S taying competitive in today's manufacturing world means cutting parts at optimal efficiencies. With the latest CNC gear, machinists optimize cutting speeds while getting extremely high-quality finishes due to improved machine control hardware and more sophisticated software functionality.

With higher-power processing and better software algorithms, new CNC equipment now offers users much more bang for the buck, according to some observers. “The trends we’re seeing in CNCs is that a lot of the features formerly reserved for the highest-end controls are being pushed down into more economy-class or production controls,” says Paul Webster, manager, CNC engineering, Fanuc FA America (Hoffman Estates, IL).

**Latest machine control technologies help operators optimize machining tasks with high-end hardware, more refined software capabilities**

*Patrick Waurzyniak*
Senior Editor
That makes high-speed machining and other advanced features more easily affordable on low-cost controls. "There's a huge volume of work coming out of the emerging markets, especially China," he says. "When our 30i-A CNC came out in 2003, it was the highest end control. It's now the 30i-B Series," Webster says. "That control is top of the line with 32 axes; it's the cream of the crop."

Some of the key new capabilities on Fanuc controls include AICC2 block processing and advanced look-ahead features, he observes. "Now we're seeing a lot of those features working their way down to the 0i-Mate, our lowest-cost control," Webster says. "The differentiator is pure axis control or paths. "Now we're also at a point where from the top-of-the-line 30i-B to our most economical 0i-Mate control, all of our controls do their math at the nanometer level."

At the high end, Fanuc recently updated the 30i-B Series control with advances in operability and maintainability including USB memory port, enhanced dual safety check, plus new punch press and laser functionality. For advanced machining with high accuracy, the 30i-B offers improved high-speed five-axis capabilities with proven architecture and software algorithms that drastically reduce cycle times while improving part accuracy and quality. The 30i-B also features Fanuc’s Smooth TCP, high-speed, multipath PMC, an enhanced tilted working plane and high-speed smoothing functions, with enhanced DSPs for advanced servo control such as multiaxis control and high-speed current control and arbitrary speed threading.

Fast Cutting at High Accuracy

As hardware gets more and more powerful, it acquires the ability to process much more complex algorithms, which can enhance overall machine performance, according to Todd Drane, marketing manager, Fagor Automation Corp. (Elk Grove Village, IL). "The trend is to cut faster, with more accuracy and better finish," he says, noting that nano-metric resolution is becoming a requirement in the medical and aerospace industries.

In industrial PC controls, multiple processors are being used to achieve these requirements, notes Drane, and also to provide more power to users to develop their own GUI and integrate data collection to enhance productivity across the manufacturing floor. Turning controls with milling capabilities are being increasingly employed to produce complex parts with single setup.

"Powerful algorithms like our High Speed Surface Accuracy [HSSA] and Adaptive Real Time Feed and Speed control [ARFS] are being introduced in our CNC controls to meet the challenge of cutting at higher speeds with better finish and accuracy," Drane states. "Volumetric compensation to enhance the accuracy of large-envelope machine tools and Dynamic Auto-tuning software to maintain machine performance over the years are being employed."

The Fagor machine control lineup features HD graphics and built-in safety for collision detection and prevention. "The new technology is a combination of software and hardware—it really has to be," adds Drane. "As you develop new complex software, you are in turn asking your hardware to do more, thus you have to continue developing fast multitasking processing methods from your hardware."

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Faster processors and less expensive memory also have enabled CNC suppliers to offer more graphical interfaces than previous controls, Drane contends. "This has resulted in very powerful user interfaces allowing people with minimal CNC skills to operate CNC machines with great ease. The ability to easily integrate and display graphics has resulted in GUIs like our ICON-based conversational programming, which is a very powerful shop-floor programming interface." In addition, he notes that more economical Compact Flash memory, USB in-
Interfaces and networking capabilities of the CNC controls allow users to port information across various platforms for analysis, resulting in increased productivity.

Among Fagor’s primary new CNC software features is the ARFS adaptive functionality in which the CNC analyzes the machining conditions including spindle load, servo power, tool-tip temperature, and automatically adapts in real-time both the axis feed rate and the spindle speed for maximum machining performance productivity, Drane adds. “The result is a reduction of cycle time coupled with a superior part finish,” he says. “Extended spindle and servomotor life is an added benefit, and usually extending tool life requires faster hardware and smarter software.”

Last year, Fanuc released its iAdaptS adaptive control solution and also the iLimitS, an option that provides real-time monitoring of the machine tool. “There seems to be more leading operators and programmers working in interactive elements, which leads to faster graphics performance,” says Pearson. “We’ve had that as part of the whole package along with our ShopMill and ShopTurn, which are now more of a step programming type of function.”

Quick Updates Through Software

The fastest way to obtain cutting-edge CNC improvements is through new software updates, which most machine control developers regularly add to their lineups to keep machinists at the forefront of machining technology.

Among enhancements for its Sinumerik CNCs, Siemens offers its Interactive Animated Elements that features 3-D graphical views that aid machinists doing shop-floor programming. “We have TRAORI [transformation orientation], which is very big in aerospace, and medical manufacturers do a lot with MDynamics, which is high-speed machining that lets you set accels and decels on the machine,” notes Randy Pearson, manager, end-user support. MDynamics enables accurate surface machining and precise contouring within the shortest possible machining times. An “Advanced Surface” path control system has been upgraded to further improve the quality and evenness of milling path velocity profiles and to reduce overall machining times.

