

No Small Challenge

Growth of Swiss-style machining spurs tooling developments.

Developments for digital communication, medical and aerospace applications are shrinking in size and growing in sophistication. It follows then that the components that comprise them would also get smaller and more complex.

To make these tiny components, manufacturers are increasingly turning to Swiss-style CNC lathes. Industry sources say purchases of Swiss-type CNC machine tools are climbing by as much as 25 to 40 percent a year.

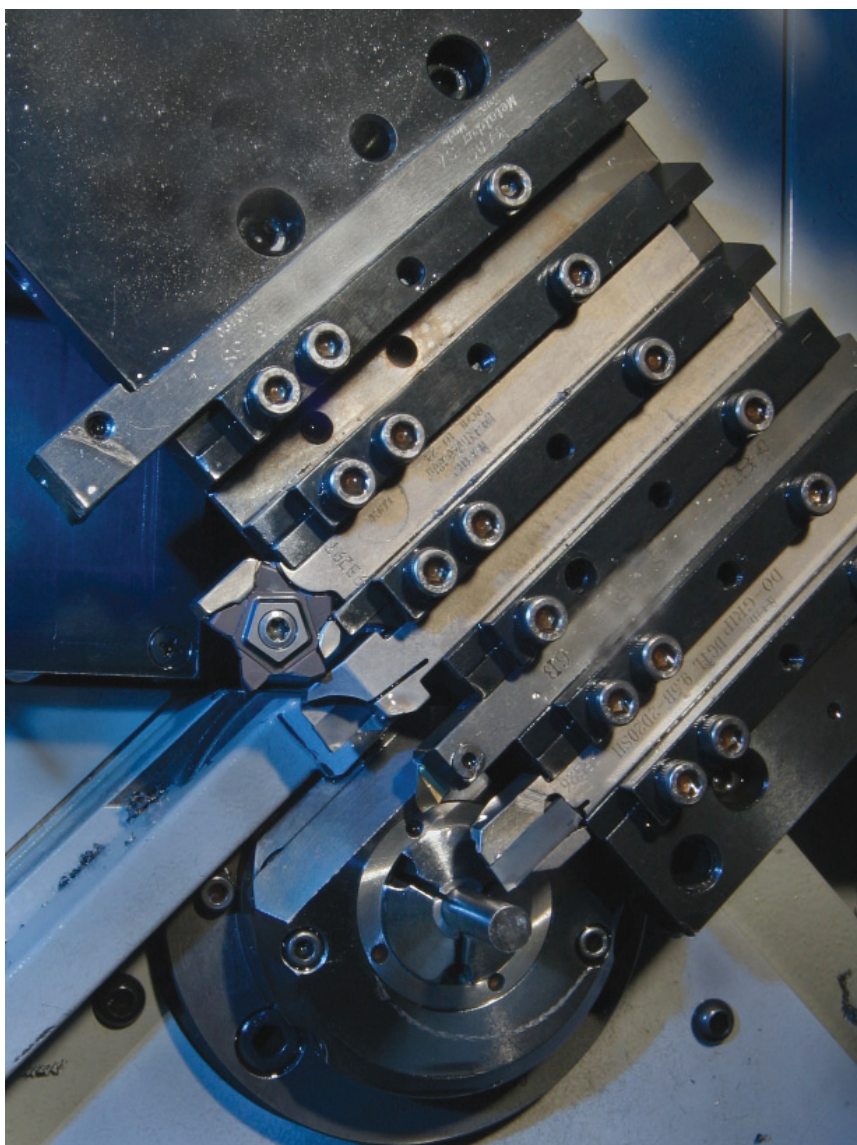
This growth has focused attention on the tooling used for these machines. To maximize rigidity and precision, tools must cut as close to the guide bushing as possible. Restricted space around the bushing limits the number of tools that can be mounted on the machine. And the close proximity of the tools to one another can complicate insert and toolholder changes.

In response to these challenges, tool manufacturers have developed a number of toolholder concepts specifically for Swiss applications.

