➤ BY ALAN RICHTER, EDITOR

Which Way to Turn?

Index; Inset: A. Richter

According to Index Corp., every part shown can be manufactured on a sliding-headstock machine, but only the group on the right should be.

Considerations when choosing between a Swiss-style machine, with its sliding headstock, and a conventional fixed-headstock CNC lathe.

Here's the scenario: Numerous other job shops that have similar equipment to your shop exist within a 10-mile radius. The equipment includes CNC lathes with 6", 8" and 10" chucks, and a 20"x40" vertical milling machine. You want to distinguish your shop from the rest and carve a niche. A Swiss-style machine, with its sliding headstock, just might be the ticket.

"We're seeing more job shop people come to us and say, 'These mills and lathes we have are great, but I want to get into something different,'" said Mark Saalmuller, sales and marketing manager for Tornos Technologies U.S. Corp., Brookfield, Conn., a Swiss machine tool builder. "In many cases, getting into Swiss-style work can make the difference, because not everyone has it and there are still some people who are afraid to get into it."

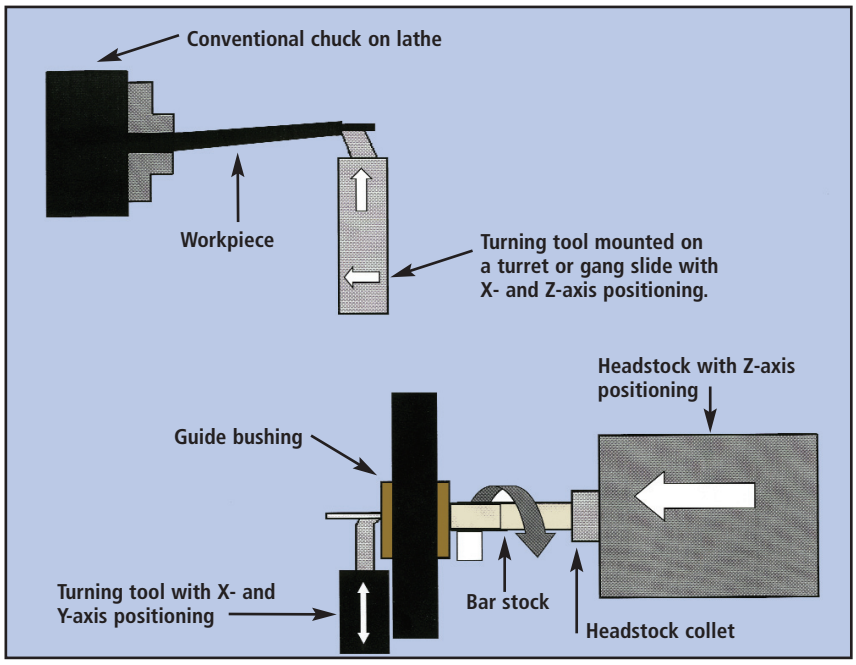
The hesitation to add Swiss-style machining capability, Saalmuller noted, is partly because of the air of mystery that shrouds sliding-headstock machines. "For many years, there has been a mystique about Swiss machines—that they are totally different than any other kind of machine and you need 'Hans from Switzerland' with a 10-year apprenticeship program to run them."

He added that the mystique is not as prevalent as it used to be and continues to diminish as more machinists become familiar with sliding-headstock machines. In addition, those entering the field tend not to have preconceived notions about the technology. "A new group of people are out there saying, 'This is CNC and it is cutting metal, how different can it be?'" Saalmuller said.

Another perspective is that more shops are adding Swiss-style machines to their equipment lineup because they see them as the only CNC alternative to single-spindle automatics. "Basically, there used to be a lot of single-spindle automatic screw machines in the market,

but they've slowly disappeared because they are cumbersome," said Klaus Voos, vice president of marketing for Index Corp., Noblesville, Ind. "The problem is that there has never been a good replacement for those machines. The conventional 2- and 4-axis lathes are too big for the kind of work that used to run on screw machines. The way I see it, if it's a normal screw machine-type part, it's not a good process if you run it on a Swiss-type machine."

Index builds turning machines, most of which are fixed-headstock machines. "Unless you need the guide bushing, or the Swiss-type process, you do not want to use it because of the limitations and drawbacks involved," Voos said.



A Swiss-style machine with its sliding headstock is advantageous when parts with long length-to-diameter ratios are machined because the workpiece experiences no deflection, as can be the case with a conventional lathe.

Distinguishing Characteristics

A machine with a sliding headstock that holds a bar and feeds it, or pushes it forward, through a guide bushing is, by definition, a Swiss-style machine. A Swiss machine has a headstock with Z-axis positioning and the turning tool removes material with X- and Y-axis positioning.

