AUGUST 2001 / VOLUME 53 / NUMBER 8

▶ BY MIKE IRELAND AND DOUGLAS PETERSON

Calculated Decision

Photographs: GE Fanuc

Let technology be your guide when selecting a CNC.

Buying a CNC or machine tool equipped with a CNC can be intimidating. There are literally hundreds of models to choose from, which are available with a staggering array of capabilities and options and that cover a wide range of prices.

To make the best decision, you need to fully understand the demands of the application, not only in terms of required CNC power and performance, but also in terms of potentially upgrading or interfacing the CNC with other devices. Ultimately, the CNC you choose should satisfy all of these needs, ensuring product quality and a healthy return on investment.

Therefore, careful consideration must first be given to the characteristics that differentiate one CNC from another. These characteristics generally fall into six categories:

- displays and operator interfaces;
- drives and controls;
- programming options;
- networking connectivity;
- open architecture vs. proprietary architecture; and
- system integration.

Operator Interfaces

Operator interfaces are the “face” of the CNC, the components users interact with most often. The complexity of the OI—that is, the number of buttons, switches and keys—is usually related to the capabilities of the machine tool it controls. Typically, the OI includes a keyboard and buttons for programming and managing operations and jog-shuttle knobs for manual control.

Recently, the focus of OI advances has centered on display-screen technology. While some CNC manufacturers still provide green or amber monochrome displays, even the most basic machines generally come equipped with gray-scale monitors. With low-cost LCD screens that display up to 256 shades of gray, the screen's information is visible in a variety of lighting conditions.

For a modest increase in price, you can get a color screen. It will convey more detail in ways that make information easier to understand. For example, cautionary messages appear in yellow and alarm messages appear in red. Color schemes can also be customized to make the display easier to see under various ambient lighting conditions, such as the green cast of mercury-vapor lights or the harsh white light of fluorescent fixtures.

Digital Power

Control at the business end of a machine tool is provided by a motor that physically turns and moves the machine's axes. The path from a CNC to this servomotor must include an interface that converts the program's bits and bytes into the necessary voltage and current to drive the servomotor.

Digital controllers, or drives, solve the problems that have plagued analog drives. The chief complaint about analog drives is their inability to maintain tool-placement accuracy over time. As motors, electronics and machining components wear, tool-placement accuracy declines because of the lack of an inherent-feedback scheme or compensation system.

This has forced users to employ highly skilled engineers to tune the drive as part of their machine tool maintenance program. Component drift can also cause problems, especially in the world of micron-level machining.

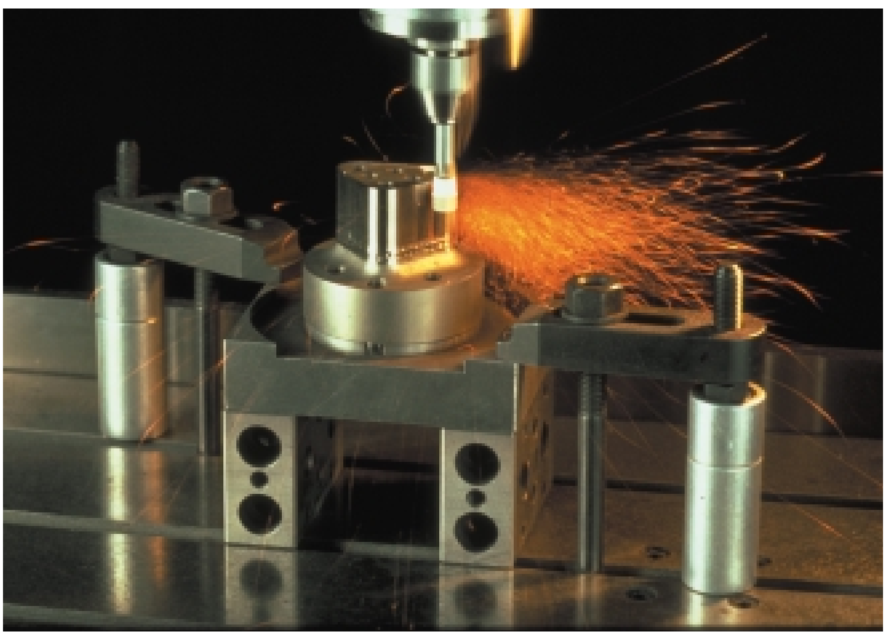
Digital drives overcome these obstacles by incorporating a closed-loop, digital-feedback system—as opposed to a compensation system—that allows the CNC to know at all times exactly where the cutting tool is in relation to the workpiece. As a result, nonlinear cutting paths are more accurately controlled and both low- and high-speed performance improves.

