

State-of-the-Art Broaching

William R. Stott, Managing Editor

To say that broaching is a mature industry is an understatement. It's often perceived as being old, dirty technology that's not very high-tech. It's the way our grandfathers used to crank out parts by the millions for automotive and other high-volume applications. To some extent, that perception is true. Broaching's sweet-spot is still its ability to manufacture large numbers of the same part at an extremely low cost-per-piece.

But there are a number of companies working to change the way broaching is perceived, and over the past 10 years, they've incorporated significant technological changes to make the process more flexible, productive and accurate.

"Everybody grows up with lathes, mills and grinders," says Lee Egrin, CEO of Broaching Machine Specialties (BMS) in Novi, Michigan. "Every shop has that, but only one in a hundred shops has a broach. People are somewhat afraid. They cringe at broaching and don't even look at it. I find that

when I finally break the barrier and I sell a man his first broach, he's back for his second in short order. Once they get into it and see how simple it is, they come back for more."

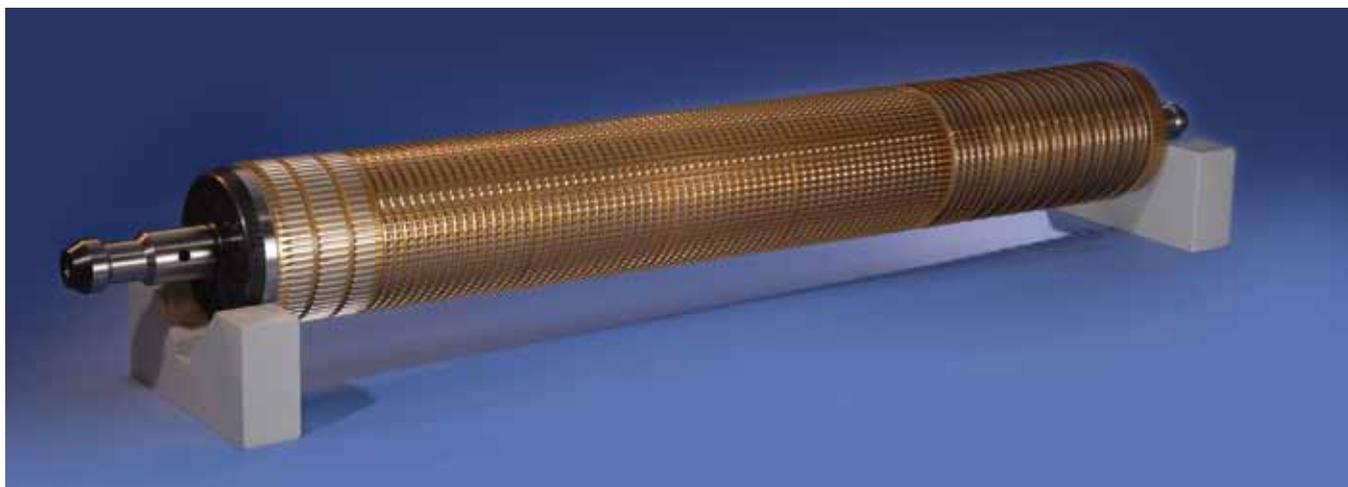
Matt Egrin, president of BMS, agrees. "Whenever we talk to anybody about buying a broaching machine and they're outfitting a building and putting in a whole machining line, they've ordered the grinder, they've ordered the lathe, they've ordered the material handling. The broaching machine is always the last thing they get to. Somehow we're always at the bottom of the totem pole."

"I think there's a fair segment of the market that has a bad taste in its mouth over the quality of broaching," says Scott Vian, vice president of Broachmasters Inc. and Universal Gear Co. in Auburn, CA. "But done properly, there's no process that will beat it for accurate size and speed of cutting. You can produce in seconds what it would take a gear shaper much longer to produce, and you'll probably end up

with a better part. People are leery of the process, but the industry as a whole has come a long way."