"With the sliding-headstock machine, instead of feeding the stock out to a stop and then having the cutting tool push past the material to cut, the material is pushed as the headstock is moved in the Z-axis direction and the tool, in our particular case, is 1mm away from the guide bushing," explained Wally Gundrum, vice president of Hanwha Machine Tool USA Inc., a Swiss-type machine tool builder located in Menomonee Falls, Wis.

In contrast, a conventional lathe has a fixed headstock, which consists of the permanently fastened housing and contains the motor drive system and spindle that holds and turns the workpiece. Parts are produced on a lathe by spinning the workpiece OD against the cutting edge of a single-point cutting tool. The tool is mounted on a carriage, which may be fed manually or automatically along the workpiece during machining.

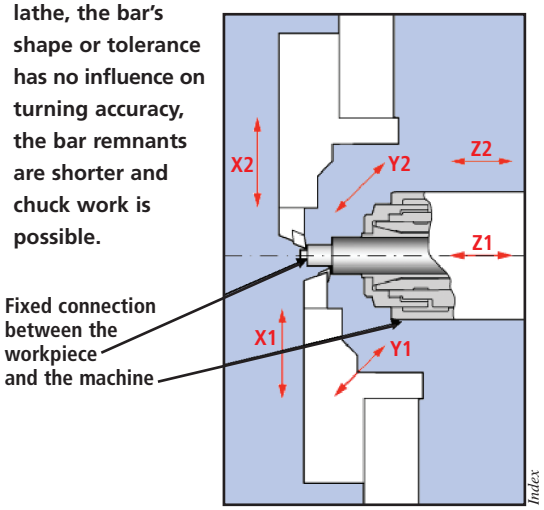
Gundrum said cutting close to the guide bushing on a Swiss machine, which supports the bar stock, provides a rigid machining condition compared to a conventional lathe, where the turning tool is mounted on a turret or gang slide with X- and Z-axis positioning. The workpiece being machined on a conventional lathe should, as a general rule, have no more than a 6:1 length-to-diameter ratio to avoid too much workpiece deflection. Long, round, skinny parts—those with a length-to-diameter ratio greater than 6:1—have traditionally been the domain of Swiss-style machines.

According to Voos, the guide-bushing concept has drawbacks. "You have a certain amount of clearance, a couple of tenths for sure, between the material and the bushing," he said.

Because most Swiss machines have an adjustable guide bushing, the amount of clearance depends on how accurately the bushing can be adjusted. "If you make the bushing too tight, there is the possibility of the material galling and getting stuck in the bushing," Voos said. "If you make it too loose, then you can't make an accurate part." As a result, the diameter of the bar fed through the bushing needs to be consistent along its entire length. "If your bar is within a tenth or a half of a tenth over the whole length, then you can adjust the bushing accurately."

Of course, an individual bar's diameter may be within a half of a tenth along its

With its fixed connection between the workpiece and machine, a conventional lathe provides better concentricity and position accuracies of machined dimensions, especially when applying live tools, compared to a sliding-headstock machine. In addition, when machining on a conventional lathe, the bar's shape or tolerance has no influence on turning accuracy, the bar remnants are shorter and chuck work is possible.



entire length, but variation from bar to bar can negatively influence throughput and part quality if more than one bar needs to be run before adjusting the guide bushing. "You don't want to run one bar at a time," Voos said. "You want to run two, three, four or five automatically, but every time you load a new bar you have a certain amount of variation from one bar to the next."

Holding On

Fixturing problems often arise when small parts are produced on a milling machine. Because Swiss-machined parts are completed in one setup, problems associated with moving a part from one fixture to another are eliminated. "There is an accumulation of error if you have to put a part into two or three different fixtures," Gundrum said.

Voos agreed that avoiding tolerance buildup is important to producing precision metal parts, but noted that a fixed-headstock machine provides a simpler fixturing scenario than a Swiss machine, which has two spindles. "You have one spindle, which is mounted behind the guide bushing, that holds the collet and feeds the material," he said. "Then you have the guide bushing itself, which is the heart of the machine and requires high-precision bearings.

"Plus, the guide bushing is much more expensive than a regular collet. It has to be very precise in regards to the roundness between the outside and inside of the bushing," Voos added. "It really doesn't matter how concentric a regular collet is."

However, if the length-to-diameter ratio of a part machined on a conventional turning center exceeds 4:1, it needs to be supported with a tailstock, steady rest or roller support. The support device prevents the workpiece from being machined where it's supported, requiring refixturing of the work if the end user doesn't have the required capabilities. Voos described such a scenario: "You machine the OD, clamp the part in the steady rest, move the tailstock out of the way and then come in and machine the end."

