

▶ BY BILL KENNEDY, CONTRIBUTING EDITOR

# True Grit

It's possible to push the envelope when grinding carbide.

It's a productivity paradox. How does grinding, arguably metalworking's slowest and most painstaking operation, fit into the just-in-time world of modern manufacturing?

Specifically, how can providers of grinding services offer short enough lead times—and deliver high enough quality—to satisfy their customers? With innovative management, advanced grinding technologies and hard work.

## Needed Yesterday

About 95 percent of the work Aggressive Grinding Service Inc., Latrobe, Pa., does involves carbide workpieces. More than one-third of those parts are blanks used to make drills, endmills and other round tools.

A large portion of AGS's business is based on delivery—not price. Fast turnaround is the main reason many manufacturers go to AGS.

"Almost all of the jobs we do are on rush deadlines," said Les Sutton, president. "They have a customer that's in desperate need, and they can't do the job internally. Since Day 1, my motto has been, 'The next time you need it yesterday, call us.' For centerless grinding, we have a 3-day turnaround; on more intricate parts, it is 5 days."

The parts AGS grinds are from 0.060" up to 16" in diameter, with most between 1/8" and 1" in diameter. "Tolerances depend on the part specifications, but on our centerless grinders, less than 0.0001" is common," Sutton said.

A quarter-mile east of AGS is Johnston's Quality Carbide. Like its larger neighbor, JQC works under the gun. "Everybody wants it now," said JQC Vice President Sam Johnston.

Also like AGS, many of JQC's customers are carbide-parts manufacturers. In addition, JQC handles a wide variety of grinding jobs from customers around the country. Foreman Gregg Robinsky said JQC does "a lot of everything," including flat and round stock, ID and OD work, and cutter blades and dies for an ammunition manufacturer out West.

By fabricating a riser to lift the work head of a machine designed to grind 12" diameters, JQC has handled workpieces over 18" in diameter, Johnston said. Routine ODs are in the 6"- to 8"-dia. range, while surface-grinding jobs might involve blades as long as 14" or simple 1"×1" pads. JQC grinds round parts as small as 0.024" in diameter and has surface-ground parts only 0.018" thick. Standard surface finishes are

in the 16 $\mu$ in.- to 32 $\mu$ in.- $R_a$  range, but the shop can achieve a finish as fine as 2 $\mu$ in.  $R_a$  with polishing wheels on centerless grinders or with its two Sunnen Products honing machines.

Johnston said tight tolerances are routine. "When you get down to a tenth," he said, "the problem is not so much the parts themselves but the devices used to measure them. You hold a micrometer in your hand and it heats up. The difference can be a couple of tenths."

To alleviate measurement problems, JQC recently acquired a Brown & Sharpe height gage that is accurate to within 0.000040" over 14".

## Multifunction Machinists

To achieve quick turnaround, AGS stands the concept of "lean manufacturing" on its ear. "Everyone talks about lean, responsive manufacturing, but the majority don't truly understand it. They try to do it from an accounting standpoint," Sutton said.



All photos: B. Kennedy

AGS President Les Sutton with one of the largest and one of the smallest carbide parts his company grinds.

Truly responsive manufacturing, he feels, requires two elements. "You have to overstaff and overequip. If I don't have someone to start on the parts when they come in the door and an available machine, how am I going to be able to process them quickly?"

Johnston at JQC said meeting deadlines on some jobs requires the most basic of productivity strategies: "If we have to, we'll stay late."

To provide flexibility and boost competitiveness, AGS cross-trains its personnel to operate a variety of machines. "Wherever bottlenecks are, we can move our workforce," Sutton said.

AGS looks for employees who enjoy changing responsibilities. "It breaks up the monotony, and I think it helps keep our workforce happy," Sutton said. "A lot of people get disgruntled if they're doing the same job every day."

The employees at JQC are also "multitrained." "Any of us can go from one machine to another," said Johnston.

AGS initially breaks long-run jobs into small batches so all departments can create setups and feed each other. "Then we do a large batch," Sutton said.

Processing a wide variety of parts usually means long setup times. Most of AGS's setups take less than 5 minutes.

In addition, grinding machines are prepared in advance to handle different workpiece configurations. For example, in OD grinding, some machines are set up to handle work between centers, while some are fitted with collets and others with chucks.

Standardization also contributes to setup speed and flexibility. All OD and ID grinders have A25 spindle mounts, making tooling interchangeable.

AGS's focus on quick response traditionally has required maintaining a large selection of grinding wheels in various configurations. "In the OD grinding department, we probably have 100 wheels mounted and balanced, in various radii, grits and forms," Sutton said.

