A SUPERTOOL for SUPERIOR GEAR BLANKS

By Fritz F. Greul

With benefits including no heat buildup or chip problems,

It stays cool, it doesn't produce problematic chips, it cuts with ease…it's the Super Tool! Well, not really. It's simply a rotating circular saw blade. But the circular saw blade is too often overlooked as a possible tool when making parts turned from bar stock, such as gear blanks. Screw machine operators have forever struggled with fine-tuning their single point tooling and set-ups in an attempt to produce better quality parts, to increase tool life, and to reduce cycle times. Now, let's be radical for a moment. What if we could use a rotating tool with multiple cutting edges?

Well, that's not so radical, as it turns out. Rotary Saw Cutting (RSC) has been around for a long time, but has been slow to gain popularity. Of course, a circular saw needs a mechanism to drive it. Over the years the attachments driving the saw have become more reliable, consistent, self-sufficient, and powerful, and attachments are available to fit a wide range of turning machines, so RSC is now more viable. Also, the advent of live tooling capability on CNC machines makes RSC a possibility without an additional investment; simply mount a circular saw and go.

Not only is RSC a viable reality, it is also far superior to single point tooling in its capabilities. The multiple cutting edges of a circular saw eliminate the problems of high heat buildup, undesirable chip formation, and high chip load. The result is a myriad of technical advantages that increase production levels, improve quality, and lower production costs: more parts per hour, more parts per bar, better finishes, increased tool life, easier and less costly scrap handling, and increased machining capabilities.

A rotating circular saw cutting through a rotating bar of stock builds up very little heat for a number of reasons. First, saws are ground with side clearance. Clearance reduces the friction between the workpiece and the cutter. Second, cutting with a rotating circular saw is an "interrupted" cut, since each tooth cuts for only a brief moment. Third, as a single saw tooth makes a cut, the chip (and heat) is immediately removed from the cutter by the strong coolant flow and the centrifugal force of the rotating saw. Finally, each cutting edge is removing only a small amount of material, keeping the chip load low.

What benefit is it to have no heat buildup? The lack of heat buildup allows the circular saw blade to be used more aggressively than a single point tool. Feed rates can be increased from one and a half to four times that of single point tooling. Increased feed rates reduce the cutoff time and, therefore, increase the number of parts cut per hour. Less heat buildup reduces the stress to the saw and material. Tool thickness can be reduced; the common saw thickness is 0.045″, which is approximately one third the thickness required for a single point tool. Tool life is longer, since a saw lasts two to 10 times longer per grind than a single point tool. These application improvements reduce the time needed to cut parts and the costs associated with raw material, tooling, and tool maintenance.

Another constant struggle for machinists is the chip. The resulting sharp, stringy, coiled chips of single point tooling are especially problematic. The chips can have a tendency to get caught up in the workpiece or the tool. If dragged across the workpiece, chips may leave undesirable markings on the part surface. The chips are cumbersome to remove, transport

rower than single point tooling so the kerf is reduce there is less material waste with which to contend. cutting with a circular saw is also an interrupted cu therefore, absolutely impossible for a circular saw t a sharp, stringy, coiled chip. The chips formed by a saw are coarse granules of material—they are not sh they are compact, so removal, transport, and storag and safe. Chip problems are eliminated.

Other than no heat buildup and no chip problem other factor largely impacts the success of rotary sav chip load. The chip load is negligible when using a because the workpiece and the saw rotate simultane Because the workpiece also rotates, the saw is alway a convex shape, so only one tooth cuts at a time an tooth removes only a small amount of material. Th chip load also helps to accommodate the higher fee speed rates attainable while rotary sawing. These in rates are possible without taxing the saw, so saw life than single point tooling life. More importantly, ho low chip load accounts for better finishes, better to control, and increased capabilities.

Part finishes are so dramatically improved when ro ing that secondary operations are often not needed. completely through the piece for a clean, smooth sur cutoff nib is virtually eliminated, and burr is significa reduced. Low chip load also affects tolerances. Tool a piece deflection are negligible, so surface squareness ness are typically within 0.002″ and often within 0.0

Finally, low chip load greatly increases the host m capabilities, cutting irregular shapes, cutting exotic cutting thin-walled tubing, grooving, forming, and sawing. Irregular shapes such as hex, square, extrud pinion stock usually present a problem for a single tool due to the interrupted nature of the cut. Rotary however, is an interrupted cut anyway. Non-round is not an additional challenge for those using rotary for cutoff. Exotic materials (hard rubber, plastic, tef and thin-walled tubing are often difficult to cut wit point tool due to cutter and workpiece deflection, r in part surfaces that are not square. Again, because chip load while rotary sawing, cutter and workpiece tion are eliminated. Part surfaces remain square and within 0.002″—even when cutting these difficult m

Rotary sawing is not limited to parting off. It can used for grooving and forming applications. Of cou grooving and forming with a circular saw, the profil saw must match the profile of the resultant part. W grooving and forming with a saw, the application a same technical advantages as cutting off with a saw.

