▶ BY GREG LANDGRAF, ASSOCIATE EDITOR

IN CONTROL

CNC customization simplifies machine operations and enhances features.

The need to improve manufacturing processes drives virtually all shop activities. Machine tool controls are no exception.

It is a period of great potential for controls. They're becoming less complicated, and more people better understand the computing technology that goes into them.

The result is an improved ability to get more out of machine tool controls than ever before. In a word, customization.

Customization Made Simple

Gains in computing power help. And Moore's Law, which observes that the maximum computing power of an integrated circuit doubles roughly every 18 months, is still a valid description of the exponential gains that microprocessors are making.

That power makes the controllers easier to work with. It's similar to the evolution of computers for business purposes. When computers were first invented, there wasn't any spare power to devote to making the interface easy to use.

Many CNCs are now PC-based. They can be customized by programming in high-level languages like Visual Basic, C++ or Java, instead of the more complicated assembly language previously needed.

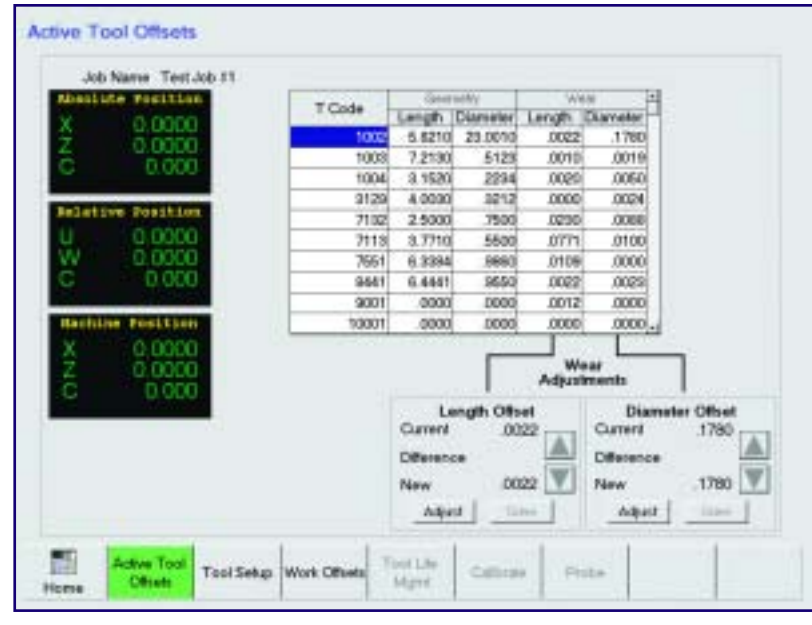
"It's a virtual representation of the CNC, so you don't need CNC expertise," said Jay Clark, president of motion-control software maker ROY-G-BIV Corp., Bingen, Wash.

High-level languages such as Java and C++ are commonly the first languages learned by computer science students. Visual Basic is also widely understood. "Microsoft Excel has a macro language—Visual Basic for Applications—that allows the development of little programs," Clark said. "For example, you could develop an application in Excel to pull information out of the controller and drop it into an Excel spreadsheet."

There are even some off-the-shelf packages that can aid in customization. "We have some PC-based tools that the customer could use to customize the human-machine interface," said Ryan Legg, machine tool industry marketing manager for Mitsubishi Electric Automation Inc., Vernon Hills, Ill. Some off-the-shelf packages, he added, allow a user to simply drag-and-drop the displays they want and associate them with a function.

"Customizing used to require an intense skill level," Legg said. "I'm not saying a monkey could do it now, but it's become a lot easier."

Legg said there is little difference between the potential customization that can be achieved with an off-the-shelf package and by coding in a programming language. "A good programmer, even with the off-the-shelf products, can



CNC Engineering

CNC Engineering's Open Vision human-machine interface allows offset adjustment, tool picture display, optional probing routines and an active tool list.

achieve a high level of customization," he said. When performing that high level of customization, however, the required skill level is comparable as well, Legg noted.

The move toward open-architecture systems will also help. By standardizing the data used by a controller, it will become easier to produce custom applications that run on top of the basic software (see sidebar).

Custom Applications

The applications for customizing CNCs are limited only by the skill and imagination of the programmer. Many, such as customized interfaces, have widespread potential benefits and, consequently, are common. Others, such as spindle analysis, are more specific. Following are several potential applications.

CUSTOM INTERFACES. One of the most widespread modifications made to CNCs is to customize the human-machine interface (HMI). "The birthmark was developing custom operator interfaces on PC-based controls," ROY-G-BIV's Clark said.

"I know of some big corporations that are looking at development of custom user interfaces," said Bob Tain, product manager at Okuma America Corp., Charlotte, N.C. "They want every machine to have the same look and feel."

