New Era In CNC Control and Maintenance

When Bob Smith, the first shift supervisor for the strut-machining department, arrives at his office Monday morning, one of his first tasks is checking emails. Not only does he want to see whether anyone in his building has sent something important to him, he also wants to see whether any of the machines in his department require attention.

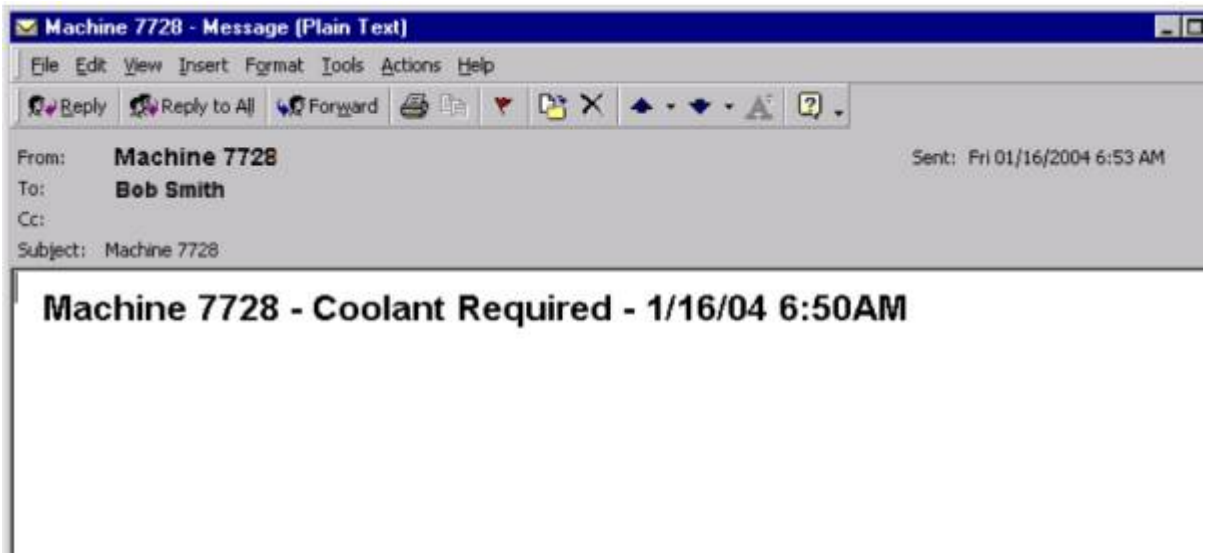

Figure 1. E-Mail sent by PC Based CNC to Maintenance Supervisor

The introduction of PC-based CNC technology into factory automation has changed the CNC maintenance activities from those for previous CNC hardware generations. These new CNC controls are able to interact among themselves as well as with other PCs, such as the standard PC sitting (next to) on Bob's desk, to an extent not possible just a few years ago.

The CNC software can be configured to send emails to specific individuals based on certain events. If a particular machine requires more coolant or is due for its monthly preventative maintenance, an email to the appropriate person can be sent without requiring an action by the machine's operator at that time. By connecting the PC-based CNC to the department network (or perhaps the plant network), the CNC can send messages to those users that its Windows account can access. These messages can include a pager since that is part of this PC technology. If a machine encounters an urgent problem, like a broken tool, the person involved in its maintenance can receive a pager message.

The development of the CNC operator interface using web browser technology enables the maintenance supervisor to connect to the CNC of interest and view its operator interface directly from his office PC. The CNC will have a fault history log so the supervisor (or anyone else involved in the machine's maintenance) can view operator and error messages that have happened in the past few days. Perhaps this reading might reveal that too many tool changer mechanical hang-ups were reported yesterday, indicating that maintenance personnel should be scheduled for this machine to make the necessary mechanical adjustments. Additional data such as Down Time, Chip Time, Part Count could also be available to the appropriate personnel.

This remote access could even be used by maintenance personnel to view the actual machine input and output conditions at the moment of a reported mechanical problem. The maintenance person might be able to determine the cause of the problem even before arriving at the machine itself.

