

► BY ALAN RICHTER, EDITOR



Tornos' DECO Sigma 8 CNC automatic lathe has a sliding headstock but no guide bushing, allowing the use of unground, cold-drawn bar stock.

Tornos

Convertible

SWISS

In the right application, a sliding-headstock machine without a guide bushing offers advantages compared to one with a bushing.

Many people associate the Swiss with chocolate, watches and the Alps. Metalcutting professionals, on the other hand, often think of sliding headstocks and guide bushings.

That's because a conventional Swiss-style machine, by definition, has a sliding headstock that holds a bar and pushes it through a guide bushing in the axial, or Z-axis, direction. The guide bushing, usually having a carbide lining, minimizes workpiece deflection by being near the cutting

zone, thereby providing the workpiece with maximum support.

The Swiss-type machining concept is effective for producing long, slender, complex, tight-tolerance parts complete in one setup. But a guide bushing costs more than a standard collet.

Guide bushings also require regular maintenance. For example, all bar stock coming from the mill has a thin film of grease on it that transfers to the guide bushing, according to Olaf Tesarzyk, CEO of Index Corp., Noblesville, Ind., manufacturer of Index and

Traub turning machines. "At least once a week you have to clean the guide bushing very meticulously," he said.

A guide bushing can be problematic, too, because it needs to be adjusted to allow the ground bar stock to pass through without getting stuck. It must do this while minimizing the amount of clearance between the bushing and material so there's sufficient support, sufficient rigidity, to produce tight-tolerance parts.

"If you're trying to hold a 0.0001" and you're losing half your

tolerance on the machine process, half of your tolerance is thrown out the window before you even start," said Dave Fricke, president of Millennium Manufacturing, a Quakertown, Pa., job shop. "You also need a guide bushing for every single stock size that you're going to run, so you're going to have another replacement part to swap in and out. And you have to rely on an operator to be comfortable tensioning a guide bushing for different workpiece materials and different part tolerances."

Millennium Manufacturing recently purchased a WL25 8-axis, dual-slide, nonbushing sliding-headstock machine from Eurotech Elite, Brooksville, Fla., to overcome these problems when producing the appropriate parts, adding to the shop's array of conventional CNC Swiss-style machines, conventional CNC machines, multitask machines and multispindle units. "What we needed was the live tools, as well as a C-axis on the main spindle and subspindle. While multitask machines

To eliminate the extra cost, and adjustment and maintenance requirements for a guide bushing, a number of machine tool builders offer sliding-headstock machines without guide bushings.

have these capabilities, they are expensive, have comparatively long tool indexes and usually start at a spindle size of 1¾", often too large for our parts," Fricke said. "We didn't need the guide bushing." He indicated the WL25 costs about 30 percent less than a comparable 1"-capacity Swiss machine.

Bushing B-Gon

To eliminate the extra cost, and adjustment and maintenance requirements for a guide bushing, a number of machine tool builders offer slid-

ing-headstock machines without guide bushings. According to Tessarzyk, these machines provide the high level of precision Swiss-style machines have a reputation for and enable manufacturers to achieve the fast cycle times Swiss machines provide because the tools are close to each other in the work area and quickly move in and out of the cut. Sometimes termed a convertible Swiss, a universal turning center or another type of chucker, they all operate in a similar manner no matter the nomenclature. "I hate to call it 'fixed headstock' because the headstock is not fixed," Tessarzyk said. "It's still the same principle of a sliding-headstock machine, but you don't have the guide bushing in front of the sliding headstock."

Being able to produce parts on a sliding-headstock machine without a guide bushing is nothing new. Many of the old cam-operated Swiss machines, such as Tornos, Bechlers and Petermanns, allowed an operator to remove the guide bushing to produce

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Many parts produced on a conventional Swiss-type machine can be more efficiently produced on a sliding-headstock machine without a guide bushing.

short, tight-tolerance parts, according to Leonard Lanute, product manager—single spindles for Tornos Technologies U.S. Corp., Lombard, Ill. For this class of nonbushing machine, the Swiss-style machine builder offers the DECO Sigma 8 sliding-headstock CNC automatic lathe.

