool, shown in a carrier, deburrs the front side and back side of a through-hole.

A Hard Case

Various hard deburring tools feature a collapsible carbide or HSS cutting blade or insert. "Because the cutting area diameter is larger than your hole diameter, the insert has to collapse to pass through the hole," said Bill Robinson, owner of E-Z Burr Tool Co., Plymouth, Mich. "A spring or flexing device helps the cutting part retract. But there is always pressure trying to push it out, so we put a polish crown on the top of the insert so it doesn't score the hole as it goes through."

These types of tools create a radius or a chamfer on the hole edge, depending on the amount of pressure and dwell applied. (It is not a qualified chamfer.) They rotate on the axis of the hole.

The Orbitool deburring tool from J.W. Done Corp., Hayward, Calif., employs helical interpolation. It is a carbide

tool with a flexible shaft and polished disc on the end. "As you spin the tool, the polished disc rides on the surface of the hole," said Stan Kroll, J.W. Done's sales manager. "As the profile of the intersection changes, the preloaded flexible shaft allows the disc to follow the changing profile automatically, allowing the tool to self-adjust and reach into the areas that need to be deburred. Conversely, the disc forces the tool to lift away from the areas that do not contain a burr." The disc prevents the insert from marring the ID.

The Orbitool creates a radius. "Some customer's drawings call for a specific radius for a few reasons. A radius allows better fluid flow. Also, sharp corners create a stress concentration that could lead to cracking in that area, especially in aerospace applications," Kroll said.

HSS and carbide hard tools deburr most materials. Aluminum creates more burrs when drilled, but they are more easily removed. In steel, the burrs are much harder and thicker.

Brush it Away

Wire and nylon abrasive filaments are the two types of hole deburring brushes. Known as "tube" or "bottle" brushes, they have a twisted-in construction. Wire brushes use stainless steel, carbon-steel or brass filament for the bristle material. Nylon brushes can be all nylon or flexible nylon filaments impregnated with abrasive grain, such as silicon carbide, aluminum oxide, ceramic or diamond.

Weiler

Weiler's Bore-Rx deburring brushes are interpolated down the length of a hole.

"Wire brushes are more capable of removing a broader range of burrs and addressing a greater variation in burr size," said Weiler's Hopkins. "Nylon abrasive brushes are a little more limited in that respect. But they are a more durable tool and impart a better surface finish than wire brushes."

Both types cut the burr off where it attaches to the hole edge. "We refer to them as being edge-selective," Hopkins said. "They concentrate all of their cutting action right on the sharp, burred edge. Once the burr is removed and a small radius is created on the edge, they do less and less work. They have self-limiting aggression."

The radius is typically minimal, but the longer the brush is allowed to dwell, the greater the radius. These types of brushes rotate on the axis.

In addition to miniature deburring brushes, Brush Research Manufacturing Co. Inc., Los Angeles, offers the Flex-Hone tool, which removes burrs and improves surface finish. This flexible brush tool has abrasive globules laminated onto the ends of flexible nylon filaments. The globules are 95 percent pure raw grain abrasive and deburr and finish with a soft cutting action.

Cogsdill Tool Products

A deburring tool with a collapsible cutting blade. As the tool enters the hole (top), it deburrs the front side. The blade collapses to pass through the hole (middle), opens again to deburr the back side (bottom) and collapses again coming back through (middle).

"The fact that it is oversize for any given hole diameter makes the tool self-centering, self-aligning to the hole and self-compensating for wear," said Michael Miller, vice president, global sales for Brush Research Manufacturing. "It supplies the cutting pressure where the burrs are actually ground off, as opposed to just being folded back and forth, which traditional brushes sometimes do."

The different abrasives used in brushes and the Flex-Hone are suitable for different materials. Aluminum oxide is for deburring nonferrous materials, silicon carbide is for most steels and cast iron and diamond is for finishing harder materials, according to Miller.

Weiler's Bore-Rx deburring brushes, for cross-holes 1" in diameter and larger, are interpolated down the length of a hole or at the intersection of two or more cross-holes. Interpolation is necessary because the Bore-Rx's construction gives them a much greater fill density compared to twisted-in brushes. This makes them more aggressive, which is effective for removing a larger range of burr sizes from even hard materials, according to the company. Bore-Rx brushes have wire or ceramic nylon-abrasive filaments. Ceramic can be used on a range of materials, including hard materials.

Another type of brush primarily for cross-holes is produced by Xebec. This brush has alumina-fiber rods, a form of flexible ceramic, so it can be used on plastic, brass, aluminum, stainless, titanium and high-temperature alloys. The brush is fed into the hole statically, and, when rotated, flares out and removes the burr.

"We remove the burr, but maintain the dimensional integrity of the hole," said Travis Horton, vice president of sales, Xebec Deburring Technologies LLC, Huber Heights, Ohio. "Our customers cannot have a radius or chamfer; they just need the burr gone."

