Tinkering with Carbide

Everybody's working with carbide tools these days, but carbide materials are expensive. However, these cutting tool companies think they might have some solutions to extend tool life and reduce costs.

Alex Cannella, Associate Editor

Whether it's skiving tools or shaper cutters, many of the latest cutting tools that manufacturers have been promoting have all taken advantage of one material: carbide. From Gleason to Star SU, many of the biggest cutting tool manufacturers have all developed carbide tooling that takes advantage of the material's rigidity and affordability, but gear manufacturers want more, so the challenge is to constantly find ways to improve tool life and tool cost.

It's a matter of juggling priorities. If tool life is the only concern, it's fully possible to improve that metric, but most methods of doing so would unfavorably spike the cost of the tool, trading one problem for another. The trick is to figure out how to improve tool life without raising costs. And regardless of what they're making, the tool manufacturers we spoke to are almost universally working to do that, each working in their own ways to improve their tools.

Federal Broach: Bridging Two Worlds

Since getting purchased by Mitsubishi Heavy Industries in 2012, Federal Broach has been undergoing a bit of a renaissance. Formerly focused on broaching, the company has expanded to make basically anything—hobs, skiving tools, even a few multilayer coatings.

It's all part of a customer-focused approach. They operate in virtually any industry that needs gears: aerospace, agriculture, automotive, industrial, the list goes on. And whatever customer they get, Federal Broach focuses on getting what they need. That means being able to supply a wide variety of tooling for basically any situation.

"Our big advantage is one-stop shopping here," Ken Kernen, senior tooling engineer at Federal Broach, said. "We build the machines. We build the cutting tools. We supply the automation."

"Now we're looking at 'really, what is the best solution?'" Dan Dennis, CEO of Federal Broach, said. "Does the customer want broaches? Do they already have a broach machine? Do they already have a hob machine? Do they want to go carbide? You have to be looking in every direction today in order to be listening to what the customer wants. You want to steer them in the right direction."

However, this leaves Federal Broach in a unique position bridging two very different worlds of gear manufacturing. On the one hand, they're "as modern a broaching company as you're going to find in America," according to Kernen. But they're also fully invested in developing new tooling in more modern fields, particularly focusing on skiving, the most recent trend to catch on in the industry.

And from that unique view straddling both worlds, Dennis still finds applications for both.

"If you want volume, broaching is the way to go," Dennis said.

Outside of that, however, other machine tools have caught up and supplanted broaching. They're faster, they're drier, and they're cheaper. And in Dennis's experience, cost is where each type of tooling can have a deciding advantage.

On paper, broaching might seem to fall short. It costs more up front to develop and test a broaching tool. But critically, more affordable options like skiving also have a shorter tool life, and if all you're doing is punching out the same part en masse, the cost of resharpening or replacing tools as they break adds up over time. Hence, broaching for volume, alternative options for anything else.

That may not be true forever, however, as one of Federal Broach's most recent offerings, the Super Skiver, is designed to cater towards one of the most volume-intensive industries in the market: automotive.

Much like with other companies' latest cutters, the big innovation with Federal Broach's Super Skiver is an additional cutting edge. Normally, skiving tools have only two, but in the Super Skiver's case, there are two cutting edges for roughing and a third for finishing. The primary benefit of this change, and the reason the Super Skiver is being marketed to automotive gear manufacturers, is longer tool life. With more blades per tool, each individual blade sees less wear and tear, and they all last longer, providing savings and improving the ability to skive in bulk.

"[The third cutting edge] allows you to lighten up the forces, lighten up the work, and ultimately getting a longer tool life," Kernen said.

The Super Skiver is a culmination of Federal Broach's work in both skiving and broaching. Traditionally, skiving tools have often only had a single blade, while broaches have had multiple cutters. And wielding their expertise with the latter helped them to develop the Super Skiver, as well as ensure that they could properly adjust their skiving machines to effectively utilize multitooth cutters with tweaks such as adjusting the cutting stroke to allow the cutter to pass all the way through the gear with full clearance on the other side.