Turning to modern times, Index Corp. introduced the TNL 26 Swiss-style machine in 1999. It has a programmable guide bushing, which always guides and supports the bar but can be programmed to clamp the bar like a fixed headstock when needed. “While milling a slot or another feature, you have a torsion movement on the bar and when it returns you’re out of tolerance with parallelism on the flat,” Tessarzyk said. “That’s why when milling you always want to tightly grip the bar.”

The programmable guide bushing proved to be popular, so Index introduced the TNL 26K—a sliding-headstock machine without a guide bushing—for producing shorter parts that don’t need to be supported by a guide bushing at all. “The TNL 26K allows you to do the same milling, drilling and turning that you do on a fixed-headstock machine, and you can even pull back the bar for an additional advantage,” Tessarzyk said, noting that a guide bushing limits the amount of pullback so there isn’t too much clearance between the bushing and bar.

In addition to the TNL 26K, Index offers various bushingless, or K, versions of its sliding-headstock machines, which now enable end users to put a guide bushing on and remove it when needed.

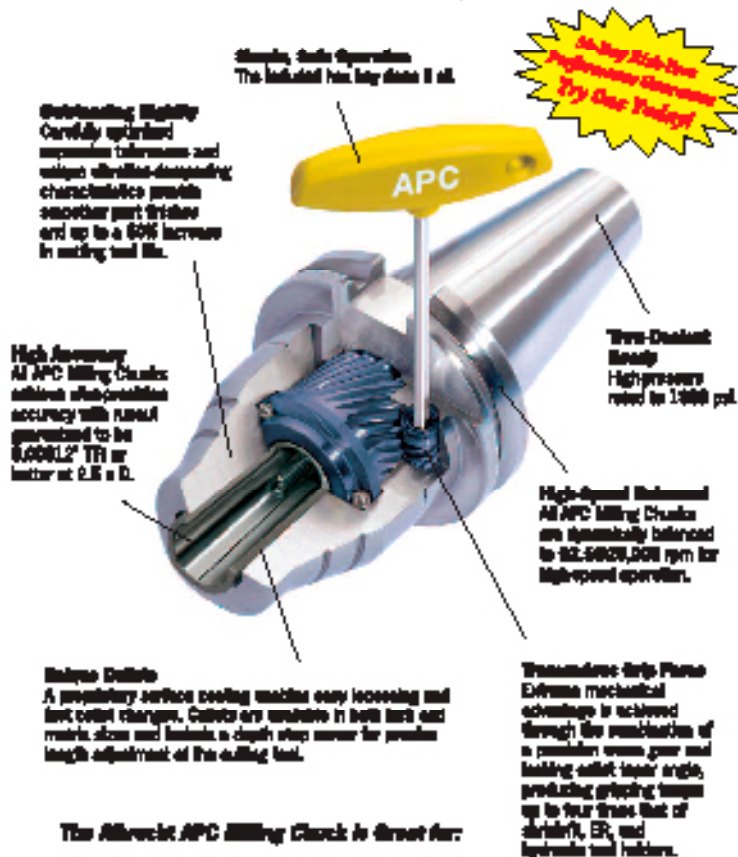
Application Driven

The general consensus among

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industry sources is that a nonbushing machine is appropriate for producing parts with up to a 4:1 length-to-diameter ratio, including ones that start as castings and forgings and are loaded automatically into the machine. "It isn't linear, so you might not be able to get 4:1 out of a 1/8"-dia. workpiece where you would easily get 4:1 out of a 2"-dia. one," said Millennium's Fricke.

Conversely, Lanute of Tornos noted that the typical part made on the Sigma 8 bushingless turning center still conforms to the company's recommended 3:1 length-to-diameter ratio, but it's also possible to perform light end-working operations on a 3/8"-dia. part up to 12" long—a 32:1 depth-to-di-

ameter ratio. "To turn longer parts, you have to think differently," he said. "You want to get creative and make the machine as productive as possible."

Lanute emphasized the efficiency of conventional Swiss-style machines, which makes them a common piece of equipment at job shops, but noted that many parts being turned today can be machined faster, more economically and with tighter tolerances on a non-bushing machine. How many of those parts are more suitable for such a machine depends on who you ask.

Lanute estimates that 25 to 30 percent of the parts produced on a conventional Swiss are appropriate for this other class of machine and many parts manufacturers don't realize it.

