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PC-based CNC: How simpler retrofits with PC-based controllers save money and extend productivity

Over the last half-decade or so there has been a battle of the boxes in CNC, in which traditional proprietary computer-based CNCs, such as those from Fanuc, Siemens, Heidenhain, and others have been competing for pre-eminence with a wide range of PC-based units that often cost far less, but which didn't carry the long-standing reputations nor the large organizations that the proprietary CNC builders have behind them. The big guys dismissed the little guys; they dismissed the whole idea of using a PC for CNC for many years, in fact, and implied, when they didn't flatly assert, that PCs were too feeble to handle the job.

But a variety of pressures have turned the situation around. "PC-based CNC" is now a selling point, whether it's based on perception or reality, and the proprietary CNC builders are now offering PC-based systems themselves. Smaller companies have been in the PC-based business for up to two decades now, with many satisfied customers, and the reputation of PCs in general has improved as so many of us have used them in our daily lives and have become comfortable and competent with them.

There are some lofty arguments still going on among the experts, but PC-based systems are here to stay. Remnants of their old negative reputation remain, however. Fortunately, with so many experienced users of PC-based CNC around to talk to, we can leap over the technical arguments and see how they've actually performed in service, often for people who also have considerable experience with proprietary systems.

Arlen Cannon, Owner of Christes Engraving Co (Anaheim, Calif) has used Allen-Bradley and other propriety CNCs as well as PC-based Centroid units. "I've had a Sharnoa with an Allen-Bradley control on it," says Cannon. "It was generally free of problems, but it kind of



A two-axis Mori Seiki lathe makes a retrofit every bit as neat and easy as the more-common machining center retrofits. Control software typically covers both

died of old age. Parts were getting hard to find. Several years ago we switched to a Centroid controller on the same machine tool. It has worked very well. There's hardly been any difference in reliability or performance, really."

Most of Christes' work is engraving in molds, forging dies, and similar applications, so their machines are making fairly short, quick, frequent moves.

The Centroid easily keeps up the pace. They've also converted an old BostoMatic to a Centroid control, which solved a service problem they had with the original.

"We're doing our CAD/CAM on a PC, also," says Cannon. "So when we have a tool-positioning problem it's not easy to point a finger at where the problem occurred -- at the CAD/CAM or the CNC. But our CAD and CAM are running under Windows, and we know we have a problem with that. We just switched from Windows 98 to 2000. Maybe it's helped a little bit. But, because of the way Windows saves files when you stop and restart, occasionally it causes a problem with a CAD file and we bury a carbide cutter into some customer's part. The DOS-based Centroid doesn't seem to create any such problems of its own."

Christes does its programming offline and, after CAM processing, feeds the Centroid G-code. "There's no comparison between programming our older proprietary CNCs with programming this machine," says Cannon. "It's easy and flexible." But Cannon points out that it's the modernity of his PC-based controls, with their advanced interfaces, that deserve the credit, rather than the fact that they're PC-based. The point is that the new controls, which are much cheaper than replacing proprietary with proprietary, do the job so well.

"And we have another new control system,

Numatix, on another of our BostoMatics. It's PC-based as well, and it also does an exceptional job."

What about the claims that PC-based systems aren't as robust as proprietary ones? This is a question that's best answered by a larger survey, but Cannon provides anecdotal evidence. "The only problem we've had is that the solid-state output relays are rated a little low for our application," he says.

"We're talking about driving a four-spindle BostoMatic, and that's a lot of weight you're banging back and forth in those quick, abrupt moves. It does put quite a load on standard relays."

"In the end," says Cannon, "this is about economics. A proprietary system for our applications can cost as much as \$75,000. The Centroids we're using cost roughly \$20,000. And service costs with our older proprietary systems were way out of line. The PC-based system is much more reasonable in terms of initial cost and in terms of service." He points out also that Centroid can supply its systems in kit form, which further reduces up-front costs, although Christes uses professional installers to do the job.

One system, multiple applications

Unlike the large builders of proprietary systems, the PC-based CNC suppliers have tended to build multi-purpose systems that use the same hardware but with add-on software for individual applications. The same controller may be used for multi-axis milling, turning, composite tape- or filament-winding, and laser cutting. For example, Jim



Inside this MachineMate 'slim line' control panel is a CE-compliant industrial PC with IPC 65 drip-type front panel. But the guts are pure PC

Panzer, Automation Engineer Manager for KI-Bonduel (Bonduel, Wis), is using a MachineMate PC-based CNC on a 4-axis Rofin-Sinar laser. "Overall, for our application, it's an outrageously good package," says Panzer. "We haven't had any failures. One time we thought we had a bad analog board, but it turned out to be a problem with our own wiring."

"We have an early version that's based on Windows NT," he says, "which has led to our only headache -- and that's another one of our own making. Our LAN is based on

Windows 2000 and getting the CNC to communicate with it would be difficult. But MachineMate has Windows 2000-based software now, so we can simply update the software if we decide to. Connecting to our plant-wide LAN will put us into a whole new ballgame of capabilities. One way or another, using a PC-based system gives you the flexibility to make things compatible via the software-only route. It would be a very hard sell now for us to go back to a proprietary system."

