Programming Key To 7-Axis Swiss Productivity

Multi-axis Swiss-style machines can mean huge savings for job shops producing complex parts. However, an Indiana shop shows that to get the most from these machine tools, efficient programming is essential.

Boyer Machine and Tool Company (Columbus, IN) has achieved dramatic productivity improvements by reducing the number of setups needed to machine typical complex parts from three to one using 7-axis Swiss lathes.

Previously, the parts typically required two lathe setups to machine each end of the part and at least one setup on a machining center for features that needed milling and drilling. Now, the lathe uses a spindle, a sub-spindle and live tooling spindle that all operate simultaneously to machine the part in a fraction of the time without operator intervention. The move to 7-axis Swiss lathes has increased the complexity of CNC programming, but Boyer has reduced the time to program typical complicated parts from 18 hours to only 2 hours by switching to a computerized numerical control (CNC) programming system that supports the latest lathe features.

To maximize the productivity potential of multi-axis Swiss-style machines, programming capability is essential to profitability.

John Boyer, vice president of Boyer Machine, notes, "The ESPRIT programming system supports all the features of our most advanced lathes, so we simply select the surfaces that we want to machine and the software then produces the program using the full capabilities of the machine."

Boyer is a full-service, all CNC machine shop, that has been family owned and operated since 1945. Boyer has 36 employees and specializes in producing smaller high-precision components on some of the world's most advanced CNC turning equipment.

For example, the company uses several Citizen sliding-head CNC Swiss lathes with barfeeds. The versatility of these machines allows complex components to be produced completely in a single setup during unattended operation, generating substantial cost reductions, which Boyer is able to pass along to its customers.

Previous Programming

The first CNC machines purchased by Boyer Machine had to be programmed writing G-codes by hand, using a calculator to determine the geometric positions. The company purchased an early CNC programming system and found that it saved time on simpler parts but was not able to handle more complicated

parts and machine features. Therefore, it continued programming the more difficult parts with G-codes, although CAD software was used to calculate geometric features. However, the complexity of the parts ordered by its customers continued to increase and machine manufacturers added powerful new features that increased the productivity but also the programming challenges of their machines. Boyer soon discovered that it was programming the vast majority of its parts by hand.

"We needed to find a programming system that was capable of handling the most complex parts demanded by our customers while supporting powerful new features provided by our machine suppliers," Boyer said.

Boyer evaluated the leading CNC software packages on the market. "Esprit stood out because of its ability to take advantage of the most advanced capabilities of our multi-axis, mill-turn turning centers without having to manually write code." Esprit SolidMillTurn and SolidTurn can program any combination of mill-turn (2- through 5-axis) and turning cutting cycles, using one or more spindles with multiple turrets (up to 22-axis), in one session complete with synchronization, optimization and solid simulation. "C"-axis rotary milling offers wrap pocketing, contouring and drilling for use on the face or OD of parts. Esprit's full 5-axis control makes it possible to program parts demanding compound angles or non-perpendicular multi-axis tool movements.

Swiss Machine Challenges

Boyer's Swiss machines present the greatest challenges to the new software package. The company performs an increasing proportion of its work on these machines because it has experienced a high demand for smaller, complicated, high-precision parts, especially from medical device manufacturers.

"We can now typically program a part of this complexity for 7-axis lathe in about two hours."

A typical component produced by the firm has four milled lobes on both the inside and outside diameters of the part. Each lobe has three distinct radii to be machined, one covering the main surface of the lobe and the other two in the transition areas where it blends into the adjacent lobe. A shoulder is counter-bored into the inside diameter. There is also a hole extending through the part, and flats are machined onto the hole so the part can be locked onto the shaft. There are also a number of other features machined on the outside diameter and both faces of the part.

"This part is ideally suited for the capabilities of today's latest Swiss machines such as the Citizen L32," Boyer says. "In the past, the part would have required two setups on a turning center to produce the two ends of the part; then at least one more setup on a machining center to machine the lobes and flats. The Citizen L32 has a main spindle, a sub spindle, supports five main spindle turning tools, four live tools, three centerline main spindle tools, and five sub-spindle tools, turning parts up to 1.25" diameter and incorporating a 12' magazine type bar feeder.

Single Setup

"We can produce the entire part with one setup," advises Boyer. "First, the part is chucked in the main spindle and turned. Then the live tooling moves in and machines the lobes and flats. Then the part is moved to the sub-spindle, while the opposite face is machined. At the same time the machining is being completed in the sub-spindle, the main spindle is starting on a new part. This approach allows us to produce the part remarkably quickly with minimal operator attention, which helps us keep the costs low. But programming these complex features on the machine used to be a major obstacle."