New Siemens Sinumerik MDynamics technology combines CNC hardware, smart CNC functions, and integral CAD/CAM/CNC process chain into a single package for high-speed, high-precision three- and five-axis milling.

Last year, Fanuc released its iAdaptS adaptive control solution and also the iLimitS, an option that provides real-time monitoring of the machine tool. “These solutions are software that leverage the Fanuc CNC and the servos we use,” explains Fanuc’s Webster. On the hardware side, performance is improved with faster spindle and servomotors, he notes, and better rotary encoders also help boost overall CNC performance. “Our latest version of the Alpha I has 16 million pulses. It’s a huge leap in accuracy.”

High-end features introduced last year by Siemens Industry Inc. (Elk Grove Village, IL) include the Sinumerik MDynamics technology for three- and five-axis milling applications. The MDynamics system combines the CNC hardware, smart CNC functions, and the integral CAD/CAM/CNC process chain into a single package for industries requiring the highest surface quality, precision, and machining speed.

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Last year, Siemens updated its Sinumerik Operate user interface with a single consistent UI on all of its programming interfaces including the HMI-Advanced, ShopMill and ShopTurn systems. The Siemens software features full conversation-al, graphical user interfaces, Pearson notes, which are popular with machinists doing programming on the factory floor. “They do it both ways. Smaller shops may do more programming on the shop floor, more for the production environments.”

For CAD/CAM-based programming, Siemens’ CNCs and developers at its sister company Siemens PLM Software (Plano, TX) continue to find synergies between the Sinumerik line of
controls and the NX CAM software developed by Siemens PLM, Pearson adds. “Most of the major CAM systems work well with our control but our partnership with Siemens PLM helps with higher-level languages and how to associate the posts with five-axis machining,” Pearson adds.

Siemens continues to offer some Linux-based controls, with the entry-level 802D and mid-range 828D controls using an embedded Linux operating system, he adds. The company also offers Linux as an option on the flagship top-end 840D control. “A lot of the new systems are going more to Linux embedded systems—they like that because it’s a very quick booting system, and also nobody’s come up with any viruses yet,” notes Pearson.

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Some newer features from Siemens also include the Control E option for controlling energy usage and allocate machining resources more efficiently over the factory-floor networks. “That’s all software-based functions, and it helps you balance your heavy workloads, perhaps by scheduling more roughing operations at night,” Pearson adds. “Siemens Integrate also is another new feature, offering tool monitoring and machine data acquisition.” Introduced at EMO last year, the Integrate system offers more simplified integration of CNCs into a manufacturer’s communication, engineering, and production processes.

**Conversational Programming Mode**

As machinists look for simpler programming, controls equipped with conversational programs can greatly speed those tasks on the shop floor. The new Acu-Rite 3500i CNC mill control from Heidenhain Corp. (Schaumburg, IL) enables operators to use an intuitive touch-screen interface along with the conversational capabilities that allow editing in plain machinist language or with canned cycles included in the CNC. The
control, which includes Heidenhain NC kernel and processor technology, also offers coarse tool support and a built-in 2½-D CAM system that allows operators to complete complicated contours quickly and easily with minimal part data.

“From inception, this control was meant to be a touch-screen control, so navigation is like many modern touch-screen tablets,” says Danny Vitullo, Heidenhain product specialist, of the new 3500i CNC, noting that the approach is something that former CNC developers Anilam and Acu-Rite, both of which Heidenhain acquired years ago, had as a philosophy for product development.

With its conversational mode of programming, the new Heidenhain control greatly eases the programming in front of a machine tool, Vitullo states, where machinists often will need to tweak, or even rewrite, a program sent from offline CAM systems. “Just because you posted the program from a CAD/CAM machine doesn’t mean it’s perfect,” Vitullo points out. “And because this control is both G code and conversational, it’s easy to edit programs any way needed.

“The real key difference is the background editing, because I can pull in a program and edit it while the machine continues to run,” he adds. “You can proof them visually while a machine is cutting the part.”

Other CNC developers also offer some kind of conversational style of programming as an alternative to traditional methods. CNCs equipped with the conversational style can enable less-experienced operators to address a lot of machine tool programming without a great deal of training.

“This subject matter has been a primary focus of our R&D department for many years,” says Drane of Fagor’s conversational programming offering. “It was important to us to not just provide a conversational method of programming, but one that is exceptionally powerful, yet diverse.”

The Fagor CNC lineup offers both ISO G-code programming capability as well as an ICON key conversational programming method, he adds. The ISO G-code includes high-level language programming methods as well as an Interactive Editor coupled with a Help mode that automatically prompts the customer through all cycles in a fill in the blank type format.

Image courtesy Heidenhain Corp.
“The ICON key conversational method allows the customer to simply choose a cycle or operation they wish to perform by selecting the appropriately pictured key, then all information is contained on a single page, including finishing pass variables,” Drane says. “This allows operator/programmers with little to no experience to quickly create working part-programs within just a few minutes.”

Both methods have access to the Profile Editor, which allows for direct entry of variables for complex profiles directly off the blueprint, Drane adds. The CNC will automatically generate the associated G-code and enter into the open program or save as a subroutine that can be accessed as needed.

For the Sinumerik CNCs, operators have three different ways to program the control, according to Pearson. Users can program with ShopMill and ShopTurn in graphical mode or instead use the Siemens DIN ISO code method. The third option is using the company’s ISO Dialect converter that translates programs from any source into usable code. “It can take their program and run it without altering it,” Pearson adds. ME