Thinking Small

Toolholders for Swiss CNC lathes are different than those for conventional CNC machines.

“There is a premium on accuracy” with Swiss machines, said Steve Piscopo, business development manager for small part/precision machining at Sandvik Coromant Co., Fairlawn, N.J. He added that all parts of the cutting



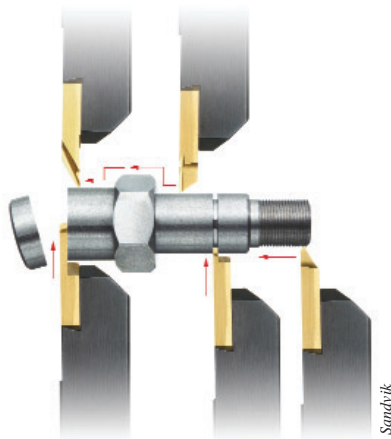
Toolholder array on a Marubeni-Citizen Cincom M16 Swiss CNC lathe at Evans Machining Service.

system have to be made more accurately, including the tools and holders.

Jan Andersson, Sandvik product specialist, said Swiss lathes put very specific demands on the toolholders. For example, an oversized holder will create fit problems in the machine. "Therefore," he said, "we have reduced the height and width tolerance on holders dedicated for these machines by about 50 percent, compared to standard holders." The tolerance contains no allowance for oversize dimensions, permitting only negative, or undersize, deviation from nominal size.

Considering the small size and tight tolerances of the parts being machined, exact location of the cutting edge is critical. Compared to standard holders, Anderson said, insert position tolerances in holders for Swiss machines are about 60 percent tighter in both the height and the f1 (relationship of the cutting edge to the tool centerline) dimensions. "If we compare this value to a standard ISO holder, this would represent about 20 percent of the tolerance allowed by ISO," Andersson said.

Rennie Elvin, national screw machine product manager and miniature-parts specialist for Iscar Metals Inc., Arlington,



In Sandvik's Corocut XS Swiss system, inserts capable of a variety of different operations fit the same holder.

Texas, said, "We can't use a standard ISO holder that we would use on a regular CNC lathe, because the insert actually protrudes from the side of the holder and would run right into the bushing."

Uptime Focus

Traditional cam-driven screw machines, the predecessors of Swiss CNC lathes, were designed for high-volume production runs. Today, Swiss machines are used for some high-volume runs, but their application generally reflects manufacturing's trend toward just-in-time sup-

ply and smaller lot sizes. The shorter-run scenario makes it critical to minimize changeover time.

Shops seeking greater uptime, Andersson said, "are interested in being able to either index the insert or change the insert style without taking the holder itself out."

That interest prompted Sandvik to develop its Corocut XS Swiss system, which features inserts that are engineered for turning, threading, parting off and grooving and all fit the same holder. "Going from one part to another, the system provides very quick setup time, because all you need to change is the specific insert for the operation instead of changing out both inserts and holders," Andersson said. The holders permit access to the insert screw from both sides of the holder, making it easy to index inserts in the machine without removing the holder.

Repeatability of insert location is high enough that only a touch-off to reset offsets is necessary before machining can resume. Andersson added that the inherent precision of the system will allow even faster changeovers, depending on part requirements. "The insert repeatability is 0.001", which, in many cases, is

Not simply Swiss

The productivity advantages of compact quick-change tooling are not limited to Swiss CNC machines. Bruce Woodward, senior metalworking systems engineer for Kennametal Inc., said the entire manufacturing industry is "highly pressed to cut costs," and that downtime for tool changes is expensive everywhere.

He cited the case of operations at Parker Hannifin's Electro-mechanical Automation North America (EMN) division, Irwin, Pa., where the KM Micro connecting mechanism is being applied in a configuration named KM25, engineered to replace conventional 1" solid-stick tooling on turret lathes up to 30 hp.