As an example, deep grooving is a great application a saw rather than a single point tool. Due to the low grooves stay square to the part, and thin walls betwee grooves do not deflect. Coolant delivery is improved ing deep grooves because the chips are immediately e allowing coolant to easily flow into the grooves. Groo cutting off can often be done at the same time by mo multiple saws onto the same arbor. The saws must be appropriately by using spacers ground to the needed

A "gang" saw arrangement is also possible for combined forming and cutoff, or for multiple cutoffs. The negligible saw and part deflection minimize the problems usually encountered when attempting single point gang cutoff since the saws themselves act as guides to eject the cut part. Some saw users cut off as many as five or six parts at a time. Of course, saw configuration tolerances are more critical when performing multiple cuts simultaneously.

Much time has been—and is still being—spent on improving the performance of single point tooling. Understanding how to apply rotary sawing is no more complicated than initially learning to apply single point tooling. However, a little training and effort toward the use of RSC will virtually assure superior results to those of single point tooling.

RSC Setup

As with single point tooling, RSC setup is application specific. The following discussion is a general starting point, which must then be refined based on the host machine, part configuration, part material, and part finish specifications.

RSC utilizes a self-contained motorized attachment, which drives the circular saw. This setup mounts in the standard cutoff position of the host machine, replacing conventional cutoff tooling. The attachment is wired directly into the host machine, so the saw is switched on and off with the main spindle of the host machine. Common host machines include Acme-Gridley, New Britain, Conomatic, Davenport, Wickman, Gildemeister, Schuette, Warner & Swasey, Brown & Sharpe, Traub, and Index screw machines, as well as Bardons & Oliver and Modern cutoff machines. The attachment can also be adapted to fit other turning machines and custom m
As mentioned earlier, if the host machine has live too
capability, an attachment will probably not be neede

The sawing attachment and saw must be positioned p
ularly to the workpiece, just as with single point tooling
the centerline of the saw and the centerline of the work
should be the same, although cutting on center is not a
with RSC. The cam (stroke) should be set to the depth o
plus 0.05″. The saw must not engage the workpiece in "

The circular saw can rotate in either direction. The
desirable cutting dynamics are achieved in an "oppo
which the saw and the workpiece are rotating in opp
directions at the point of their intersection. During a
cut, both saw and workpiece rotate in the same direc
point of intersection. Because an opposed cut deliver
cutting conditions, a climb cut is only recommended
cutting high carbon materials with high speed steel s
the parts cannot be easily ejected during an opposed

Speeds and feeds are faster when cutting with a saw
set the feed rate at double that of the single point too
From there, rates can be adjusted higher until cutting
start to deteriorate. Feed rates can be as much as 400
higher than single point tooling. Depending on the a
tion, workpiece rpm is usually the same or slightly h
with single point tooling. Set the saw speed to 150 to
higher than the workpiece. Feeds and speeds can be t
depending on cutting objectives (for example, parts p
versus part surface specifications) and tool life.

Proper coolant type and coolant flow are critical, a
lubricating qualities of the coolant are more importa

the cooling qualities. When using high speed steel saws to cut ferrous metals, it is necessary to use an oil coolant with a heavy concentration of active sulfur. Active sulfur prevents galling at low cutting temperatures (under 350° F). Water solulable coolant can be used with carbide saws, or when cutting aluminum or brass parts. Coolant flow must be strong and directed to the point where the saw enters the material. The coolant flow must also be distributed equally to both sides of the saw to promote even saw wear and to easily flush chips from the workpiece as the saw rotates through the work.

Changing saws is easy and takes only a few minutes. The operator needs to make sure that the saw is securely clamped, is running in the proper direction, is running true, and that all arbor and support spacers are in good condition. Adjustments are rarely necessary because height settings repeat every time. Location settings may need occasional adjustment, but only to maintain the tightest length tolerances.

Saw Blade Configuration

To utilize RSC to its fullest potential, proper saw configuration is vital. Decisions on several items must be made, including saw material, saw diameter, saw thickness, number of teeth, tooth angle, rake angle, and surface treatment.