Moreover, electromagnetic noise—a common problem at low speeds—is not as great a concern with digital equipment. The digital data is checked for errors so noise problems can be corrected before the tool executes the command.

Digital drives also address certain control algorithms, like feed-forward, which are cost-prohibitive with analog drives. And, acceleration and deceleration profiles are enhanced when the drive is digital, giving the machine greater control of the tool in turns and corners.

Further enhancing accuracy, digital drives enable machine "learning," in which the drive detects an error during production and makes the adjustment without an operator command. Nonround parts, in particular, can be produced more accurately because of this process.

To enhance accuracy, digital drives enable machine "learning," in which the drive detects an error during production and makes the adjustment without an operator command.



To select the right CNC, you first need a complete understanding of your application and what it demands.

Programming

Traditionally, programming a CNC has been restricted to formal, machine-specific languages. While some of these programming standards still exist, the improved processing power and storage capabilities of modern CNCs allow programming with higher-level software that more closely resembles spoken language.

One of the most significant advances in CNC programming has been the growth of macro-programming. Macros are powerful tools for programmers and operators alike. They simplify mathematical computations, cause text or graphical images to appear on the screen and even perform decision-making tasks. The need for specialized programming skills is virtually eliminated, because anyone who is familiar with part programming can understand the language and its structure.

Macros, which are transferable from machine to machine, allow a user to repeat a standard procedure again and again. For example, if a group of parts has the same bolt-hole pattern, that pattern can be defined as a macro. Every program for that group of parts can call on that macro for the bolt holes, no matter what other machining needs to be done.

In another example, creating shaft threads for an electric motor can be defined as a macro. Shafts of varying lengths can be machined according to specific parameters, with the macro determining where the shoulder starts and how the threads are cut. Thus, every shaft will have exactly the same thread, regardless of its length or other size characteristics.

A macro can run independently of other operations, minimizes errors from part to part and reduces programming time dramatically.

Network Connectivity

The most crucial aspect of connectivity is transferring parts programs from the computer, where they are written and stored, to the machine that does the work. High-speed data buses and greater network reliability have increased connectivity options for CNCs, as have the growth of CAD and CAM systems.

In many plants, engineering stations are connected to the machines via high-speed Ethernet connections. Long recognized as the *de facto* standard for office networks because of its efficiency in transferring files and sharing resources, Ethernet allows a PC user to monitor the machine tool in action, upload and download programs from a remote location and coordinate scheduling.

Ethernet-capable machines also allow the actual machining operations to be included in enterprise-level software systems. That means planning, inventory, production and shipping can share information to maximize productivity and reduce costs. Most CNCs come standard with Ethernet capability or the manufacturer offers it as an option.

On the shop floor, machine tools often connect to other equipment, such as a pallet shuttle that holds the next workpiece to be machined. Large machines may have limit switches, OIs or other components separated by distances of 100' or more. Facilitating intra- and inter-machine communications are input/output (I/O) links, proprietary networks and Ethernet.

For most facilities, retrieving CNC data for broader applications is a step taken long after a machine is installed. In these cases, the data-acquisition component—the programmable logic controller, PC or related I/O modules generically referred to as "black boxes"—communicates with the factory's host system via a communication protocol selected by the user or the manufacturer of the black box. Communication from the data-acquisition component(s) to the CNC is typically via RS-232C.

When adding a new CNC to an existing machine and data-acquisition system, one of three scenarios typically plays out. In the first, the protocols from the older data-acquisition system are already compatible with the CNC. In the second, the data-acquisition components are no longer needed, because the CNC links directly to the host system. Or, in the third scenario, an entirely new data-acquisition system is needed. With so many possibilities, data acquisition is certainly an important issue to consider when purchasing a CNC.

