MAY 2007 / VOLUME 59 / NUMBER 5

Custom Control

➤BY BILL KENNEDY, CONTRIBUTING EDITOR

Heidenhain

CNC providers offer a variety of human-machine interfaces engineered for ease of use. An example is this HR 410 portable handwheel from Heidenhain that enables an operator to move axes in small increments via turns of a handwheel and to make the changes with no need to stand at the machine's control panel.

CNC makers enhance and adapt their technologies to serve a range of shop needs.

Asking "What CNC is best for my shop?" is like asking "What car should I buy?" Vehicle choice depends on your specific requirements and skills, considering whether you want to carve up twisty roads at high speed or simply haul the soccer team to practice. To serve diverse markets, carmakers continually develop new technologies.

CNC development is much the same, with manufacturers serving a wide range of end-user operations. At one end are enhancements aimed at achieving high cutting speeds and accuracy levels for complex parts, and on the other end are improvements in the human-machine interface (HMI) and software products that simplify programming.

Control Choice

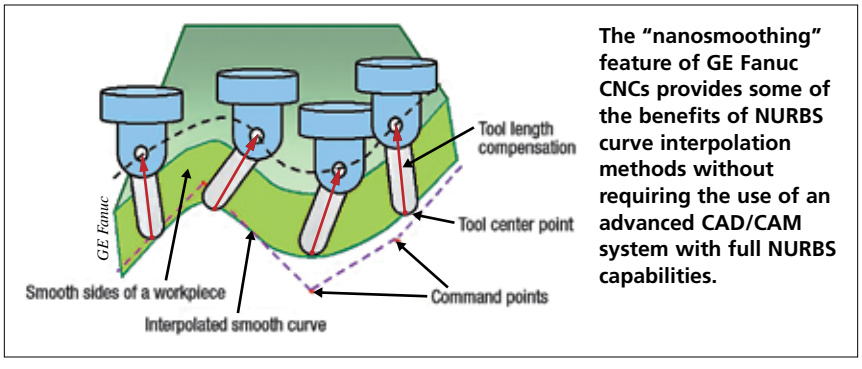
According to Chris Weber, national sales and product manager for the machine tool division of Heidenhain Corp., Schaumburg, Ill., the operations being performed determine the control strategy. Simple jobs—such as hole-making, facing and 2-D milling—can easily be handled by a point-to-point control, such as Heidenhain's TNC

124. The operator can control three axes manually with axis buttons, and no programming is required. For more complicated jobs, NC programs can be generated and stored at the control.

Complex jobs require CNCs such as the company's iTNC 530 control, engineered for 5-axis simultaneous contouring and high-speed machining. CNC users at this level continually seek ways to more fully exploit the capabilities of high-performance machine tools.

To that end, Heidenhain recently introduced updated software with enhanced features, including adaptive feed control that measures spindle load by monitoring current draw. When the machine is operating at a programmed feed rate and a significant drop in spindle load occurs, it generally means the tool has moved out of the workpiece material and is "cutting air." In that case, the control will assume a rapid advance mode until the tool resumes contact with the workpiece.

"The opposite is true, too," said Weber. "If markedly higher spindle loads are detected, the control automatically slows down the feed rate to protect the spindle motor and tooling."



The "nanosmoothing" feature of GE Fanuc CNCs provides some of the benefits of NURBS curve interpolation methods without requiring the use of an advanced CAD/CAM system with full NURBS capabilities.

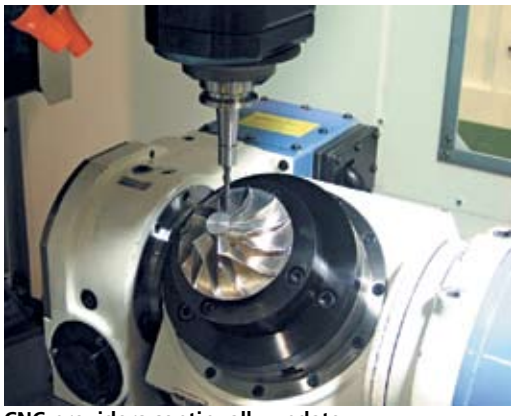
He noted that controls above the entry level should have certain basic features, including Ethernet connectivity to permit large part programs to be imported from an off-machine computer or server, combined with sufficient on-board storage to host those programs for execution.

"Our position is that the control is not a storage device; it's an execution device," said Weber. "A program is stored on the server and is downloaded to the control to execute it. A control must have enough memory to hold the part program you are executing, and maybe to hold a couple of other programs that you want to edit at the machine."