### Organizing the Shop

The ability to respond rapidly depends on the organization of the shop. AGS's operations are divided into functional departments that include OD, ID, surface and centerless grinding, and a honing group. Although a job shop, AGS has cells within departments, each

## Wheels of fortune

**A**ggressive Grinding Service grinds with several brands of wheels to ensure it can meet varied customer requirements. "I've never been able to find one manufacturer that makes good wheels for all applications," said Les Sutton, president.

The shop carries out an ongoing test program, with at least five wheels—from different manufacturers and with different combinations of grit, resin and vitrified bonds—being evaluated at any one time.

Johnston's Quality Carbide also applies a variety of wheels.

"Wheels from various companies may perform differently despite having the same grit and/or same bond," said Sam Johnston, JQC's vice president.

Sutton said AGS's testing is leading his firm to use more vitrified-bond wheels. Vitrified bonds are extremely hard, but they are hard to dress.

"They're harder to work with than a resin or copper bond, but that's what gives them their performance," Sutton said. "Once you get a vitrified wheel dressed, it will outperform any other wheel, generally, by a 3:1 ratio in terms of life and holding a form or a radius."

AGS converted a large portion of its OD grinding to vitrified-bond wheels. Sutton worked with suppliers to reduce wheel costs by as much as 50 percent. How?

"We're buying them in very large volume," Sutton explained. "We order a dozen or two dozen wheels at a time. With vitrified-bond wheels, our stock removal rates are up to 50 percent higher in some cases. Life may be four times longer."

Sutton thinks most grinding shops have not looked closely enough at wheel cost vs. grinding time. If he had to make a choice, Sutton said he would rather eat a wheel up and reduce production time. But, he said, "I'm getting the best of both worlds with vitrified wheels. I'm able to get a higher stock-removal rate without using up wheels [too quickly]. I'm taking very aggressive cuts with wheels that can handle them."

—B. Kennedy

## Ceramic success

**I**n addition to carbide, Johnston's Quality Carbide grinds a variety of other hard materials, including ceramics and heat-treated steels. For example, the shop recently produced fine-grain, alumina-ceramic seal rings for pipes used to transfer abrasive materials. The rings had a 9.5" OD and an 8" ID.



Johnston's Quality Carbide grinds steps and chamfers into ceramic seal rings that are used in material transfer applications.

JQC ground a 0.25"-deep and 0.5"-wide step into the OD and then put a 0.125", 45° chamfer on the outer edge of the step.

Initially, a 180-grit, vitrified wheel was used, but it caused fine chipping on the edge of the part. Switching to a 180-grit resin-bond wheel stopped the chipping.

"The vitrified wheel was too hard," said

Sam Johnston, vice president. "It was like glass against glass."

The switch allowed JQC to easily exceed the customer's surface-finish specifications.

"The job called for a 30 to 60 R<sub>a</sub>," Johnston said, "but the actual finish we produced was as fine as 20 R<sub>a</sub>."

—B. Kennedy



Qualified machinist Brandon Beech (left) works with Tru Tech software in a grinding cell at AGS to carry out such operations as centerless grinding of carbide tool blanks (right). Beech said the software enables him to grind complex contours while tending to two other machines.

of which is run like a standalone business. A team leader in each cell knows what jobs are coming to him and how they will affect other areas. Each morning, a production coordinator meets with team leaders, evaluates the production schedule and distributes the work.

JQC's Johnston said the small size of his shop allows the organization to be less formal, for the time being. "Right now, I know where every job is. As we grow, that will change."

CNC technology has reduced the advantage AGS enjoyed over competitors by maintaining a large inventory of wheels. CNC grinders enable complex forms to be ground with standard wheels and minimal operator involvement.

AGS began using CNC machines in 2000, when it purchased a CNC grinder from Rollomatic.

The OD grinder utilizes technology similar to that employed in Swiss-style screw machines to make small cylindrical parts. The machine holds a round part in a collet, and a V-block supports the part with only about 0.030" sticking out. Two grinding wheels move in and out to create the diameters, angles and radii as the part is pushed through the V-block.

"Because the part is supported right at the point of grind, we can grind down to a 0.002" diameter," Sutton said.

The machine is designed to grind high-precision blanks and punches, from 0.001" to 0.500", in one clamping. "It will grind within 0.000050" surface tolerance and straightness," Sutton noted.