One area of advancement in broaching technology is the introduction of CNC technology and better controls. Colonial Tool Group of Windsor, Ontario specializes in applying modern technology to older machine concepts. "We've upgraded all of that older technology with CNC and servo drives," says company president Brett Froats. "Many different parts can be programmed into the machine, so all you have to do is set up the part and push a button. In the old days, you'd broach a part, make some adjustments, and broach another part. There was a lot more trial and error."

"Uniform velocity and acceleration from the mechanical CNC provides for a better cutting action, resulting in improved tool life and accuracy," says F.J. "Butch" Wisner, vice president of engineering and marketing for Nachi America. "Mechanical CNC systems have significantly improved a broach-



Courtesy of Forst Technologie GmbH.

ing machine's flexibility. Today, if parts are similar in size and configuration, robot and vision systems can be used to perform automatic changeover, including broach bar and fixtures, providing for lights-off manufacturing."

In recent years, CNC controls have paved the way to the elimination of hydraulics and replacing them with servo drives and ball screws for many applications. These new electromechanical machines represent the wave of the future for many involved in the industry.

"Forst combines table-up machines with electromechanical drives to eliminate the hydraulic unit, which saves space and lessens the environmental risks," says Ulrich Salwender, vice president of sales for Forst GmbH in Solingen, Germany.

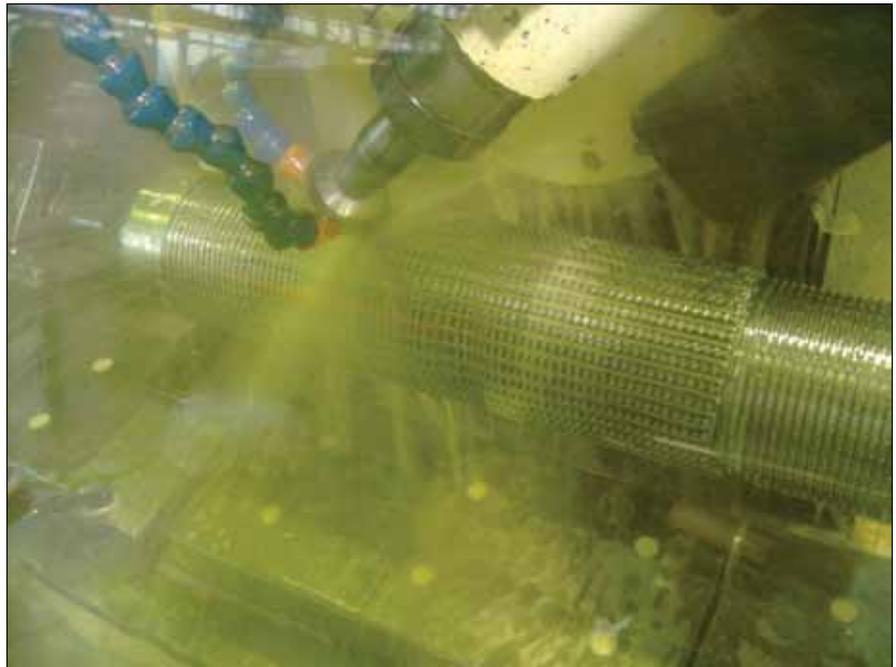
"We find the major advances to be in the electric drive machines nowadays," says Matt Egrin of BMS. "We've gotten away from the hydraulic drives. The majority of new machines the BMS builds today are electromechanical drives—servomotors driving a planetary roller screw or ball screw."

Egrin points to a number of advantages of electromechanical machines. Because there is no hydraulic cylinder and no oil compression, there's greater accuracy in the machine. "With an electromechanical machine, you've got a constant torque with no backlash, which results in a smoother cutting action, better part quality, better part finishes and better tool life."

The advantages of the electromechanical machine might lead to as much as a 30 percent increase in tool life, Egrin says, not to mention a much better surface finish.