What constitutes sufficient memory is job-dependent. For example, in high-precision mold machining featuring small incremental step-overs in the toolpath, programs can be huge. Weber said the iTNC 530 control has a 30-gigabyte hard drive to handle such large part programs.

The high-end machining typical in the mold and die and aerospace industries requires a control's central processing unit (CPU) to quickly process massive amounts of data. Ryan Legg, machine tool industry strategic accounts manager for Mitsubishi Electric Automation, Vernon Hills, Ill., said the company's 700 series controls feature a block processing rate of 135,000 blocks per minute, which he said is twice as fast as Mitsubishi's previous generation control, introduced 8 years ago. The reduced-instruction-set-computing (RISC) CPU is linked to a high-speed optical servo network and programmable logic controller (PLC) engine, as well as a new generation of servo and spindle amplifiers that significantly reduce cycle times. Legg described controller technology as "an ever-improving process."

Randy Pearson, marketing/applications engineer for the machine tool business unit of Siemens Energy & Automation, Elk Grove Village, Ill., said many advances in control technology are occurring in full-contouring 5-axis, higher-speed machining. He cited Siemens' development of 5-axis transformations that allow users to focus on the profile of the surface being machined rather than the mechanics of the machine tool being used.


GE Fanuc

CNC providers continually update hardware and software to facilitate 5-axis machining.

Pearson explained that traditional CNCs require a postprocessor that converts the CAM data defining a part to the commands required to move the machine axes. During the conversion process, some data is left behind, and part accuracy can be affected. Siemens' 840D controller is engineered to directly accept part data via a 5-axis kinematic translator called TRAORI (transformation number, orientation vector, rotary axis offsets). Access to more complete part data enables the control to calculate smooth and accurate toolpaths, according to Pearson.

He said the system is useful for running the same part on different machines. Without the 5-axis transformation technology, "for every machine with different mechanics and different tooling, a shop would have to write a specific program to run the part," said Pearson. "They may be reposting the same program four, five or six times to run it on different machines. With 5-axis transformation technology, the shop can use different machines and different tools and cutters because the control can compensate for them."

Paul Webster, CNC product manager for GE Fanuc Automation Inc., Charlottesville, Va., said manufacturers are moving away from using multiple stand-alone machine tools and toward performing complex operations on a single multitask machine. In multitask machines, tooling, parts and fixtures may be in constant motion, so CNC manufacturers are boosting the capability of their controls to perform interference checks. Tool offsets, fix-

ture positions and other factors are integrated into the control to "make sure that the machine is secure and cutting the way you want," Webster said.

He added high-speed machining is increasing manufacturers' interest in "higher resolution, nano interpolation, higher block processing speeds and larger buffers so they can put more complex programs in the machine and still cut accurately at very high speeds." Webster pointed out that interpolation programs based on non-uniform rational B-splines (NURBS) mathematical models are an accepted way to accelerate complex machining. However, he said, many shops "can't afford or don't have the CAD/CAM system to be able to do NURBS interpolation."

For these shops, Fanuc offers a "nanosmoothing" feature in its controls that provides some of the benefits of NURBS methods. "It actually uses a standard part program, but then does a NURBS-fit curve to that program," he said. The method estimates the original free-form curved surface using the minute line segment program created in the CAD/CAM system, then interpolates the generated curves in nanometers. Nanosmoothing, Webster said, provides "a lot of the advantages of NURBS without having to have the advanced CAD/CAM system required for a full NURBS package. Because it isn't a true NURBS program, you don't get some of the reduction in part program size, but you do get some of the advancements in part accuracy."

The following companies contributed to this report:

GE Fanuc Automation Inc.
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Haas Automation

At WESTEC 2007, Haas Automation equipped an EC-400PP HMC with a prototype version of an Internet-based "inspect and change" interface that enabled use of a Blackberry wireless device to view data related to running G-code programs.

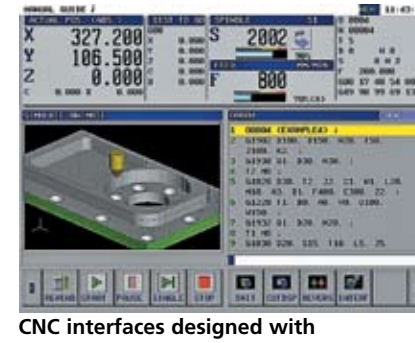
Connectivity and interoperability are becoming watchwords in the metalworking industry. Kurt Zierhut, director of electrical engineering at Haas Automation Inc., Oxnard, Calif., said, "More and more customers want to connect their machine tools to their network, if not the Internet." Zierhut noted that interoperability was a featured topic at the January 2007 regional meetings (held in six locations) of AMT—The Association for Manufacturing Technology. Discussions covered methodologies that would allow various controls, sensors, applications and other platforms to readily communicate with each other.