The connecting mechanism of the KM Micro quick-change system features tapered, coincidental cones that maximize the contact area between the shank and cutting unit by spreading the rear portion of the taper.



EMN produces linear stages, servo-motor-driven positioners and tables, ballscrew leadscrew tables, stepper drives and Cartesian robot systems. Workpiece materials include mild steels, aluminum

and some bronze.

Greg Moser, manufacturing engineer, said the motivation for adopting quick-change tooling was "quick changeover. We do a lot of small lots; 50 pieces would be a big order. We were looking to decrease setup time."

The shop currently has KM25 tooling fitted to three turret positions on a Hitachi Seiki Hitec-Turn 20S2 CNC lathe. Each position utilizes two different cutting heads, including two each for OD turning, threading and grooving. Changing cutting styles only requires switching cutting heads. Machinist John Guckert said he can change the cutting head, while leaving the shank in the machine, in less than 1 minute. This compares favorably to the 4 to 6 minutes it takes to change a conventional-shank tool.

Moser said the efforts to reduce downtime are part of the facility's continuous improvement process.

—B. Kennedy

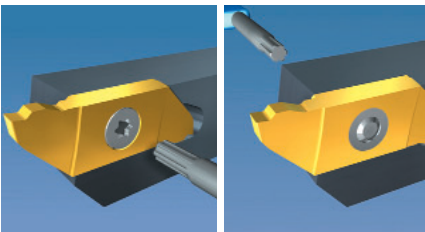


At Parker Hannifin's EMN division, John Guckert (left) and Bob Bayus inspect a KM Micro quick-change shank and cutting head.

sufficient,” he said. “If you have a part tolerance of ± 0.003 ”, why would you spend the time to touch off?”

Another Swiss-type lathe toolholder system that permits insert indexing without removing the toolholder from the machine is Swiss Cut tooling from Iscar. The insert can be clamped or released from either side of the toolholder. The insert has a threaded bushing, through which a screw pulls the insert into the pocket. An O-ring mounted on the screw prevents it from falling out of the pocket while the insert is being replaced. Inserts designed for different operations fit into the same pocket, often eliminating the need to change toolholders when preparing to machine a different part.

Evans Machining Service Inc., Clairton, Pa., uses the tooling. Dan Evans, the company’s vice president of production,



In Iscar’s Swiss Cut toolholders, options permit changing inserts from the front (left) or the back of the toolholder.

said quick changeover is important in operations on the shop’s Marubeni-Citizen Cincom C32 and C16 Swiss CNC lathes. Over the course of a year, Evans Machining makes over 600 different products, in varying lot sizes, for the military. “We are continually setting up and doing new parts,” he said. “With the Iscar system, you can change out a back-turning insert, put in a grooving insert and you’re ready to go.”

Allen Evans, the shop’s owner, said virtually no resetting of tooling is necessary between changeovers. Repeatability, he said, “is always within a couple of tenths,” adding that the shop has a tool-setting machine that seldom sees use.

A sure way to slow down insert changeover is to drop the insert or pin into the machine. “It’s hard to find,” said Tommy Townsend, president of WhizCut of Sweden USA, Little Rock, Ark.

As a preventive solution, he de-

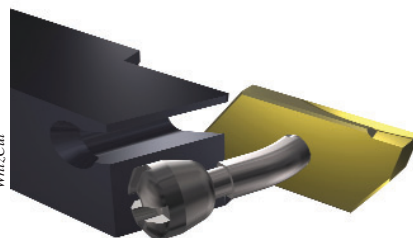


Dan Evans (left) and Allen Evans of Evans Machining Service discuss setup of Iscar Swiss Cut tools on a Marubeni-Citizen Cincom M32 Swiss CNC lathe.

scribed his company’s WhizFix Swiss toolholding system. The tool pocket features an open-ended longitudinal slot instead of a through-hole for the side-operated insert pin. The pin and insert remain connected throughout the indexing process. Townsend said the arrangement “allows you to operate the screw from the side opposite the chuck, slide the pin and the insert straight out, index the insert, slide it back in and lock it back up—all without moving the stick from its location. An experienced operator can do it in 12 seconds. The insert relocates almost perfectly to where you had it before, so you don’t have to go in there and do a lot of tweaking.”