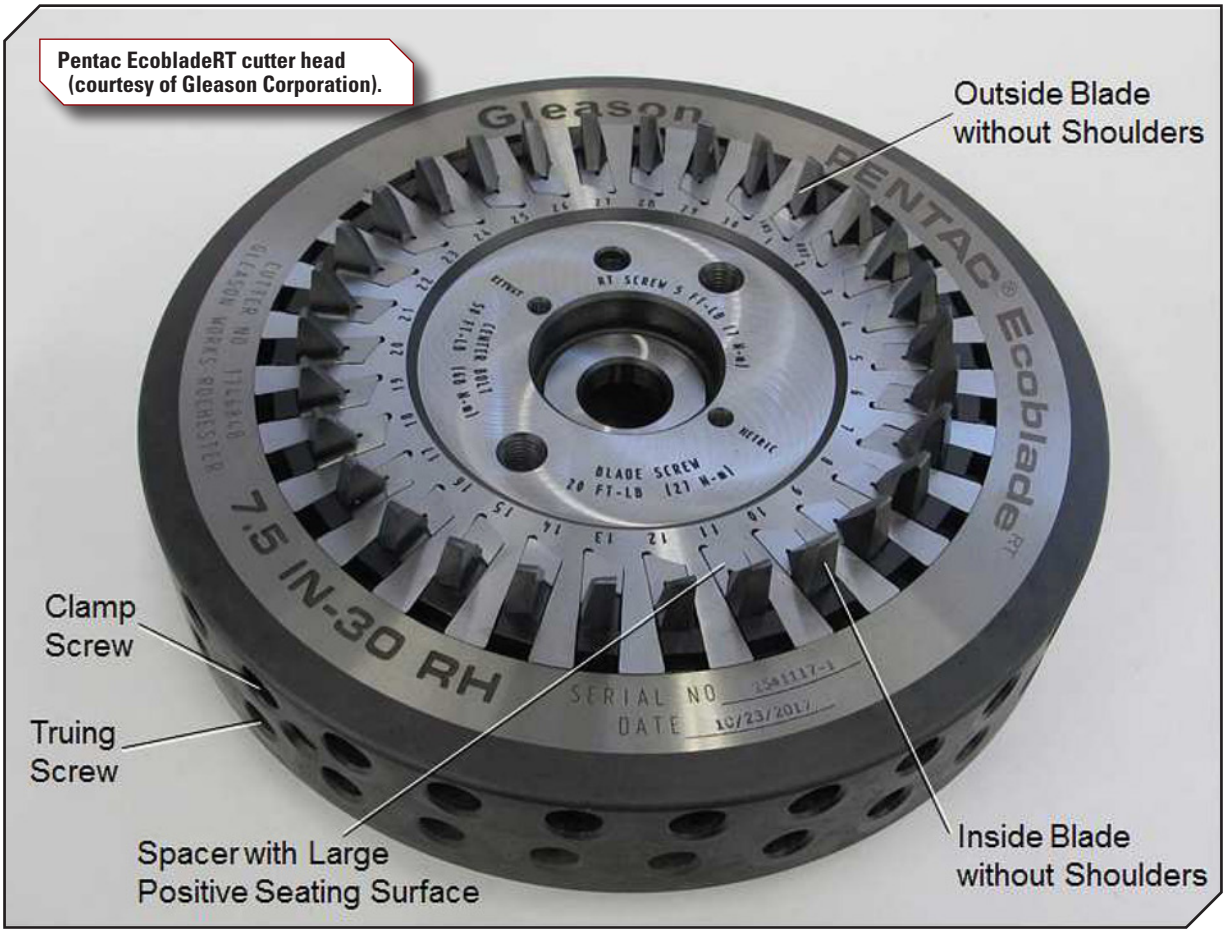
"We wanted to look at it more from the broaching side," Kernen said. "How could we combine broaching technology with skiving technology?"

In that sense, Federal Broach not only straddles two very different worlds, but brings the expertise and sensibilities of both together.

Gleason: Focusing on Flexibility

Gleason, as always, is a fount of new gear tooling innovations. Their latest work runs from straightforward improvements to their bevel tooling to larger, cutting edge Industry 4.0 projects.

Over the past several years, Gleason



has been expanding their Pentac line of bevel tooling.

"Gleason has a very long history of bevel cutting tools," Lance Bell, director of sales for USA and Canada at Gleason, said. "And this particular tool, the Pentac, was developed a while ago to create a better seating surface, provide more rigidity, more stability in the cut, which leads to better part quality and higher tool life."

The Gleason Pentac tooling system has been continuously developed and improved over the years, expanding the line with more industry-specific tooling such as the Pentac Plus, Pentac Aero, Pentac RT and now, most recently: the Pentac Ecoblade RT.

The Ecoblade RT System is also designed to tackle one of the stick blade cutter system's primary challenges: its trueing capabilities, specifically real truing in both planes, radially and axially.