Pat Harrington, vice president of sales for control integrator CNC Engineering Inc., Enfield, Conn., said, "One company bought two machines from different manufacturers and put them into a single cell. We put a PC front-end on to make them look identical."

One immediate benefit is ease of use,

Open wide

RS274 touches anyone who uses a CNC machine—but it soon could be history.

RS274 is the programming language that contains the traditional G and M codes—the codes that define the machine and program functions. It's the standard CNC language, but it has a serious flaw.

"Almost no one adheres to the pure standard because it's outdated and has almost no functionality," said Terry Gustafson, executive director of the machine tool work group for the OMAC Users Group, an association working to develop open-architecture guidelines for machine tool controls.

STEP Tools

STEP Tools says its ST-Developer software cuts costs and programming efforts for building, maintaining and operating STEP applications.

RS274 basically provides the necessary information for a point-to-point toolpath. "Our goal is to use STEP [Standard for Exchange of Product Model Data] standards to combine the toolpath and part geometry," Gustafson said. That would incorporate toolpath compensation and machine tool dynamics, he added.

The standardization that open architecture provides promises to facilitate customization. "We're concerned with how information is presented down the wire," Gustafson said. An example is whether a specific piece of data is reported as a real number or a double-precision integer.

If the same type of data—representations of part geometry, for example—is reported in a standard format, then any controller configured to the standard can read and use that information. "Custom modules and applications would be much more flexible and easier to integrate by adhering to proposed standards," Gustafson noted.

"By providing richer information, you provide more scope for controls to be intelligent," said Martin Hardwick, president of software provider STEP Tools Inc., Troy, N.Y. "What you get is a very high-level description of the task that can be dropped onto any machine physically capable of making the part."

He said the first application will likely be to improve machining accuracy. "You get a full definition of the surface, so the machine can keep itself closer to the surface," Hardwick explained. He noted that the data volume required will actually be reduced, because it requires fewer interpolations to include the actual surface data than to determine it based solely on the toolpath.

Custom operations are another possibility. "Say you've got a group of three holes," Hardwick said. "You could define the feature and any variable parameters and then describe the custom operation for it." A high-level description, facilitated by the open architecture, makes it possible to run that operation on a machine specialized for it or on a more general machine.

Programming will be easier, Hardwick said, because there will be fewer details the programmer needs to describe. It also will make the operator's job easier, because he can see the toolpath instead of just the codes. "That's one reason people are reluctant to go to 5-axis machining—the codes are hard to understand," Hardwick said. "Or high-speed machining—the codes come too fast."

Open architecture is still an emerging development, Hardwick said. "We have the ability to create data files and have demonstrated potential savings. There's still some work to do before we have widespread applications."

Gustafson said most major controller vendors are part of OMAC, and a couple are pursuing pilot projects. The group is also seeking end users' feedback. "We want to work on the right problems," he said.

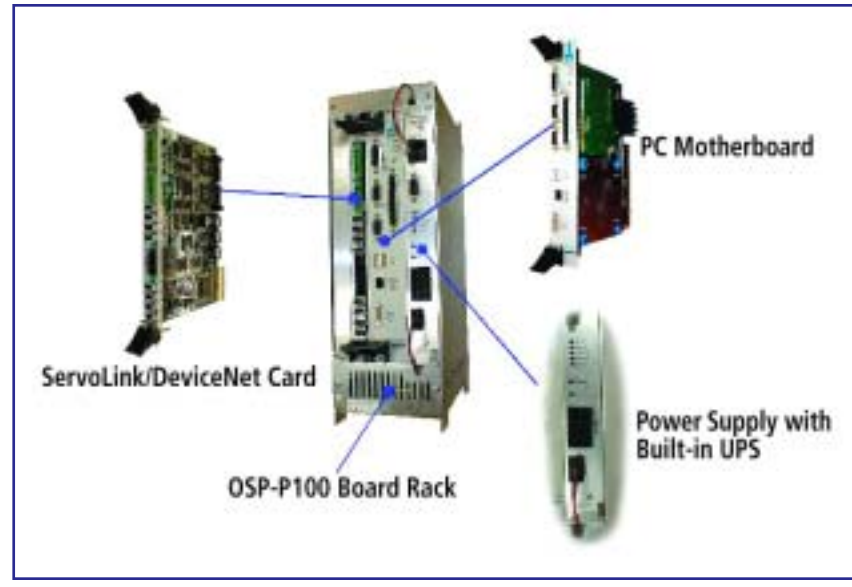
—G. Landgraf

because the control can be customized to work like one the operator is already familiar with. That, in turn, reduces the training required. It also can make it easier to switch from one machine to another.

"The cost savings potential is dramatic," said Clark.