Single-minded machine

Swiss-style machines—with or without guide bushings—are often dedicated to producing one part day in and day out. Such is the case at Alpha Omega Swiss Inc.

After making a titanium orthodontics component on two conventional Citizen Swiss machines using two operators, the Yorba Linda, Calif., job shop purchased a Cyclone-25 CS 7-axis sliding-headstock screw machine without a guide bushing 2 years ago from Ganesh Machinery, Chatsworth, Calif.

The part is only 1/4" long and the bar is rigid enough that it doesn't need the support of a guide bushing. In addition, the machine has seven rotating tools: four cross-driven and three axial-driven tool stations. "That particular model offered the amount of mill tools we needed," said Randy Jones, Alpha Omega's vice president. "We didn't need the guide bushing support; we needed the milling."

He considered a chucker lathe for the job but determined that wouldn't do the trick. "I searched all over for a machine that gave me seven milling positions, but could not find any model with enough milling positions for that small of a part," Rose said. "Usually, only big lathes have that many milling positions."

As luck would have it, the solution



The Cyclone-25 CS machine from Ganesh Machinery.

came to him when the local Ganesh sales representative visited the shop unannounced. "The dealer came in and said, 'I can make this part,'" Rose recalled. "I said, 'You're sure? Show me.' He brought the machine in here and I had my doubts, but he kept his word. He said he could do it and he did."

Since then, the machine has been producing 240 parts a day with one operator attending to the machine part of the time compared to 100 parts using the previous method. The shop runs just one shift.

"It's been holding ± 0.0002 " for 2 years and very little adjustment goes into the machine," Rose said. "It's rare that we make an offset, and we're cutting titanium. We offset for tool wear and that's about it. We can go several days without making a tool change."

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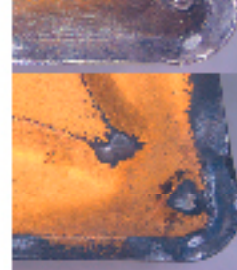
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Swiss watchmakers—practically responsible for the creation of Swiss-style machines—were in that category, insisting they needed a guide bushing to make their intricate, very small parts even though many of those parts aren't long, he said.

"Then, we worked with a few of our watchmaking customers and had them try the nonbushing machines, and on the short parts, these machines fit such a niche in the watchmaking industry that they're becoming the standard now," Lanute said. "Because bushingless machines don't require ground stock and they're a lower capital investment, there's a shift on that side of the pond, where watchmakers are looking at the process, realizing the value and saying, 'We should have done this years ago.'"

Millennium's Fricke said only 25 percent of his shop's Swiss work, primarily for the medical and electronics industries, requires a guide bushing. "When we looked at our portfolio of small parts, we noticed that most of them did not need a guide bushing, and with the increased material cost, we were looking for a way to reduce that cost," he said. "We have moved several of our parts to the WL25 SY2 and have found that not only is the material cost lower, but it is easier to set up and runs very fast. With the WL, we have the capability to take on some additional complex work and run more competitively."

According to Tessarzyk, Index conducted a market analysis 4 years ago and found that 70 percent of the parts produced on conventional Swiss machine in the U.S. "are not Swiss parts," and the figure is as high as 80 percent in other countries. He noted that shops produce non-Swiss parts on conventional Swiss machines because so many of those machines are available in the marketplace and they think only sliding-headstock machines with a guide bushing provide the needed precision.

Jeff Walz, president of Eurotech Elite, which also provides fixed-headstock CNC multiaxis machines, concurred, estimating about 80 percent of parts produced on conventional Swiss machines could be produced more

efficiently without a guide bushing. "As the number of shops with Swiss capability has increased, customers are forced to look for ways to cut costs and keep their margins. As they investigate this, many are looking for ways to produce small parts for less money," he said. "Many are now looking at multiaxis turning centers sized for small parts, but which do not use a guide bushing."

Bar Issues

Because a Swiss machine with a guide bushing requires ground bar stock, the cost to run these shorter, small parts is much higher on a Swiss machine than on a machine where lower cost nonground bars can be used, Walz noted.



Index Corp. says its Traub TNL12K sliding-headstock turning center reduces setup times for short turned parts because the guide bushing is not necessary. This also results in workpiece material savings because remnants are significantly shorter.