Head Games

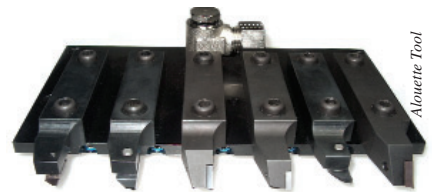
One method of speeding changeovers while maintaining accurate tool location involves leaving the tool shank clamped in the machine and changing a cutting head that holds a preset insert. Kennametal Inc., Latrobe, Pa., offers the KM Micro system, which consists of a tool shank and quick-change heads. Three turns of a Torx screw on the side of the holder releases the clamping unit.



In the WhizFix Swiss toolholding system, the insert and locking pin remain connected during indexing.

William Long, engineer in Kennametal’s Tooling Systems Engineering Group, said the connecting mechanism features tapered, coincidental cones that maximize the contact area between the shank and cutting unit by spreading the rear portion of the taper. The system best increases machine utilization, Long said, when users gage inserts offline, enabling them to replace the head and cut again without further gaging. Center-height repeatability between changes is better than $5\mu\text{m}$, he said, noting that “center height is what most people worry about. You’ve got to put the cutting edge on the center of the workpiece.”

A different approach to speeding changeover utilizes the toolholder as the active quick-change component. Alouette Tool Co. Ltd., a Fairport, N.Y., distributor of Swiss machining prod-



In the Tecko TTC system, two quick-lock screws release each toolholder from the baseplate. Depending on the size and model of the Swiss CNC machine to which it is fitted, use of the system can open up as many as four additional tool locations.

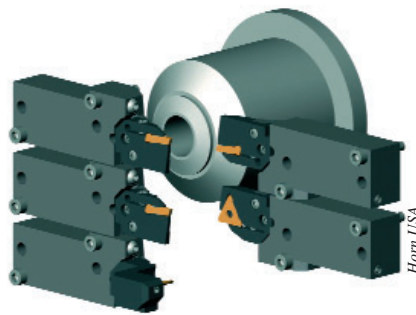
ucts, offers the Tecko TTS system from Swiss toolmaker Bimu SA, Tavannes, Switzerland. The system is for use on Tornos and Star Swiss CNC machines.

David Brogan, Alouette’s president, said the Tecko baseplate mounts in the machine in the space normally occupied by standard holders. A typical plate holds four Bimu toolholders, each secured by two quick-lock screws. Two turns of each screw permits removal of the toolholder, and then, Brogan said, “you can flip the insert, put the toolholder back in the machine, tighten those two screws and you’re ready to go again. You don’t have to go to the presetter because you’re going to be within $15\mu\text{m}$ of the last cutting edge.”

Chad Kmeic, plant manager at Merit Screw Machine Products Co., Broadview, Ill., said use of the Tecko system

at his facility has accelerated setups because operators do not have to go back to the presetter to verify the toolholder. On a Tornos Deco 10mm machine fitted with Tecko toolholders, Kmeic said "we have found that we do not have to take the tooling back out and get our preset measurements. We incorporate the geometry into the next program, possibly change to a fresh insert, and we are up and going. We don't have to touch off again." He said repeatability on fresh inserts is within 0.0003", enabling him to cut parts with 0.0005" tolerances without further adjustments.

In addition, Kmeic said, use of the Tecko system increases the rigidity of the entire cutting system. "It enables us to run at increased feed rates, and we ac-



Horn USA and Tornos Technologies worked together to develop tool blocks and toolholders that fit directly to the machine cross-slides, eliminating multiple toolholder interfaces and increasing toolholder rigidity.

toolholding system from Horn USA Inc., Franklin, Tenn., for Tornos Deco machines. Working with Tornos, Horn developed tool blocks and toolholders that fit directly to the machine cross-slides, eliminating multiple toolholder interfaces and increasing toolholder rigidity. For the smaller machines that handle 7mm and 10mm stock, monoblock holders employ 3-edge indexable inserts for external diameters. The 13mm, 20mm and 26mm machines offer more space for the holders, permitting the use of removable cassettes to hold the inserts and speed changeovers.