After the purchase of the Rollomatic,

Sutton came across what he views as an intriguing combination of software and grinding machine technology. "I saw Tru Tech machines at IMTS 2000. The system enables you to grind multiple diameters on a simple centerless ground part with straight 1A1 wheels," Sutton said.

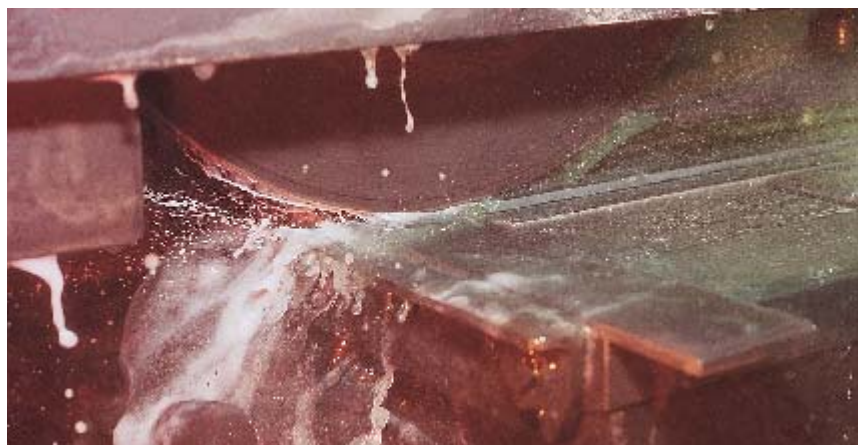
Parts that once cost \$200 to \$400 to produce, in terms of setup time and grinding wheel expense, are now made for \$50, he said. He used grinding of a 1" drill as an example of the cost-savings possible. Previously, to grind the drill's diameters, radii and nose angle, the blank would be put in a collet and ground with a variety of wheels. To reduce the 1" diameter to 0.800", with a 1/8" radius on the corner, a wheel with a 1/8" radius would be applied. If the drill featured a step to a 0.600" diameter, with a 1/16" radius, another wheel would be required. Finally, to make the drill point, either the machine head had to

turn on an angle or another wheel would be needed.

Sutton said, "With the Tru Tech, I can use a straight 1A1 wheel with a 0.010" radius on the corner, grind the 0.800" diameter and 1/8" radius at one time, slide over, grind the 0.600" and the 1/16" radius and then put the point on, all in one pass with one wheel."

AGS's work on a carbide bushing for oil-field applications exemplifies Tru Tech's software capabilities. Previously, four grinding operations and four machine operators were required to prepare the bushing for threading. With the new software, one operator can run two machines and grind more bushings per shift.

"The Tru Tech unit masters off the major diameter, so everything can run within 0.000050," Sutton said. However, he cautioned, "you have to give it a good centerless-ground part, or you're going to have difficulty."



Surface grinding of angled carbide splitters at Johnston's Quality Carbide.

Another notable feature is Tru Tech's talking software. The Windows-based software features voice-guided instructions, reminders and safety alerts.

"It's easy to use; my guys were operating it in a day," Sutton said.

JQC employs Tru Tech CNC technology, too, to grind ceramic seal rings. Previously, without the CNC, Johnston said JQC would plunge the step on a manual grinder, then change to a 45° wheel to make the chamfer. Today, the part is completed in about 21 minutes, as opposed to 50 minutes when a wheel change was necessary.

### Simple Doesn't Mean Fast

Sometimes even simple-looking parts can require multiple steps that eat up time. The solution may be simple,

too: run harder.

As an example, JQC operator Mark Kibler pointed to a run of 3½"×1" angled carbide splitters. The grinding of the carbide preforms calls for removal of 0.035" to 0.045" of stock. After the sides are flat and parallel, finishing passes are in the 0.0002" range.

One special requirement of the job is a slot, preformed on the part, that must be 0.019" deep. On an Okamoto ACC 12-24ST surface grinder, Kibler repeatedly flips the part and makes "dust" passes to clean up the preform and make the sides parallel. To accomplish the cleanup, it's crucial that the rough preform have sufficient excess stock. Taking finishing passes of about 0.0002", when the sides are flat and parallel, can reduce manufacturing time. Kibler said

JQC grinds as much as 0.0006" per pass to boost productivity in rush jobs, but he noted such a feed rate is "really smoking" and wears wheels faster.

The trade-offs inherent in carrying out that kind of high-productivity grinding are often necessary to meet extremely short turnaround times. And it may not suit every grinding shop's operating philosophy. But sometimes it's required—especially when a shop has to grind parts "needed yesterday."

The following companies contributed to this article and the sidebars:

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