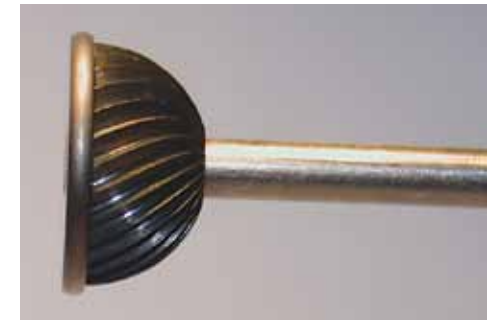
The dimensional integrity of the hole is maintained because

the alumina-fiber bristles only cut on their ends; there is no side cutting action. The brush actually grinds and when it hits the area where the burr intersects on the cross-hole, it knocks it off at the point where it was created. This capability is specific to Xebec products, according to Horton.

Because the Xebec brush works with centrifugal force, it flares out (within its range) to whatever size is needed and finds the hole edge. "Imagine a main bore with cross-holes; we could deburr that main bore and the cross-holes with one brush. One of our brushes can go from 0.394" to 0.787"," he said.

Taking the Advantage

So how does the user decide when to use deburring brushes and when to use hard deburring tools? Compared to a hard tool, a brush is more flexible, according to



Weiler's Hopkins. "It is much less likely to change the edge geometry and allows for greater variations in the dimensional tolerances of the part."

A brush tool's primary disadvantage is its limited aggression. It will not remove an attached burr as well as a hard tool, especially on hard materials. "Brushes work pretty well in terms of just knocking the hanging burr off," J.W. Done's Kroll said. "But if a burr becomes a certain thickness,

The mechanized deburring option

Cleveland Deburring Machine Co. offers machines for consistent, reliable and repeatable deburring processes, including deburring holes. Six standard machines are available but Cleveland-based CDMC can customize many existing machines for specific parts.

Typical customers are in the automotive, aerospace and defense markets. "Our customers produce moderately high volumes and up," said Adam Mutschler, CDMC's owner. The company's machines start at about $20,000.

CDMC mainly uses brushes on its hole deburring machines—mostly nylon abrasive brushes, but also carbon steel or stainless steel wire brushes, depending on the severity of the burr. "If the burr is really bad, sometimes we'll use a prequalifying tool," Mutschler said. "It can be anything from a countersink tool to a Cogsdill-style spring-loaded tool, which is great because it does both sides of the hole in one pass. We use the tool first and follow it with a brush to remove any residual sharpness."

For a new application, CDMC first determines the best hole deburring process. The variety of parts is vast, so the part spindle and work area are usually designed for a specific part or part family.

The machines are equipped with a rotational part spindle or a through-feed

Cleveland Deburring Machine

A nylon abrasive brush is applied to the face of an automotive part.

system for workholding. With a rotational application, an operator or robot places a part on the machine work spindle. A cylinder or a round part is held wherever the customer requests, then rotated as the brush or brushes are applied, deburring one or several holes. If the part is a flat plate or face-drilled, it passes under a series of brushes that deburr the entire top face or faces of the part.

CDMC offers several options for brush wear compensation. The brush automatically feeds and adjusts for wear by itself, with a pneumatic pressure set and maintained with automatic amp compensation. For this, "the motor driving the brush feeds back to the programmable

The Orbitool deburring tool from J.W. Done has a flexible shaft with a polished disc on the end and helically interpolates to selectively remove burrs without damaging surfaces.

J.W. Done

the brush can't remove it."

The general rule of thumb is that if the burr is heavy enough that it cannot be broken off by working it back and forth two or three times or by pushing it off with a pencil, a brush probably is not the best choice.

Xebec's brush is even more of a finesse tool. "Anything over 1mm is too thick to come off with our tool," Horton said. "For a larger burr, you want to go to an-

logic controller how much amp load is drawn, which really just tells you how much pressure you are applying to the part," Mutschler said. "As the brush wears and that pressure goes down, that amp goes down and the PLC automatically feeds the brush in incrementally."

As for setting up the deburring process, Cleveland uses a worst-case scenario. "In some cases, customers send us prototype parts that have almost no burrs because their drills are sharp and they are babying the parts," Mutschler said. "Once they ramp up into production, the burrs become way worse because the speeds are up and they aren't changing the tools as often. So we always try to build a safety factor into the process so if the burrs do get worse, we are covered."

The company has a full-service applications lab for testing a part before quoting a machine. "We don't even know until we test the part how the machine is going to look," Mutschler noted.

If the application is not something CDMC's engineering team feels is a good fit for its equipment, it can point the customer elsewhere. The company has a great deal of knowledge and experience about, and allies in, other deburring processes, such as thermal, cryogenic and vibratory deburring.

—S. Woods

other kind of brush."

Another application where a hard tool has an advantage over a brush is in removing the burr from the edge of a through-hole. "Because of the action with which a brush works, the bristles have to strike against the edge to which the burr is attached," Hopkins said. "When inserted into a through-hole, the direction of spindle rotation is actually wiping the bristles along the edge, which doesn't produce an effective deburring action.