"In some cases, we've been driven into electromechanical machines in order to make the required surface finish tolerances," Egrin says. "Someone will put a print in front of us, and it's got a considerably tighter surface finish tolerance than what you'd normally see in broaching. We figure those are best done on an electromechanical machine."

Ken Nemec, president of American Broach and Machine in Ypsilanti, Michigan, agrees that electromechanical machines are often the ideal solution. American Broach offers



CNC machine tool technology has allowed for more accurate production of broach tools. Courtesy of Colonial Tool Group.

both hydraulic and electromechanical machines. "Generally speaking, the electromechanical machine is very desirable for many applications," Nemec says. But he also points out that electromechanical machines have their disadvantages as well.

One of them is that the high-end servomotors and ball screws are very expensive and often take much longer to order or replace. So if something goes wrong with an electromechanical machine, there's a better chance it will be out of service for longer than a hydraulic machine. Whereas hydraulic machine repairs are fast, easy and readily available, ball screws and other electromechanical components have notoriously long delivery times.

One way that machine builders combat this disadvantage is by stocking the service and repair parts. American Broach, for example, guarantees its customers stock replacement screws for its machines for a minimum of 10 years after the machine was purchased.

Despite the advantages of electromechanical machines, one area where hydraulic machines still rule is in bigger applications. "When you're getting into very high tonnage machines—say, over 60 tons—we probably stay with a hydraulic machine," Egrin says, but even that is changing. "As the motor technology increases, pretty soon

you're going to make those high-tonnage machines with electromechanical drives as well."

Another technology that many broaching systems builders are taking advantage of is the increased capabilities offered by advanced engineering software. 3-D modeling software such as *Autodesk Inventor* helps these companies create broaching systems that can do more things and be delivered more quickly and reliably than ever before.

"Software gives you the possibility to design things you might not have taken on before," says Egrin. "Recently we developed a machine for a customer that actually had two different broaching axes. We were broaching parallel to the horizontal in one plane, and at a 45-degree angle on another plane. There was also a lot of automation, and a deburring station at the machine. This required a lot of out-of-the-box thinking. Whereas this would normally have required multiple machines, we were able to incorporate it all into one machine. Without the luxury of the advanced design software, that's something we might not have been able to design."

Wisner of Nachi adds that the advances in software allow for much less trial and error: "The ability to

continued

produce 3-D CAD and solid model simulation has significantly improved the first-time success rate for a newly designed broach tool. Historically, broaching has been an iterative process



Hard broaching allows for cutting of hardened parts after heat treating. Shown here are hard broaching tools and sample parts. Courtesy of Forst Technologie GmbH.

of continuous improvement.”

The trend toward reducing setups and incorporating multiple functions in one machine seems to be a growing trend in the industry. “For years, we’ve been combining other secondary operations in our machines,” says Steven Mueller, president of Ty Miles Inc. of Westchester, Illinois. “We’re able to broach, drill, de-burr, tap a hole and perform other secondary operations along with broaching. For example, with a gear part, you might be pulling a keyway, but also drilling a timing mark into the part.”

In addition to the increased flexibility and capability of broaching machines, broach tools have also improved. Better qualities of steel and more advanced coatings have resulted in tools that produce better parts and have longer tool life.

One of the areas where this is having a significant impact is hard broaching, says Ulrich Salwender of Forst. “Hard broaching with machines operating at 60-meters-per-minute has become a common process,”

Salwender says. “By re-broaching hardened components, distortions coming out of the heat treatment process are minimized and the surface quality is improved.”

This capability has shown dramatic results in automated assembly lines where gears are press-fit onto shafts, Salwender says. The lines suffer from fewer stoppages caused by inadequate gear quality. In addition, hard broached internal splines press-fit onto shafts can transfer higher torque, because there is a better surface match and increased contact area.

Better tools also allow for processes such as dry broaching. “The cutting tools are made out of a higher grade steel and receive a special two-layer coating,” Salwender says.