Double vision

Say your shop produces small, short turned parts and you find a fixed-headstock machine to be advantageous. Or suppose you're making long, skinny parts and require a Swiss-style machine with its sliding headstock. Now both turning processes are available from Index Corp. in the same machine design—but not within the same machine tool. Index's Traub TNL12/TNL12K and TNL26/TNL26K models are based on a building-block concept, which allows the user to configure the machine to his requirements.

"We started out with a Swiss-style machine and then offered it not only with a sliding headstock, but also with a fixed headstock," said Klaus Voos, Index's vice president of marketing. "The user isn't able to convert from one to the other, but we offer both models."

Index

The working area of the Traub TNL12 machine.

The TNL12/TNL12K model (the K indicates the machine has a conventional fixed headstock) has a bar capacity of 16mm, two 6-station turrets, a 4-station end-working tool carrier, a counter spindle and a 4-station back-working tool carrier. Index reports that the turret tool carrier concept allows for a higher tool capacity in the machine. The maximum number of fixed tools for this model is about 26, 18 of which can be live.

The TNL26/TNL26K model has a bar capacity of 32mm, two 12-station turrets, a 5-station end-working tool carrier, a counter-spindle and a 5-station back-working tool carrier. This model can accommodate about 58 fixed tools. Of these, 32 can be live. "Almost everything in the machine is the same except for having a collet or guide bushing. It's hard to tell the difference between the two when looking at them," said Voos.

An added benefit of the turrets is, because of the high-speed indexing system, chips get thrown away from the tools, making the machines well suited for producing medical parts. Because the sliding- and fixed-headstock machines are from the same building block, all tooling and other workpiece-related accessories are fully interchangeable between machines of the same model size. Programming and operating are also identical.

"We've had a lot of interest so far. It's hard to tell if one model is more in demand than the other because the machine is still new," said Voos. And, added Voos, shops making both short and long parts can always buy one of each.

—Amy Wallis

That Was Turned?

End users are able to make parts on Swiss machines that look milled by using techniques such as polygon turning, sometimes termed polygon milling. Gundrum explained that the polygon turning unit, which is a live tool, has two or four inserts. The unit is synchronized so that when an insert cuts the bar stock, it cuts the bar at the same radial position each time the workpiece rotates. This enables geometries such as hexes, squares and flats to be machined faster than on a milling machine. "We're doing a part for one of our customers that starts as round bar stock, and when we're done with it, there will be nothing round on it," he said.

Of course, with extensive live tooling capability, conventional turning centers are also able to produce parts that don't appear to have been turned—and there may be little or no turning required.

"Some [turned] parts look like they came off a milling machine," said John Baldwin, senior applications engineer for Marubeni Citizen-Cincom Inc., an Allendale, N.J., builder of Swiss machines. "When it was simply turning and

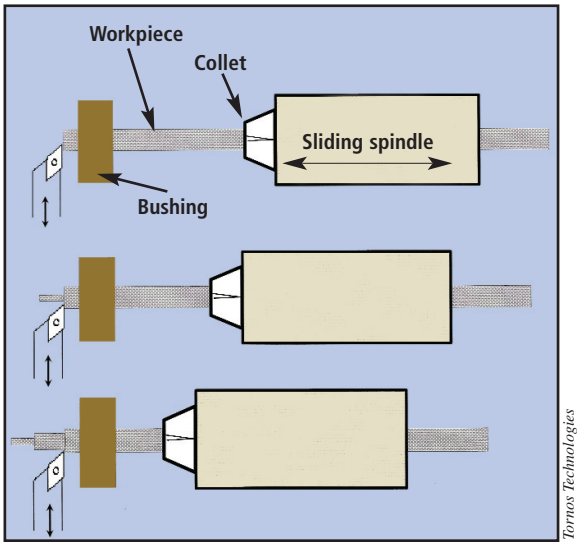
cutting off, it was different. Now, our machines are combination lathes and machining centers. They have live tool capability, plus multiple operations can occur simultaneously."

Voos concurred. "We have one customer that makes a little ratchet wrench, which is typically not a part you make on a turning machine," he said. The advantage is that the part is machined from bar stock. Whether the stock is round, square or hex-shaped, it can be fed automatically using a bar feeder. "When doing the same thing with a machining center, you can't feed the material automatically," Voos said. "You have to load it somehow."