The More the Merrier

Usually, the more complex a part is the greater the number of tools required to produce its contours. The set number of tool posts in a Swiss machine can prevent a shop from using all the tools it needs to produce a part complete, but some toolholder systems address the issue.

Kennametal's KM Micro system is one example. In addition to the shank-and-head system described earlier, the tooling is also available in a flange-mount version that can be installed on new machines or retrofitted to existing machines. The flange-mount tool blocks take up less space and enable additional tool positions to be used within the conventional tool-block envelope. Kennametal says that compared to a standard setup, flange-mount tools on a dedicated tool block can provide an additional one to three tool positions.

The Tecko system provides similar benefits with respect to tooling capacity. A baseplate that holds four tools bolts into the space of three standard holders, leaving a standard tool position open. The new total of five tools provides greater machining flexibility. Depending on the size and model of the machine, the Tecko system can open up as many as four additional tool positions.

Using existing tool positions in a non-standard way is another method to boost the tooling versatility of a Swiss machine. Kyocera Industrial Ceramics Corp., Mountain Home, N.C., has introduced a line of external turning, grooving, threading and profiling tools designed to fit in the tool-post positions originally engineered to hold round-shank tools used for internal machining.

Brian Wilshire, Kyocera technical



Round-shank toolholders with inserts for external turning from Kyocera fit tool positions designed for tools made for internal machining.

center manager, said some shops try to use standard boring bars to achieve the same effect, but the distinguishing feature of the Ceratip tools is a closely controlled center height. Many boring bars are set above center to facilitate the boring operation, Wilshire said, and that can cause problems when turning where "you don't want to be above center, particularly on a small-diameter part."

He noted that center-height tolerances of standard bar and insert combinations are in the range of ± 0.005 " or larger. On Swiss machines, where the part diameter can be 0.020" or less, "0.005" above center, percentage-wise, is huge. It can have an effect on tool life and part size."

For further height control, Kyocera has introduced a line of inserts made to a ± 0.001 " center-height tolerance.

The following companies contributed to this report:

Alouette Tool Co. Ltd.

(585) 388-1240
www.alouettetoolco.com

Evans Machining Service Inc.

(412) 233-3556
www.evansmachine.com

Horn USA Inc.

(888) 818-HORN
www.hornusa.com

Iscar Metals Inc.

(877) BY-ISCAR
www.iscarmetals.com

Kennametal Inc.

(800) 446-7738
www.kennametal.com

Kyocera Industrial Ceramics Corp.

(800) 823-7284
americas.kyocera.com/kicc/

Merit Screw Machine Products Co.

(708) 344-9170

Sandvik Coromant Co.

(800) SANDVIK
www.coromant.sandvik.com/us

WhizCut of Sweden USA

(800) 592-8840
www.whizcut.com

“With approximately ± 0.001 " on the holder as well, we can get much closer to center height without tedious measurement,” Wilshire said.

Wilshire added that when turning a larger part (0.25"-dia. or greater), an approximate total of ± 0.002 " center-height tolerance is not large relative to the part diameter. Depending on the part, it may

be possible to install and use one of the new round-shank tools without further adjustment. “If you can reduce setup time and also create new tool positions, it makes it easier for the operators, as well as the programmers,” he said.

Sandvik’s Piscopo said that developing toolholding systems for Swiss CNC machines is “a constant chal-

lenge. The perception is that these are very small, slight machines and applications, but in many cases, you end up with a bigger DOC or some odd tool combinations.”

Tool designers face “interesting contrasts that are out of the norm,” he said, adding that it is a certainty that “parts are always going to get smaller.” \triangle