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▶ BY BILL KENNEDY

Screw machines keep pace with technological advances.

Dedicated to Change

All photos: Bill Kennedy

A multispindle screw machine at work.

For more than 100 years, multispindle automatic lathes have been paragons of metalcutting productivity. Generically called screw machines, these mechanically operated, rugged workhorses employ interlocking gears, cams and shafts to perform multiple operations simultaneously and turn out parts with cycle times as quick as 10 seconds.

In recent years, however, changes in manufacturing have altered the status of screw machines. Inventory reduction and just-in-time deliveries meant that factory orders increased in frequency, but each order was for a smaller quantity.

Since customers specify increasingly tighter tolerances, precision and flexibility are valued over volume and speed. And the dedicated nature of screw machines is often seen as a handicap.

However, with careful process planning, the use of innovative tooling and digital technology, as well as intelligent machine upgrades and retrofits, screw machines can continue to be powerhouses of production well into the 21st century.

Planning Speeds Changeovers

Once a screw machine is up and running, parts pour out of it at high speed. But setting up the machine for a new part—choosing and changing the gears, cams, collets, pushers and tooling—requires knowledge, skill and time. Setups often consume hours and shops are constantly looking for ways to reduce setup times.

Joe Podufal, owner and president of Clifton Automatic Screw Machine Products Inc., Lake City, Pa., said that prior to the advent of just-in-time deliveries, "we had never run less than 50,000 pieces of anything that was less than 1" in diameter. Nowadays, we regularly run 10,000-piece orders." Podufal said the trend of the industry points to shortening setup time through innovations such as ready-made setups, running similar types of single parts together or running families of parts.

An obvious way to save setup time is to reduce the number of changes required to machine a new part. For example, dedicating a machine to one size of bar stock can eliminate collet changes. Alternatively, handling similar parts with one set of cams saves the time needed to change cams.

Joe Stupica, mechanical engineer for screw-machine producer National Acme Co., Cleveland, recalled a case where the changeover from machining one shock absorber shaft to another took only 15 minutes. However, he said it took a lot of planning. The only difference between the shafts was their length. Cutoff for the two shafts was in the same location, so changing collets wasn't necessary. Therefore, a quick-change stock stop and preset quick-change toolholders were the only changes needed.

"You get the maximum advantage from screw-machine

At one company, a special TiN-coated, solid-carbide insert (left) replaced a HSS dovetail form tool (right). The company said the carbide tool offers longer tool life and allows higher cutting speeds in producing a stainless steel wrist pin (center).

cycle times when you minimize part-changing downtime," Stupica said.

Some users take advantage of the screw machine's speed and perform secondary operations when necessary. Wes Szpondowski, screw-machine superintendent at fastener-maker Wyandotte (Mich.) Industries Inc., said, "Sometimes, when we do a 1,000-piece job, we don't engineer the job as a finished product coming off the machine. We keep the job simple, so we can get it set up and running within a few hours."

Tooling Tactics

Tooling improvements can also increase screw-machine productivity. Quick-change tooling, preset off the machine and switched with the previous setup, cuts downtime. Size considerations, such as tool length and the tight workspace within a machine, are important, so toolmakers have developed compact tooling systems specially designed for screw machines.

A first step toward quick-change involves mounting square-shank lathe tools on the cross and end slides. Simply changing inserts—instead of the whole tool—saves gaging and test-cut time.

Familiarity with the intricacies of how a screw machine operates is crucial, too. Jim Brady, senior vice president at U.S. Tool & Cutter Co. Inc., Farmington Hills, Mich., said, "Many screw-machine guys know their equipment inside and out and can make it sing."

Brady also mentioned that screw-machine tools tend to be either HSS or carbide, and that many users' first—and only—experience with carbide was negative. Older carbide grades couldn't hold up in the high-volume, high-impact world of screw machines. Today, tool manufacturers use tougher carbide grades to increase productivity.