I/O communication varies from CNC to CNC. When a machine's CNC is replaced by one from a different manufacturer—as might occur during a retrofit—the I/O typically is replaced as well. Additionally, while protocols such as DeviceNet and Profibus are available, new standards based on Ethernet are preferred.

Open vs. Proprietary

In recent years, more has been written about the relative benefits of open systems compared to proprietary systems than any other aspect of CNC technology. The discussion usually focuses on whether users want (or need) a system that allows them to choose hardware or software components, or whether they want a system in which components are preselected.

Many machine tool users really want both. They want some components, like servos, spindles and axes control, preconfigured from a single vendor for reliability and performance. They also want the ability to add items—like software—of their own choosing.

At the user level, "open" often means "Windows-compatible." In reality, an open platform supports the decision to run Windows. The core CNC element is the same as for a proprietary system, but an open system includes a parallel platform that allows Windows, and users' favorite programs, to run. A Windows-based system also ties into the plantwide networks discussed earlier, as

Helicopters responsible for getting CNC off the ground

The first numerically controlled machines were developed more than 35 years ago to produce the contours of helicopter blades. These early NC machines relied on rudimentary calculations to determine the paths and curves that tools followed.

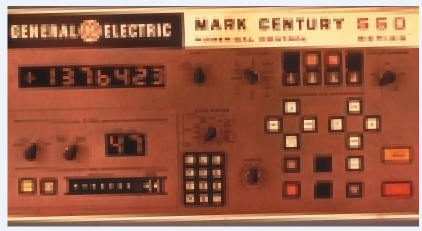
Government contractors, particularly those in the aerospace industry, were the primary users of NCs through the mid-1960s. They were the only ones with the time, money and personnel needed to keep the equipment running.

NCs became more affordable, compact and capable in the late '60s. And, it became possible to add computational power to NCs. Because the machine tools were already expensive, the computational power offset the relatively slight increase in cost.

The enhanced capability and affordability helped spur the growth of CNC machines. Many companies' first exposure to computers came when they purchased a CNC machine.

As PCs became more powerful and affordable, CNC processors and program storage capacities fell behind. CNCs evolved at a slower pace, but eventually they became more reliable and easier to use. And with their wider acceptance came lower costs.

Advancements in CNC technology have tended to follow a cycle wherein a new machine tool's CNC pushes the envelope for cutting performance, making the tooling



For many companies, CNC machine tools were the first devices they purchased that used a computer.

the limiting factor in productivity. Then an advance in tooling surpasses the CNC's capability, necessitating that an improvement be made to CNCs.

The cycle has shifted in recent years to focus on "working smarter." Rather than relying on brute force to remove material from the workpiece, newer machines take advantage of sophisticated raw-material shaping and advanced programming to deliver more precisely finished parts.

Significant advancements to operator interfaces have been made the past few years, too, as machine tool builders have strived to make their products as user-friendly as possible. Additionally, the explosive growth of computers for everything from computer-aided drafting to manufacturing-execution systems has led to development of CNCs able to connect to a wide range of nonmachining systems.

—M. Ireland, D. Peterson

many enterprise-level applications run in the Windows environment.

Know Your Integrator

With so many performance features and communication options available, choosing a CNC is a complex task. One shortcut through this maze is maintaining a good relationship with your CNC vendor or integrator. Working directly with a knowledgeable, experienced professional saves valuable time that might otherwise be spent researching products and solutions.

Ideally, the vendor or integrator should totally understand your applications and be able to address your short-term need for performance as well as your long-term needs for upgrading and broadening data applications and communications.

The most crucial aspect of connectivity is transferring parts programs from the computer, where they are written and stored, to the machine that does the work.

Though choosing a CNC can seem daunting, with a little research and good advice, you'll find the solution that's right for you.

About the Authors

Mike Ireland is an account manager for GE Fanuc Automation North America Inc., Charlottesville, Va. Douglas Peterson is vice president of CNC business at GE Fanuc and president of CimWorks Inc., a GE Fanuc company based in Kirkland, Wash. To receive additional information about GE Fanuc, call (800) 648-2001, or visit the company's Web site (www.gefanuc.com). CimWorks: (800) 955-7100, www.cimworks.com.