Boyer trained several programmers to access the capabilities of the 7-axis Citizen Swiss lathe using G-codes. The programmers used a solid model of the part to determine geometrical coordinates required to generate machine moves. Nevertheless, it was still a very long and tedious process to write the code needed to program the machining operations. Programmers had to type in the geometrical coordinates for each of the machine moves.

The entire process took an average of 24-hours. Once the programming was completed, an extensive testing process had to be performed on the machine before actual parts could be produced. This was because it was so easy to make errors, such as mistyping a coordinate, which could cause a crash that could damage a tool or even the machine if the part was produced without testing. The programmer could also easily forget to machine a feature on a complex part.

New Software

Esprit has dramatically streamlined the programming process for this and similar parts that are produced by Boyer.

With the new software, the programming process begins by importing the native solid model in Esprit. The CAM software then automatically recognizes the features in the part geometry such as pockets, islands, profiles, part boundaries, holes, etc. The software automatically organizes each feature into a tree. The program then picks each; selecting each feature of the part in sequence and picking a tool to machine it from a graphical representation of the Citizen Swiss lathe.

The knowledge base that is included with the software automatically generates typically machining parameters, including cutting speed, feed rate and depth of cut. Boyer programmers check the parameters and often make changes based on their knowledge of the cutting tools and materials used in the shop.

Once the operations are defined, the programmer sorts them into the order in which he wants them performed.

Push-Button Toolpaths

When the programmer finishes defining a program, he pushes a button; Esprit generates the toolpaths and G-Code needed to machine the part.

The programmer then simulates and verifies the G-Code program inside Esprit, viewing each cutting tool being loaded and taking its assigned cuts along with the entire machining environment in dynamic 3D solids. In some cases, he may see that the final geometry does not exactly match the design intent so he goes back to the initial part geometry, makes a small change and pushes another button to update the program. In other cases, he might see an opportunity to reduce machining time by moving a feature to a different tool or changing the order of operations.

"We can now typically program a part of this complexity for a 7-axis lathe in about two hours," Boyer says. "This represents a dramatic reduction in programming time and the time to test the program on the machine is also greatly reduced because simulation helps us nearly always get the program right the first time. CNC programming has become one of the strengths of our company, helping us out-compete most other contract machining companies." *DP Technology Corp.*

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Marubeni Citizen Acquires Brookdale Associates

Marubeni Citizen-Cincom is proud to announce the acquisition of Brookdale Associates. This acquisition will be a joint venture with Citizen Machinery Co. Ltd and Marubeni Corporation.

Brookdale Associates has been a leading distributor for Marubeni Citizen-Cincom (MCC) for more than 20 years. With the cooperation of the MCC Tech Center, they have developed many tooling accessories, including the Cool Blaster high pressure pumps, which have made Cincom products more productive. The synergy between the two companies will bring value added engineering capabilities to MCC distributors and customers throughout North America.

Left to right, seated: Jim Sasanecki, Pat Sasanecki, Hiroshi Shinohara. Standing: Yutaka Nakamura, Shinya Izumi, Kenji Sugimoto, Atsuya Abe, John Antignani, Shigeyuki Baba, Matt Hiroshige.

An official signing ceremony was held at the Brookdale facility in Agawam, MA on Nov. 18, 2005. Those present were Yutaka Nakamura (Citizen Machinery), Shinya Izumi and Shigeyuki Baba (Marubeni Corp), Kenji Sugimoto (Citizen Watch Co.), Atsuya Abe, John Antignani and Matt Hiroshige (MCC) and Jim and Pat Sasanecki (Brookdale) in addition to Brookdale personnel and guests. The ceremony was concluded with a luncheon for all in attendance.

The new company will be called Citizen Machinery America Inc (CMA). Jim Sasanecki of Brookdale is expected to stay on as V.P. of Engineering. Mr. Hiroshi Shinohara of Citizen Machinery Co. Ltd will be President, and John Antignani of MCC will be Executive Vice President. This new company will support MCC's efforts and help maintain Cincom's number one position in the North American swiss type market.

The new company (CMA) will occupy the same Brookdale facility and will continue to operate with the same sales, service and engineering personnel providing continued service to the New England customers on Citizen, Wasino and Eurotech products.

For more information about Marubeni Citizen-Cincom and their full line of widely accepted swiss-type turning centers, please go to www.marucit.com.

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Item	L20 V	L20 VII/VIII
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Max. machining length	200 mm (7.87")	200 mm (7.87")
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Back spindle speed	8,000 rpm	8,000 rpm
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