However, Brady warns shop owners that a critical factor in applying carbide tools effectively is the machinist. "He has to understand carbide tooling and not treat it like HSS." Specifically, carbide-tool users should minimize interrupted cutting, maximize machine rigidity and pay particular attention to tool alignment, especially with carbide drills.

Szpondowski said: "We run a lot of carbide. We used to grind a lot of HSS tools. Now we form with carbide off the cross slides, and we run carbide off the end slide just about everywhere—cut-offs, back drilling. It's almost limitless as to where you can use it."

Some say the screw-machine benefits of volume and speed come at the expense of precision. In fact, machine integrity and maintenance are the most important determinants of precision and performance.

Dick England, a Pennsylvania-based consultant and troubleshooter for the screw-machine industry, said he surveys a machine's condition "from the electrics to the mechanics" to see if it is up to a given job.

The survey determines, for example, if the end tool slide has any movement in it. "If it does," he said, "it may not be able to do what is required. You have to have a solid machine."

And, ongoing maintenance is crucial. "If you neglect a machine, you're not going to get the performance you want out of it," England said, adding that a good screw machine can hold a tolerance of 0.0005" and even run ceramic tools.

Upgrades Increase Efficiency

Thousands of screw machines have been reconditioned, rebuilt or retrofitted to increase their efficiency, and screw-machine manufacturers continually upgrade the technology. The addition of electronic controls and the replacement of gear drives and cams with electronic servomotors can significantly increase machine efficiency.

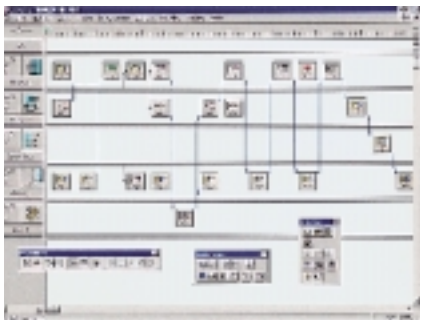
Pat Muscarella, vice president of sales and marketing for screw-machine builder Davenport Machine, Rochester, N.Y., said, "A machine may be capable of producing 1,800 parts per hour, but its efficiency after a year may be as low as 65 percent, due to bar loading, maintenance, tool changes and so forth." Therefore, he recommends installing servomotors on the machine's transmission to save maintenance costs.

He said that after his company replaced the mechanical transmissions on a machine with electronic ones, it operated maintenance-free for 18 months.

Also, he said that replacing the mechanical transmissions with electronic ones reduces downtime and can in-

Clifton Automatic's Jim Hunt preselects tools and toolholders so they can be mounted quickly on a machine.

Bar stock is fed into an Acme-Gridley screw machine.



Offline programming with Tornos-Bechler software enables users to construct a sequence of operations and create time and distance codes for each tool. The codes are read by the screw-machine controls.

crease a machine's efficiency 5 to 8 percent. Another 5 to 8 percent efficiency increase can be achieved by upgrading to faster drives. "A 10 to 15 percent increase in efficiency is really significant when you're making millions of parts a year," he said.

On a screw machine, the lock-step synchronization among motors, gears and cams can restrict flexibility. Powering cross slides with CNC-driven servomotors and adding CNC attachments broaden a machine's capabilities.

National Acme's Stupica said, "CNC servos allow you to pick up a spindle offset and change feeds. In addition, since the programs provide a start point and a home position on the slides, the part configuration can be changed. You don't have to change cams or feed rates."

Attachments for pickoff, back finishing and threading also help a shop eliminate secondary operations. "I had 15 people in my secondary department; now I have five," said Clifton Automatic's Podufal. "That's mainly because we put more attachments on the screw machines to complete the parts."

The rugged nature of screw machines provides a solid base for productivity modifications. Wyandotte Industries' Szpondowski said he constantly looks for ways to upgrade his machines. "We're getting into high-pressure pumps and through-coolant tools. It's amazing what you can do with one of these machines. You can constantly upgrade. A job can start out at 20 seconds per part. But, by tweaking over a period of a year, you can get it down to 12 seconds."