"To get the right geometry for a large variety of different parts, we would have to make very wide carbide blades to fit within these slots [in the cutting head]," Bell said. "...The bottom line was because of that, there was a lot of wasted carbide. So we're making these really large blades with this smaller portion for the cutting section, and then as you would sharpen them and grind them back, you were grinding back a lot more carbide than was ideal. That made the blades more expensive than necessary, even if the tool cost per part is still on a very competitive level.."

Gleason had a bit of a needle to thread here. There was a desire to improve the tool line's truing capabilities and reduce the amount of carbide required to make a blade, but it couldn't come at the cost of the rigidity that was the whole reason for the Pentac line in the first place. And their solution was to add a V-shaped spacer to the Ecoblade's carbide cutter.

This created a few different dynamics. Having a blade that can wedge into the V spacer keeps the tool snug, and importantly, it allowed Gleason to reduce the size of each individual blade, which of course meant a lower cost of materials and a cheaper to produce overall product. Nobody's going to turn their nose up at that. And at the same time, it did indeed solve the stick blade truing challenges.

But above all, the Pentac Ecoblade also offers mechanics expanded flexibility.

"By going this way, customers are able to buy [fewer] different types of heads to cover a broader range of parts that they might have to cut... By using the spacer system, you can cover a wider range of parts," Bell said.

Flexibility in general seems to be a priority at Gleason, a "key factor we're keeping in mind," according to Bell. Not just for job shops that might do a wide variety of different jobs, but also for industries like automotive that are focused on high-volume work.

"Any kind of flexibility that we can create, whether it's in cutting tools, whether it's in workholding or other kinds of tooling, that's going to be beneficial to the customers nowadays. Every customer I know is trying to leverage as much of their technology as possible to be as flexible in their market, as well."

And the Ecoblade isn't the only innovative cutting tool Gleason's developed either. Ease of use and tool cost per piece was also a consideration when developing their first chamfer hobbing system.

The big design challenge that Gleason tried to tackle with its chamfer hobbing was burrs left on a component after the initial cut. Chamfer hobs are designed primarily with the automotive industry in mind, where increasing focus on electric vehicles has also meant increased scrutiny surrounding accuracy and gear noise. With hard finished gears, leaving those little burrs behind after chamfering just isn't an option. When chamfer rolling you'd have to instead reset the machine with different tools to make a second hob pass at the same component, or use a chamfer rolling tool with a burnishing wheel to ensure quality.

But as a clean cutting process, Gleason's chamfer hobs are designed to eliminate that second step by ensuring the burrs never show up to begin with. And when you only have to cut once, you have to spend less time per component and productivity goes up.

On the higher tech end, Gleason's also continued its work in the field of Industry 4.0. In addition to existing projects such as its Closed Loop software system, Gleason Connect, Gleason Fingerprint, and Remote Machine Maintenance, Gleason's introduced "gTools," a preventive maintenance solution that allows users to both track and study their inventory of cutting tools. It works through RFID chips and data matrix codes personalized for each tool, much like an ID, and track that tool through its entire lifespan.

gTools doesn't just track on-the-job performance metrics like how many cycles a tool has run for, parts it's cut, or its accuracy, but also other major events such as when the tool was last sharpened, and how much material was ground off to do so. And utilizing it can allow a manufacturer to not just predict when a tool might fail, but also understand how well the component's performing, and how you might be able to tweak your machine's settings to improve that performance. And as an additional perk, the RFID chip can also transmit the tool's settings directly to the Gleason machine it's operating on, reducing the risk of user error during setup.

Star SU: Expanding Applications for Carbide

Star SU, meanwhile, has been following a different trend.

"One of the changes that we're seeing in the marketplace is the use of solid carbide in not only the cutting/power skiving applications, but now we're also seeing it being used in traditional shaping applications," Tom Ware, product manager of gear tools at Star SU, said.

Shaping applications aren't the traditional domain of carbide tools, but according to Ware, it's an increasingly valid option, one made possible not necessarily by improving carbide tools, but in the ways that the machines they operate on are changing.

"The concern had always been previously that carbide was too brittle to hold up under the impact load of a shaping application," Ware said. "But more and more customers are making the adjustments in their machines to make solid carbide shaping cutters a viable alternative to high-speed steel."

Those changes haven't been massive, either. We're not talking about revolutionary sea changes that require you to buy a whole machine, but smaller adjustments in how existing machines are

being programmed — increased stroke rate, reduced rotary feed rate, and any other tactic technicians can think of to create smaller chips during the manufacturing process.

But despite those efforts, carbide's achilles heel still shows up here, as well. As with everyone else wrestling with carbide tools, there's an active effort on improving tool life, but for Star SU, the big focus is on finding a way to do it without ballooning the cost to manufacture them.