Not only is ground stock more expensive, feeding it through a guide bushing can be problematic. Fricke said he's had trouble running ground stock because the ground surface is annular to the bar so the surface finish radiates out from the bar and not in the direction it travels. "As the bar slides in and out of the guide bushing, it's going up and over all those very small ridges," he said. "If you do have an imperfection with ground stock, it usually snags the bar in the guide bushing."

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Tornos reports that its DECO Sigma 8 CNC automatic lathe provides a diameter accuracy of $\pm 1\mu\text{m}$.

In addition, hex and other shaped bars can be easier to machine without a guide bushing. "With a Swiss machine, hex stock is usually kind of a hassle," Walz said. "With the odd shape, you just can't machine the material cost effectively."

The bar remnant is also shorter without a guide bushing. Tornos' Lanute noted that the average remnant on a conventional Swiss lathe is 7" compared to about 2" on one without a bushing. "Just think of how many more parts you can get out of that bar stock," he said. Plus, changing bars takes time and doing it less frequently saves money. "If it takes 45 seconds to do a bar change, over the course of a week, month, year, that's a lot of idle

time," Lanute added.

Quicker to the Cut

In addition to eliminating the need to set up and adjust the guide bushing, Tessarzyk said setting up the bar feeder takes less time for a bushingless machine.

Fricke indicated a 10 percent reduction in setup time for such a machine, "which can definitely make the difference between getting a job and not getting a job." He added that his Eurotech machine's setup is easier because it has a tool presetter for touching off on X, Y and Z axes of every tool, front and rear. For most Swiss machines, that's done offline or inside the machine where space is limited, making access to the tool tips difficult. "You get your first piece off quicker if you're not making huge offset adjustments or trying to find where the real edge of your tool is," Fricke said.

Tessarzyk pointed out that unlike many Swiss machines, the Index and Traub ones don't have gang-style tooling where every tool in the holder, or gang plate, has to be adjusted individually in the machine. "It greatly increases the setup time because you have to do all the measuring in the idle time when the machine isn't running," he said. Instead, the machines come with a presetting tool and tools are preset for the next job outside of the machine while it's producing parts.

Once a bushingless machine is up and running, Lanute said cycle time can be reduced by using a high-frequency electric or pneumatic spindle that rotates up to 120,000 rpm instead

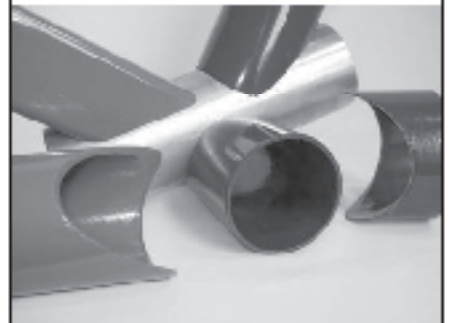
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of a 10,000-rpm mechanically driven spindle for cross milling, facemilling or drilling. "Our standard machine comes with the ability to have three spindles mounted in it," he noted.

The higher spindle speed is particularly helpful when applying microtools, such as a 0.003"-dia. drill. At 10,000 rpm, "you're going to break the tool or have a very slow cycle time," Lanute said. "With a 100,000-rpm spindle, I just reduced the cycle time by 15 to 20 percent because I can drill at the recommended surface footage."

Cycle time is also reduced because machines without a guide bushing allow more material removal with each

pass. Walz said this is possible with a Eurotech Elite machine because it has 7.5-hp spindles compared to around 3 hp on a traditional Swiss machine. "We have a little more horsepower than the typical Swiss machine, so you can take heavier cuts."

For simpler, shorter parts, cycle times for this class of machine can be in the 6- to 10-second range, according to Lanute. "That's competing with cam feeds and speeds," he said, "and because the bushingless design reduces accumulated error due to fewer moving parts, we're able to hold microns—which eliminates grinding."

Because a sliding-headstock

machine without a guide bushing is application driven, Tessarzyk emphasized that the machine "is not the cure for everything." For example, many manufacturers have multiple Swiss machines dedicated to producing one part day in and day out, and while Swiss machines without guide bushings may provide a significant benefit, a multispindle machine may be a better option. "If you run four Swiss machines on the same part, which probably requires two operators," he said, "you're better off running a CNC multispindle machine because the efficiency is much bigger and you only need one operator." △

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