The greatest advantages are achieved when you put advanced cutting tools and modern machine tool technology together, Salwender says. “The combination of modern machine technologies and improvements of the cutting tools not only improved quality, productivity and cost effectiveness. It



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also gives the possibility of broaching materials that were not considered broachable before. One example is the large annulus gears in planetary gearboxes for heavy-duty applications like trucks, tractors, earthmoving equipment, wind mills, etc. In this lower-volume business, customers are trying to reduce the number of variants. With the increased volumes of now-broachable components and higher flexibility of our machines, broaching of such gears with straight or helical profiles replaces shaper cutting."

But despite all of the advances, creative approaches and efforts on the part of machine and cutting tool manufacturers, most agree that broaching is a shrinking industry, not a growing one.

The reason for that is the increased applicability of competing technologies. Powder metal parts, for example, can be designed with formerly broached features integrated into the part. Eliminating machining steps is one of the hallmarks of powder metal technology.

Also, many surface or external broaching applications can also be performed by milling machines or machining centers, and through better software and tools, those machines have also become more capable than ever before.

"The broaching business is losing applications where external machining is needed," Salwender says. "The development of high-speed machining

technologies has increased the breakeven point where broaching becomes profitable."

However, everyone we spoke with for this article was enthusiastic about the future of broaching. To those in the know, it's still the operation of choice for many applications.

"Broaching is still one of the fastest, most economical ways of removing material accurately," says Brett Froats of Colonial Tool. "There's no other process that competes with that."

"Broaching is still the most economically viable process for producing internal forms—gears and splines, for example," says Scott Vian of Broachmasters. "I don't think there's anything faster or better."

"Once a manufacturer invests, broaching produces a steady stream of quality parts for decades, with less effort than any other process," says Ken Nemec of American Broach.

"Speed and the number of pieces
continued

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Modern broaching machines replace hydraulic systems with electromechanical systems, including servo drives and high precision ballscrews or planetary roller screws. Courtesy of Broaching Machine Specialties.



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in the bucket at the end of the day are really what broaching is all about. Bottom-line, broaching is still a very efficient metal removing process," says Steven Mueller of Ty Miles.



Advanced automation, material handling and CNC controls represent the latest in broaching technology. Pictured here is a 50-ton, two-station CNC helical broaching machine from Forst.

Clearly, broaching has its believers. But perhaps Matt Egrin of BMS puts it best: "The perception of broaching is that it's an enigma. People don't understand it, so they're afraid of it. But it really is quite simple technology, and a very stable, repeatable process. Once you set that machine up, dial it in and run it for a few parts, it will run like that for thousands—tens of thousand—of cycles. You can make a lot of money running millions of parts off a broach, and it costs you hardly anything to maintain and operate the machine." ⚙️

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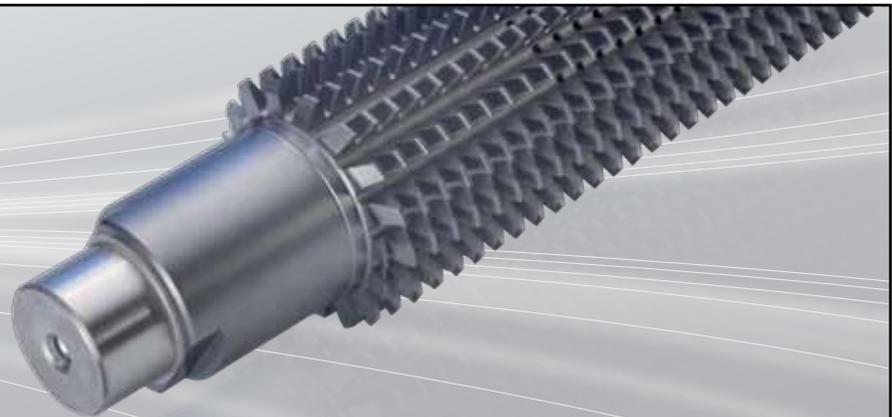
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