Diameter Matters

While 6"-, 8"-, 10"-dia. and larger workpieces can be chucked in conventional turning centers, the diameter of the workpiece that can be Swiss-machined is limited by the size of the guide bushing that the bar stock goes through. "Most of the sliding-headstock machines don't go much above 1¼" (32mm), so, naturally, if you have a lot of work that's above that size you may lean toward a traditional fixed-headstock machine to do those parts," said Saalmuller. "But when you get into 1¼" and below, a Swiss machine is more attractive."

However, the maximum diameter for a Swiss machine is expanding. "It's starting to eke up," said Gundrum. "We have 35mm machines, and there are a couple of 38mm machines on the market."



Tornos Technologies

As the workpiece is fed through the Swiss-style machine's guide bushing, cutting continues to take place nearest the point where the workpiece is supported the most.

In addition to the cost of a Swiss machine going up as the diameter increases, rigidity becomes more of an issue. "The bigger the bar stock, the more rigid the machine needs to be to cut it," Gundrum said, "because more harmonics are created with the larger bar stock."

Because a part can't be chucked in a

Feeding productivity

Adding a bar feeder is an inexpensive way to automate the machining process.

"It's critical to automate the process to compete globally," said Bruce Kiwala, national sales manager at LNS America Inc., a Cincinnati-based manufacturer of bar feeders and accessories. But what should you consider when loading bar stock into a Swiss-style machine vs. a conventional lathe?

LNS America

The Express 220 bar feeder is for loading bar stock into sliding- or fixed-headstock machines with a capacity up to 20mm.

Several basic options are available for feeding bar stock into machines: a single bar loader, a magazine bar loader or a magazine short loader.

With the short loader, bars need to be cut to the length of the headstock but the equipment consumes less room on the shop floor. According to Kiwala, the short loader, which automatically loads bars into a machine, is popular. "We sell more of these than any other product."

LNS offers models for both Swiss-style and conventional lathes. This includes, for example, the Express 220 and 320 automatic bar feeders for sliding- and fixed-headstock lathes. The bar feeders allow complete changeovers to be made in 8 minutes. Torque, feed rate and other parameters are set automatically. The machine operator manually adjusts only the collet size for each new bar-stock diameter.

On Swiss-style lathes, it is necessary to coordinate the bar feeder's pusher and the movement of the bar because the bar moves back and forth during machining. The Express bar feeders have electronic synchronization, where the programmable logic controller logs the bar's movements the first time a part is processed. The PLC then matches the bar's movements with the pusher.

An option for small-diameter bars is LNS's Spindle Synchronization System. The 3-S adds a linear-feedback device that tracks the headstock's movement. So, a headstock that moves back 1" would cause the pusher to move back 1".

In addition to magazine-type loaders, which require a large investment, single-tube bar feeders are available. With a single-tube feeder, one bar is loaded manually at a time. "For complex parts where cycle times are 5 minutes or more, a magazine loader doesn't make sense," explained Yves Scemama, LNS president. When comparing manual and automatic bar feeders, "it is important to balance the cycle time with the length of the bar and the complexity of the part," he said.

Scemama noted that LNS offers a quick-reference chart to help end users select the best bar-feed model for their requirements. The chart takes into account such considerations as type of headstock, whether auto or manual load is needed, bar length, floor space, diameter range, changeover and tray capacity.

—A. Wallis

Swiss machine, sliding-headstock machines are not suitable for turning certain parts—regardless of their diameter. "If you need to machine a casting or machine from a slug, that needs to be done on a fixed-headstock machine because it won't fit through the sliding-headstock machine's spindle bore," Gundrum said.

On the other hand, a conventional lathe isn't appropriate for parts ⅛" in diameter or less. "You can't machine things like tiny pins very well on a regular lathe-type machine," Voos said. "The part itself is not rigid enough to be machined without the tool being very close to the collet or support mechanism."

But when end users aren't making parts that are too long or too skinny for a conventional lathe, turning away from a Swiss-style machine can be in their best interest. "We've seen more and more people who have worked with Swiss machines and are familiar with the drawbacks associated with the guide-bushing concept," Voos said. "They like the idea of having an alternative to the sliding-headstock machine."

Nonetheless, the Swiss machine builders agree that their segment of the industry is definitely growing, opening up new markets for those who weren't in the sliding-headstock arena and helping them be more competitive. The key might be to avoid bringing a lot of baggage to that arena, which machinists coming from a culture of traditional Swiss machining might have a tendency to do. "I find a lot of the nontraditional Swiss people are, in some ways, more open-minded about trying different things on the Swiss machine than the people from the cam days of Swiss machining," said Saalmuller. "They come with a completely clean slate, where they don't know what did or didn't work in the past, so they're like, 'Well, let's try it and see if it works.' We've got a few customers who have gone that route and it's phenomenal the way their business has turned around." △

The following companies contributed to this report:

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