Circular saws for rotary sawing are commonly available in two materials: solid carbide and high speed steel. S.f.m. of the job will usually determine which is to be used (carbide surface feet rates require solid carbide saws). Carbide saws also cut more cleanly, resulting in better surface finishes and less burr or reduced nib. Cuts with carbide saws are less demanding on the equipment, and tool life is five to 10 times bette of high speed steel tooling. Heat sensitive materials geometries also require the use of carbide saws.

A good starting point for saw thickness is one ha thickness of the single point tool (often one third th ness is enough). Aggressive cutting, deep cuts, and la eter materials might require a thicker saw. For softer smaller diameters, and thin-walled materials, narrow are used. The goal is to use the thinnest saw blade po

The distance to the cut, the depth of the cut, the tion of the tooling zone, and other attachments de the diameter of the saw. Saws for rotary sawing rang 1/2″ to 6″ in diameter—the most common is 4″. U lowing formula to calculate the saw diameter.

Diameter = 2(distance from center of saw arbor to outside ment+depth of cut+tooling clearance needed for attachment+approach+breakthrough+0.025″ minimum pe gang cutting) + 2(regrind stock, which is application speci

The number of teeth on a saw requires careful co tion. A coarser tooth configuration should be used workpiece diameter is 1.5″ or larger, when the wor a hole, when doing deep cuts, or when feed rates a 0.003″ i.p.r. As an example, a 4″ diameter saw with (seven teeth per inch, 0.140″ tooth gap) is conside A finer tooth configuration is used for small diame 1″ diameter), cutting to center, thin-walled tubing, ishes, and feed rates up to 0.003″ i.p.r.

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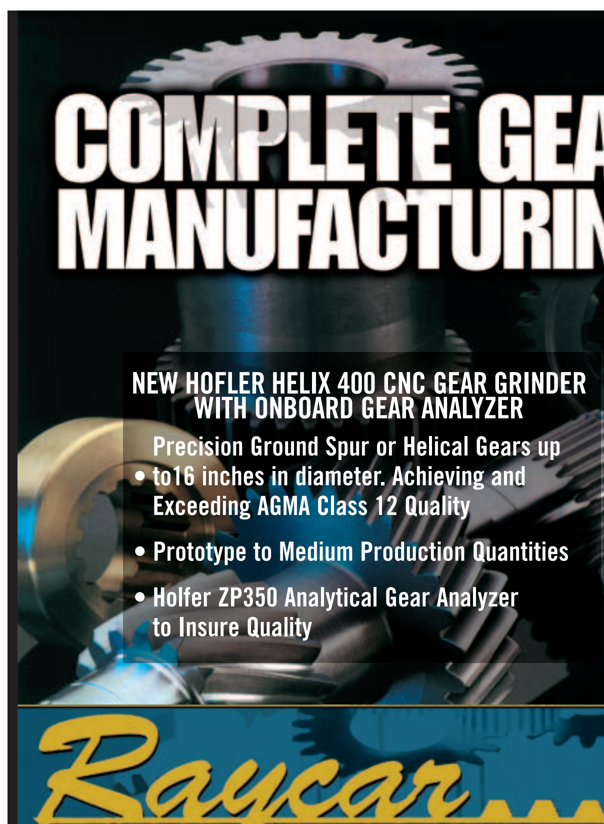

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TABLE 1

	CARBIDE SAW	HIGH SPEED STEEL SAW
12L14, 1215, aluminum, brass	No treatment	LN (Liquid Nitride) or TiN
1010-1026, high carbon steel alloys, SS	TiN (Titanium Nitride) or TiCN (Titanium Carbonitride)	LN or TiN
52100	TiCN or TiAIN (Titanium Aluminum Nitride)	N/A

Tooth angles are the last consideration for saw geometry. Cutoff angles reduce burr or the nib, produce better surface finishes, and control ring problems. Use the smallest cutoff angle possible to gain the desired results because larger cutting angles can affect tool life. A good starting point is 7° for a carbide saw and 10° for a high speed steel saw. The standard rake angle is a positive 2-4°.

Finally, saw surface treatments must be considered. Surface treatments increase tool life and produce better surfaces finishes. Generally, the same treatments used on single point tools apply to the saw. Use Table 1 as a guide.

With the many technical advantages rotary sawing offers over single point tooling, this "super tool" must not be overlooked. Cutting off is the one operation common to all parts turned from bar stock. Technical improvements in the cutoff can significantly affect a company's productivity, capability, and costs. Add to this the possibility of grooving and forming, and a company can then truly revolutionize the way it manufactures turned parts.

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