"Brushes are best for cross-hole applications, where you have intersecting bores, because they can come in at a right angle," Hopkins continued. "That is

Xebec Deburring Technologies

A Xebec deburring brush has alumina-fiber rods that flare out when rotated to remove burrs.

what gives you the proper action for the bristles to remove the burr."

The Flex-Hone does not have this through-hole limitation because it is larger than the hole and "pops out" on the back side of the hole.

However, if the holes are very small, the user may still need to apply a miniature brush for through-holes. And that is another advantage of brushes. Some hard tools can deburr holes down to 1mm, but, for most, the smallest is about a 2mm hole. "If we go any smaller than 1mm, it gets very intricate and very expensive," said E-Z Burr's Robinson.

For instance, Brush Research makes stainless steel brushes down to 0.6mm and nylon abrasive brushes small as 0.8mm. (Brushes are always listed for the size of the hole they are intended to be used in. They are made slightly oversized to provide optimal cutting pressure).

Another advantage of brushes is they can provide a better surface finish than hard tools. "In some cases, people want finer surface finishes for functional purposes," Miller said. "We've had other instances where people want to make the surface rougher, such as for a part for adhesive bonding." Also, if a drill is very sharp, the inside of hole may get gouged and require finishing with a brush.

Deburring Large Holes

Both hard tools and brushes are dedicated to specific hole size ranges, so they are offered in many size increments.

However, with the Orbitool, the same tool used on a smaller hole can be interpolated around a larger diameter hole. "This is often the case when the application requires a smaller radius or a finer surface finish," Kroll said. "We may choose a tool one or two sizes below the 'standard' size for the hole to achieve a finer cut."

Typically, hard tools are used for holes up to about ¾", because those are the

Heule Tool

Heule's COFA deburring tool deburrs the contours of an elliptical hole when two holes intersect or when a hole is not perpendicular to the surface.

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ones where it is the most difficult to get to the back side of the hole, according to Cogsdill's Lopes. However, that doesn't mean hard tools can't be used to deburr larger holes. "For bigger holes, there are other options. You have room to go in with a bigger cutting tool." Those options include form tools, recessing tools and cartridge-type, or cassette-type, tools.

For brushes, however, "the sky is the limit," Hopkins said. "Depending on the construction, brushes up to 16" in diameter or larger can be manufactured. And if they are interpolated around the ID, there is almost no limitation as to how large the hole can be."

For the brush to maintain its form, it must be used properly. A common mistake is selecting a brush too large for the hole. "People think if the hole is 1" in diameter, they should use a brush that is 1¼" in diameter or larger," Hopkins said. "But that will severely limit brush life and effectiveness. Brushes are generally a little oversize from the specified nominal diameter of the hole in which they are intended to be used, so you have an interference fit to begin with."

The Flex-Hone can finish diameters as small as 0.157" and as large as 36". Xebec's brush is for hole diameters from 0.138" to 0.787". And when using the Xebec surface finishing brush as a cross-hole brush, the range extends to 4.8".

Special Holes

"There are certain configurations that some traditional hard tools just can't do," J.W. Done's Kroll said. "These include an angled hole, a hole drilled off-center to that cross-hole or cross-holes approaching a 1:1 ratio."

One of the biggest problems when cross-hole deburring is the ratio of the

Brush Research Manufacturing

Example of a tube with cross-holes deburred with a Brush Research Flex-Hone.

two cross-holes. Most hard tools need at least a 2:1 ratio—the cross-hole has to be twice as large as the hole being deburred. "As the two hole diameters approach a 1:1 ratio, the resultant edge-of-intersection becomes more of an elliptical shape, a 'potato chip' shape," Kroll said. "It is much more difficult to follow that contour using a traditional hard tool without breaking the tool or generating an inconsistent chamfer/radius. The Orbitool does not have this limitation. The flexible shaft allows it to automatically lift in and out of the cut when it encounters an irregular edge or shape."

Heule's COFA and Cogsdill's SEDT deburring tools are also suitable for elliptical and angled surfaces, such as a hole in the side of a tube.

"With an elliptical hole or a hole coming out at an angle, you'll get a saddle-shape effect," Lopes said. "You are going to heavily deburr two edges 180° apart and then at 90° you are going to deburr those edges very lightly. The SEDT allows the cutting blade to rock back and forth and will try to find the surface as it is going around. If it detects too much material, it starts moving away, if it detects not enough material, the spring pushes it back."

Brushes can be used in elliptical holes if the difference between the major and minor axis is not too great, and angled holes can be readily deburred with brushes if a bottom-end construction is used on the brush, according to Brush Research's Miller.

However, according to Miller, the key to deburring is "reducing the amount of burrs you make, so you minimize what the deburring tool has to face. Using good machining practices to reduce the number and severity of burrs is always the first option." **CTE**

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