"You can imagine when the customer starts with each of their skiving tools, all of them were very into the optics of very low cycle times," Deniz Sari, sales manager for Middle Europe at Star SU, said. "A lot of pieces per day they could produce. But then more and more questions came up. They are not looking to have 20, 40, 60 tools. Is there any way they can improve the tool life dramatically on the existing Scudding technology?"

So how does Star SU go about improving tool life? There are always coatings, such as Oerlikon Balzers' Balanit Altensa aluminum chromium nitrate coating. There are also a number of ways Star SU is improving the cutting tools themselves. In recent years, they've focused on research on improving surface finishing, polishing, and cutting edge conditioning, all of which contribute to longer tool life.

But as Star SU has continued to develop their cutting tools, they've also had to focus on extensive value-added services. The gear manufacturing industry's talent shortage is no secret, but an increasing number of gear cutters are leaning on the expertise of companies like Star SU well after they buy a tool.

"There are also cases out there where customers will only allow [you] to quote if you can agree to offer technical service afterwards," Sari said. "So if you bring the tool, you also have to bring the technology."

This expertise comes in several forms. Sometimes, it's simple, standard services like tool resharpening and recoating. Other times, it can extend to providing training classes in customers' facilities and performing troubleshooting.

"We're becoming their process engineers in many cases," Ware said.

However, Star SU has ultimately rolled with these industry changes, and according to Sari, the company is happy to perform these additional roles in addition to providing their usual line of tools.

"For us, it's not a huge problem because we chose [to be a] technology leader, as well, and this is why we can work very well with today's environment," Sari said.

Liebherr: Reducing Delivery Time

Star SU isn't the only company increasingly going above and beyond just providing a quality tool to assist their customers. According to Haider Arroum, team leader of sales for tools at Liebherr, the company has also had to tackle an influx of inexperienced customers. They don't just have to contend with the industry's talent shortage, but also new customers that previously outsourced their gear work to specialists, but now

want to do that work in-house. Gear manufacturing, however, isn't a process that one can just pick up and start doing on a whim — it takes expertise, and companies like Liebherr are the ones that have to provide it.

In order to provide that expertise and properly guide these companies to the best cutting tool for them, Liebherr has a clear picture of their customers, and they have a wide range of tools they can guide those customers to.

Some of their most recent products, of course, are also in the field of carbide materials and skiving. In particular, Liebherr has focused on what they call cubic skiving. And according to Arroum, Liebherr finds themselves in a unique position to leverage their expertise as a turnkey provider to further their work in this field.

"We have machines, we have tools, and we have the technology," Arroum said. "...We are playing with these three factors to reach a stable process — so good quality, fast production, and also tool life."

Liebherr offers a comprehensive range of gear tools, many years of experience in gear manufacturing and maximum product quality.

Here, however, Liebherr differs a bit from other companies. While tool life is certainly a selling point, Liebherr's eye is primarily on maintaining affordability and improving delivery time.

"Nowadays, we see that our customers are more asking about delivery time," Arroum said. "So the supply has to be fast. Quality is mandatory. Nobody is talking about quality today. Tool life is also something which is expected...But the challenge will be fast deliveries and price."

Liebherr's been doing plenty of work

outside of their skiving line as well, however. They've recently changed the material of their immediately available stock tools from SP2030 to SP2052 — and use Alcrona coating on those tools to boot — in a bid to improve how well they work with stiffer materials. The harder SP2052 will allow these shaping tools to be used in industries such as aerospace that work with harder materials and demand higher quality components.

That demand for higher quality is driving other moves at the company, as well. Liebherr continues to focus on developing closed loop manufacturing systems. They're not just focusing on closed loop production for one or two tool lines, but trying to build it up for every kind of tool they sell. That means not just skiving, but also other products like CBN grinding wheels.

According to Arroum, it's a required move necessitated by quality expectations from customers.

"Each micron has to be at the right place," Arroum said. "You must work with closed loop. There's no other chance."

Quality may be expected as a matter of course, but the goalpost of that expectation is always moving. When shifts in the industry such as automotive's focus on electric vehicles and gear noise are met by an also ever-improving ability to detect imperfections, adopting new processes like closed loop manufacturing are what keep Liebherr ahead of the curve. And one of the best ways to maintain that high level of quality is to remove the risk of human error, one of closed loop manufacturing's biggest and most oft-touted selling points.

While Liebherr might not have a brand new shiny cutting tool line to raise eyebrows and draw headlines, it hasn't meant that the company has been idle. As the company works on all of these different projects to incrementally improve the quality of the products they already do have, Liebherr is still driving innovation in the field.

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