Applying Digital Technology

"Parallel processing" wasn't in anyone's vocabulary when the first multispindle automatics hit the scene, but the phrase is a part of screw-machine terminology today. As servos and CNC controls have increased flexibility, progress has come on the software side, too.

Furthermore, CNCs can relieve shop owners from the inherent burdens of cam-operated screw machines; namely, their reliance on hard-to-find, trained labor. Mark Saalmuller, national sales manager for machine-tool builder Tornos Technologies U.S. Corp., Brookfield, Conn., said: "Cam machines are as fast as hell. For many applications, you still can't beat them. But setting up cam machines is cumbersome and you need skilled operators, who are hard to find."

He added that CNC machines could be set up faster, offer greater precision and help shops move away from form tools. The only down side is their relative lack of speed.

To develop a machine with the advantages of CNC but the speed of the cam machines, Saalmuller said Tornos

Diversifying the equipment mix

Changing customer demands have prompted some traditional screw-machine-focused shops to change their machine-tool mix. Joe Podufal, owner and president of Clifton Automatic Screw Machine Products Inc., said his largest customer has parts that are ideal for machining on rotary transfer machines (RTMs).

Three rotary transfer machines replaced nine screw machines at Clifton Automatic.

"I had 19 multispindle machines," said Podufal. "I sold nine of them and replaced them with three rotary machines."

He added that he does setups on the RTMs in 3 to 4 hours and they perform the same operations as the "multis" could, except for forming on the OD, where jaws are holding the part. "But," he said, "I can do ID drilling, tapping and broaching. On the OD, I can slot, groove and form on the end where the workpiece is not held."

In the end, Podufal said the rotaries took the work from his nine screw machines, in addition to other work. "Screw machines are still a big part of our business," he said, "but we're going into the new century doing other things."

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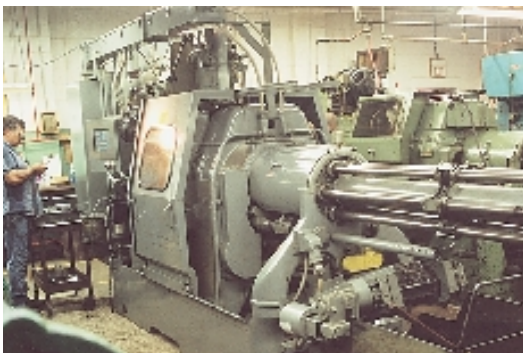

A CNC screw machine is easier to set up than a cam machine.

established a joint venture with Fanuc to create what they call parallel numerical control (PNC) technology, where programs are written offline.

PNC begins with a real-time, Windows-based simulation of the machine. The program generates time and distance codes that locate each tool at a certain point every 8 milliseconds. When the machine runs, the control reads the codes. Time is saved, because the control does not perform calculations. "In a sense, you're eliminating the dwell times of a CNC," Saalmuller said.

Even small timesavings loom large in the single-digit-cycle times of screw machines. Shaving 20 seconds off the cycle time of a large part may not seem significant, but, in a large-volume screw-machine run, a few seconds can constitute huge savings.

Saalmuller pointed out that many manufacturers who previously didn't consider CNC are looking at it now. One example is the plumbing industry, where demand for high-end fixtures has raised finish and tolerance requirements, creating a need to maintain production speed while eliminating secondary operations. Automotive customers, too, are specifying more complex parts with correspondingly tighter tolerances.

Despite their diminishing popularity, multispindle screw machines still offer unique productivity advantages. For machining large volumes of small parts in extremely short cycle times, they are practically unbeatable. And process planning, tooling selection and machine upgrades allow screw machines to offer clear benefits, even on smaller lot sizes. In addition, new technologies are helping these machines move into the 21st century.

While acknowledging the improvements offered by CNC lathes and machining centers, Podufal feels screw machines will always be profitable: "We have CNC lathes and machining centers, but when you're going to run the big volumes, there's no way you're going to touch screw machines. The new machines definitely help us, but we know that we must keep the screw machines, because that business will always be there, too."

About the Author

Bill Kennedy is a writer living in Latrobe, Pa.