Traverse rates are relatively high with a laser, and the Rofin-Sinar machine is capable of multi-axis contouring with simultaneous Z-axis tracking, so it's a good test of a PC's ability to keep up a demanding pace. "The only limiting factors we have are with the mechanics of the machine, not with the CNC," says Panzer. "It's servo-and-ball-screw driven. We're using flying optics (in which the laser remains stationary, while a mirror-and-lens optical head is the part that moves) in the X- and Z-axes and traditional machine-tool mechanics on Y, where the part itself actually moves. We used the ballscrew system because it was fast enough so we could hit the production rates we needed by using traditional machine-tool mechanics. The flying optics in two axes help us to maintain the focal point."

Adapting a machine tool controller to a laser was a simple software plug-in issue. The laser has a capacitive sensor to track Z-axis position, so the laser's focal point can be maintained as workpiece thickness varies across its surface. "This sensor didn't require

When the first Intel 286's became available, Centroid started making PC-based CNCs. That's over 20 years ago, and so the idea that it's still an unproven technology is getting hard to defend. Unlike some of the newer entrants, Centroid uses MS-DOS for its operating system. The O/S has been a sticking point for PCs and CNC, and using DOS has avoided many wait-state and other technical issues that crop up with Windows.

Other builders use proprietary operating systems or they work carefully around Windows, as MachineMate does. There also is some work going on with Linux, which developers say is free of some of the Windows problems.

None of them have a problem with speed today. At the terminal end, where digital data is sent to the machine tool and is received back from encoders, CNC builders

often build in their work-arounds to buffer and isolate limitations of the operating systems. Based on experience, they have been successful in doing so -- overcoming one of the complaints that builders of proprietary systems level at PCs.

Taking another view of the proprietary-versus-PC-based argument, it helps to keep in mind that computer numerical controls predate the desktop PC by slightly more than a decade (for the historically inclined, the first NC actually was a CNC, built for the US Air Force in the 1950s, but we're only counting commercially available units), so early CNC systems were designed and built from the ground up by each manufacturer, without a common blueprint. Each of the CNC manufacturers took a slightly different path. Thus, the business started with all proprietary hardware designs, and, by the

time the general-purpose personal computers appeared on the scene, CNC was advanced far beyond the capabilities of personal computers -- in terms of specific performance, if not in flexibility. It wasn't so much that proprietary controls were using faster components, only that they used them more efficiently, dedicating them to each task in the way that best took advantage of their capability.

Now, speed in processors has eliminated that issue entirely. It's a matter of how well each builder has done the job of tailoring the computers' capabilities to the needs of CNC. Rather than getting involved in the technical arguments, the best way to answer it is to ask experienced users -- a practice we recommend for anyone considering a retrofit or a choice of CNCs on a new machine tool.



The big cabinet is almost all empty space in this Burgmaster retrofit, now that the old CNC has been stripped out. But the cabinet was already there, and the PC-based CNC fit in easily

any special interfacing," according to Panzer. "It plugged right in to the controller, sending its +10 to -10V analog signal into the CNC. The controller has a A/D converter built in. MachineMate's German source had available a software add-on that handled the height control for the Z-axis, and that took care of coordinating height control with X-Y positioning".

"We're using the hard drive to store programs, but that isn't a major issue for us with this application. The controller can far exceed what the machine can do. On the other hand, the ability to buy parts at a computer store is a major issue. Keyboards and mice, even a floppy drive -- I could run down to Best Buy and pick one up -- if I had to. So far, I haven't."

Panzer's experience with MachineMate on the laser has encouraged the company to think about using the control for other retrofits. "We have a 3-axis Monarch mill which has a 10-year-old proprietary control. We're thinking about a MachineMate retrofit. And there will be more. Anything else important? Our opinion is, just don't worry about it. We had reservations in the beginning, but, as we went along, we realized they were unfounded fears. It was a lot better than we expected it to be."

Without going into as much detail, we asked other MachineMate and Centroid users about their experiences on a 10-axis filament winder and a high-speed mill, as well as a

couple of old-mill retrofits. Our three questions were, is it doing the job for you, have you had any problems, and would you consider going back to a proprietary system for any reason? The answers were all positive for the PC-based CNC. Nobody we've talked to has said they would think of abandoning a PC-based system.

That's not to say there haven't been glitches in installation or setup, but users seem to brush them off as simple things to fix. The overall impression is that they know what to expect with the PC itself, from other experiences, and the interface and software issues have been solved fairly easily.

Most of all, users seem to be happy that they have a "generic" system and that they aren't tied into a single source for both hardware and software. Because we didn't talk to anyone who had abandoned their software, the actual degree of flexibility is subject to question. But that's a positive in the sense that the CNC software for PC-based systems doesn't seem to prompt people to change.

There are still arguments about the advantages and disadvantages of PC-based versus proprietary, but they aren't evidenced by the experience of most users. CNC in general is a highly developed technology today, and the PC hardware platform appears to be capable of handling a wide variety of control tasks reliably and efficiently. And, with a PC on your machine tool, you can always play Mine Sweeper with it during lunch. ■



The old control on this twin-spindle Matsuura VMC was hard to keep running, too slow, and had insufficient parts-program storage. A modern PC solved all three problems



A 3rd party add-on program gave this Knoxville-area jobber conversational programming for programming at the control. Flexibility to handle add-ons is a big advantage of PCs' open architecture



Monarch VMC retrofitted with a MachineMate MM1, a low-end Windows NT-based control, performs all of the functions of the CNC it replaces, and more



Attached to a Sunstrand five-axis Omnimill with rotary table and pallet changers, the MachineMate MM5 control could control 8 axes simultaneously if it had to. Power and multi-axis capability is no longer an issue