Customized HMIs can be effective on single machines as well. Harrington described a control his company customized for a remanufactured grinding machine. "We ran the standard CNC in the background, and a simple display with soft keys (buttons with labels that the controller changes as situations warrant) on top," he explained.

Harrington said the controller only requires the operator to push buttons and enter data where appropriate. Details such as spindle speeds and feed rates are still available one level below—easy to access if needed, but out of the way so it won't confuse or overwhelm the operator with unneeded data.



Anatomy of an open-architecture CNC bus.

REMOTE OPERATIONS. An increasingly common feature on machine tools is one that lets the builder diagnose problems remotely.

"These applications have some level of standardization, but they need to fit into the customer's scheme," said Mitsubishi Electric's Legg. "Maybe they want it interfaced so we at Mitsubishi are monitoring. Others want the [machine tool builder] to do it, and in some cases they want both."

There are also options for the "alert" mechanism, Legg said. The control can be made to sound the alarm only when an error occurs, for example, or it can dial in automatically at set times to be checked.

Customization also makes it possible to control the machine remotely. "You can go into the user interface from anywhere," said Okuma's Tain. "You can couple it with video or a cell phone, or open it up to the machine tool builder."

FILE MANAGEMENT. Networked equipment can introduce complications for the operator, because specific files need to be moved to—or kept in—specific locations. "It can hinder operators if they're not strong with Windows," said Jody Romanowski, manager of the Manufacturing Software Division of Machinery Systems Inc., Schaumburg, Ill. "Companies don't want people in the file manager."

To make it simpler, Machinery Systems has created custom applications that the operator can use to move files of one specific type from one application to another. It's a safer approach as well, because files won't be misplaced.

Digital file management also reduces paperwork. "Right now, the biggest thing people are looking to do is move into a paperless environment," said Tain.

ERROR IDENTIFICATION. ROY-G-BIV's Clark said one customer uses an application to alert the operator of a machine with a manual toolchanger if he was about to choose an inappropriate cutting tool. The Visual Basic application reads the tool's bar code and then compares tool data to the part program to determine if it is possible to make the feature using the tool the operator is about to apply.

SETUP IMPROVEMENT. When The Timken Co.'s Industrial Services Division, South Bend, Ind., had a grinding machine rebuilt, the work included controller customization to improve tool location and setup. "We were after a dramatic reduction in setup time," said Phil Jackson, the division's engineering group leader.

Timken uses the machine to grind the race surfaces of the inner rings for large bearings used in heavy industrial applications. One of the customizations, which CNC Engineering performed, added a coordinate system for both the dresser and the part. "Before the rebuild, all setup was mechanical," Jackson said. "One component 'knew' noth-

The following companies contributed to this report:

CNC Engineering Inc.
(860) 749-1780
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Machinery Systems Inc.
(847) 882-8085
www.machsys.com

Mitsubishi Electric Automation Inc.
(847) 478-2100
www.meau.com

Okuma America Corp.
(704) 588-7000
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OMAC Users Group
www.omac.org
(318) 635-7800

ROY-G-BIV Corp.
(509) 493-3743
www.roygbiv.com

STEP Tools Inc.
(518) 687-2848
www.steptools.com

The Timken Co.
(219) 288-7188
www.timken.com

ing about where the others were. Now, we can take the wheel off and, 6 months later, put the part back on and the machine will remember the position."

Also, Timken incorporated an acoustic emission control to aid in dressing the grinding wheel. Instead of having to dress to position, the control tells the dressing tool to approach at an accelerated rate until the control captures an acoustic signal, indicating the position is close and that the dresser should slow its approach.

The net result was a dramatic reduction in setup time. Before the modifications, setup took 3 to 4 hours. "Now the setups average an hour, and have been completed in less than 15 minutes," Jackson said.

MACHINE MONITORING. "If I can analyze why the spindle's not being used to capacity, I can make more money," said Okuma's Tain. A custom application can reach into the application program interface to gather and present that information. Other process data that needs to be analyzed can be gathered in the same manner.

"Many control suppliers have packages if the end users don't want to do it themselves," Tain said. Third-party integrators can develop the data acquisition packages as well.

DATABASE OPERATIONS. Databases offer another facet to customization. For example, Fanuc controllers allow 4-digit tool codes, CNC Engineering's Harrington said. "If the customer uses an alphanumeric [code] system, we can create a database to translate from one to the other in the background," he added.

The same principle can apply for procedural shifts, such as a grinding process with 100 set points. "If one [point] moves, traditionally you'd have to adjust 100 programs," Harrington said. "With a database, you can just adjust one and the database will do the rest."

The Future of Customization

Computing power will continue to increase exponentially for at least the immediate future. As a result, machine tool controls will continue to become smarter and more flexible. Advancements are coming from machine tool builders, software vendors and the academic community.