Haas exhibited an example of such a system at WESTEC 2007 in Los Angeles, equipping a pallet-changing (6-station pallet pool) EC-400PP HMC with a prototype version of an Internet-based "inspect and change" interface linked to information contained in the machine's CNC. The arrangement enabled use of a Blackberry wireless device to view data related to running G-code programs via macro variables. Information—including run time, alarms, temperature and loads—were available outside the machine via the Web. Zierhut said the approach is a way to access machine information on a wider basis, integrate it into overall operations and solve the "machine is an island" problem.

End-user demands for increased communication and integration are drivers for a new series of modular CNC CPUs from Mitsubishi Electric Automation, whose products include motion, robotic and programmable logic controllers as well as CNCs. Legg said a number of customers, especially larger facilities employing multiple motion control technologies, want to integrate their controls. In response, Mitsubishi introduced a CNC central-processing module that plugs into its PLC rack-style platform. The C70 module uses the same HMI as other Mitsubishi controls, and the common platform permits fast and simple changeovers of motion control technology, according to the company. The modular system also includes a general-motion-control CPU, and a robotic controller is under development. Legg said the system is "targeted to applications where multipath control is needed" and is intended for customers who use a variety of PLC and CNC technology in one plant to manage machining centers, transfer lines and other equipment.

Ease of Use

Some shops, however, are less concerned about integration and



GE Fanuc

CNC interfaces designed with straightforward controls, interactive screens and graphic simulation, such as this Manual Guide i interface from GE Fanuc, enable an operator to input, test and execute a program without comprehensive knowledge of G-code programming.

connectivity than about finding operators to run their machines. With a shortage of trained machinists, many shops need machine controls that are as easy as possible to use, said Haas Automation's Zierhut. "This is really the thing we are hearing the most; it has always been a consideration in what we build," he said. "We needed to make our machines more intuitive to get the larger user base. This drives us to improve the ease of use for low-experience machinists."

Haas designs and builds both the hardware and software for its CNC systems. Hardware development focuses on user-friendly concepts, such as keyboard standardization among the company's machines. Software enhancements include the new Intuitive Turning and Intuitive Milling systems, which guide the operator through basic machine functions and machining operations using a single tabbed screen and do not require knowledge of G code.

Also addressing ease-of-use issues, GE Fanuc recently introduced the Manual Guide i operator interface. The HMI's straightforward controls, interactive screens and graphic simulation enable an operator to input, test and execute a program within a third of the time required in a standard CNC ISO (G code) environment, according to the company. GE Fanuc's Webster said the system "doesn't program for you; it asks you questions about how you want to program and tells you what your format should be, so it allows you to use preprogrammed cycles for pockets, hole patterns and facing." The interface enables an operator to work effectively without "having to be 100 percent up to snuff on every programming feature on the control," he said.

Mitsubishi Electric Automation

In addition to part-programming assistance (left), CNC screens can provide process-simulation information (upper right) and troubleshooting procedure assistance

Retrofit Alternative

Taking advantage of new CNC technology at any level doesn't necessarily mean buying a new machine. "For every shop, there is a different threshold as to where retrofitting makes sense," said Heidenhain's Weber. "Typically, the more expensive the iron, the bigger the machine, the more viable it is to do a CNC upgrade or a CNC retrofit."

He distinguished between an upgrade, which is "taking an old slow control off, and putting on a better control," and a retrofit, which "might involve doing that, but also mechanical work on the machine, changing the drive system and changing the motors—and every step in between." Webster pointed out that new CNCs, with compact CPUs and flat-screen HMIs, can fit in the space formerly occupied by an older control's bulky CRT screen. That has "made it relatively easy to retrofit old machines with the same equipment you use on a brand spanking new machine," he said.

Webster said intermediate-level retrofits are also popular. "A lot of people have a machine tool with a relatively current system but want to add more functionality. They go for options like a stand-alone 4th axis table." Such an addition would require another motor, another drive amplifier and another controllable axis in the CNC in addition to the table itself. "It's not a retrofit at that point; it's an addition to an existing machine," Webster said.

There is no one-size-fits-all CNC enhancement or upgrade. Webster said, "There are so many different types of machine tools out there, it's impossible to have one answer for everybody." However, improvements in CNC technology are driven by improvements in computer technology. "Every 18 months, you've got a leap in computer technology; as processors get faster and memory gets cheaper, you can do a lot more on your CNC." Control technology changes more quickly than machine tool technology, "and that's actually important for machine design, because you don't want the computer piece to be the limiting factor; it allows a lot of flexibility in the machine's mechanical design. You want your control to be able to do everything." △