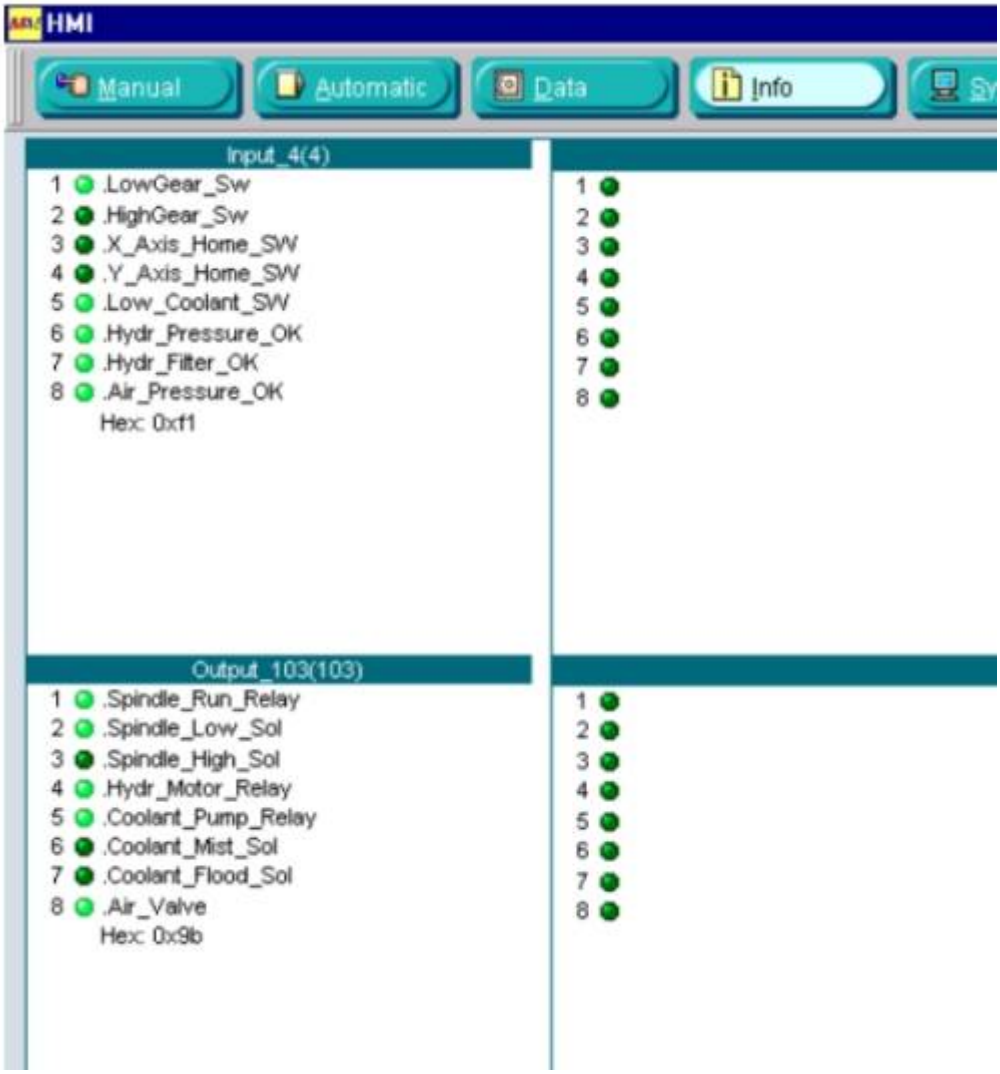

Figure 2. Typical CNC display showing the state of Inputs and Outputs

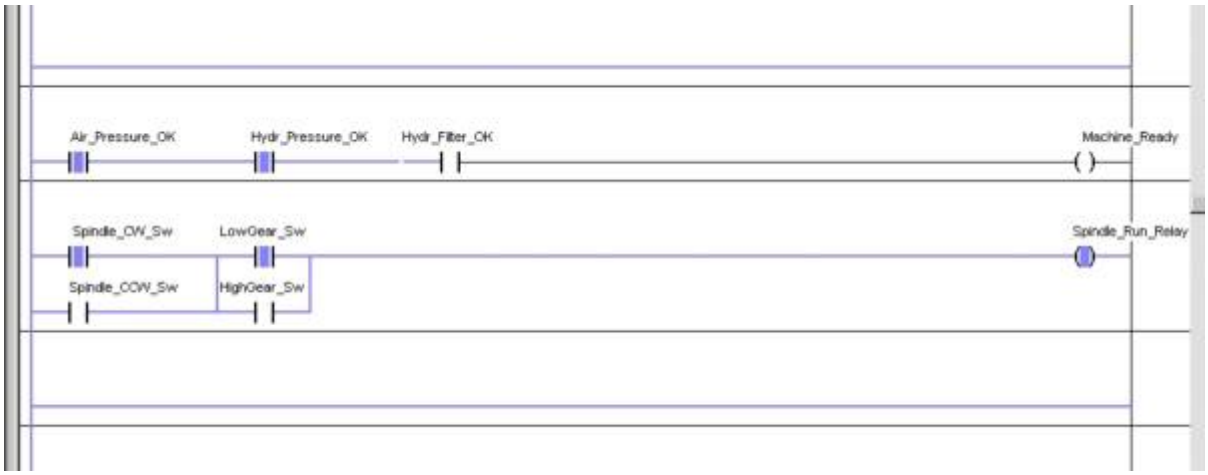

Figure 3. Typical PLC display showing real time animation and power flow

The PC-based CNC architecture allows a wealth of opportunity for data management in the factory. Part programs and production information can be moved via a network (Ethernet, etc). If archival of files is required, the common USB or built-in (IDE) technologies can be used to write a CD and this activity requires very little time. The PC-based CNC has a very large data storage capacity with its internal hard disk drive. Even if a factory has minimal automation overhead (in other words, no network), the PC provides the floppy disk, serial interface (COM port), USB and parallel interface (LPT port) to move data around using these common technologies.

Figure 4. USB Memory stick (or pen disk) is available up to 1 Gigabyte capacity and is very reasonably priced ($20 for 32 Mb). This device can be used to back up the entire CNC system software, move part programs, parameters, etc., at a very low cost.

During the machine installation, the machine OEM is able to record the initial machine configuration with a network connection or even a dial-up modem connection (factory to customer). Some PC-based CNCs can record CNC performance data. A CNC with a software oscilloscope can save its accumulated data for later reference. This multi-channel oscilloscope can be configured to record the benchmark with performance data

for certain features, including axis performance or mechanical timing, so that a later comparison (with the same benchmark testing configuration) can reveal changes in timing. With that remote connection, the OEM could check the machine many months or years later and check for these differences, that might reveal performance issues that can be addressed with preventative maintenance before those issues become problems.

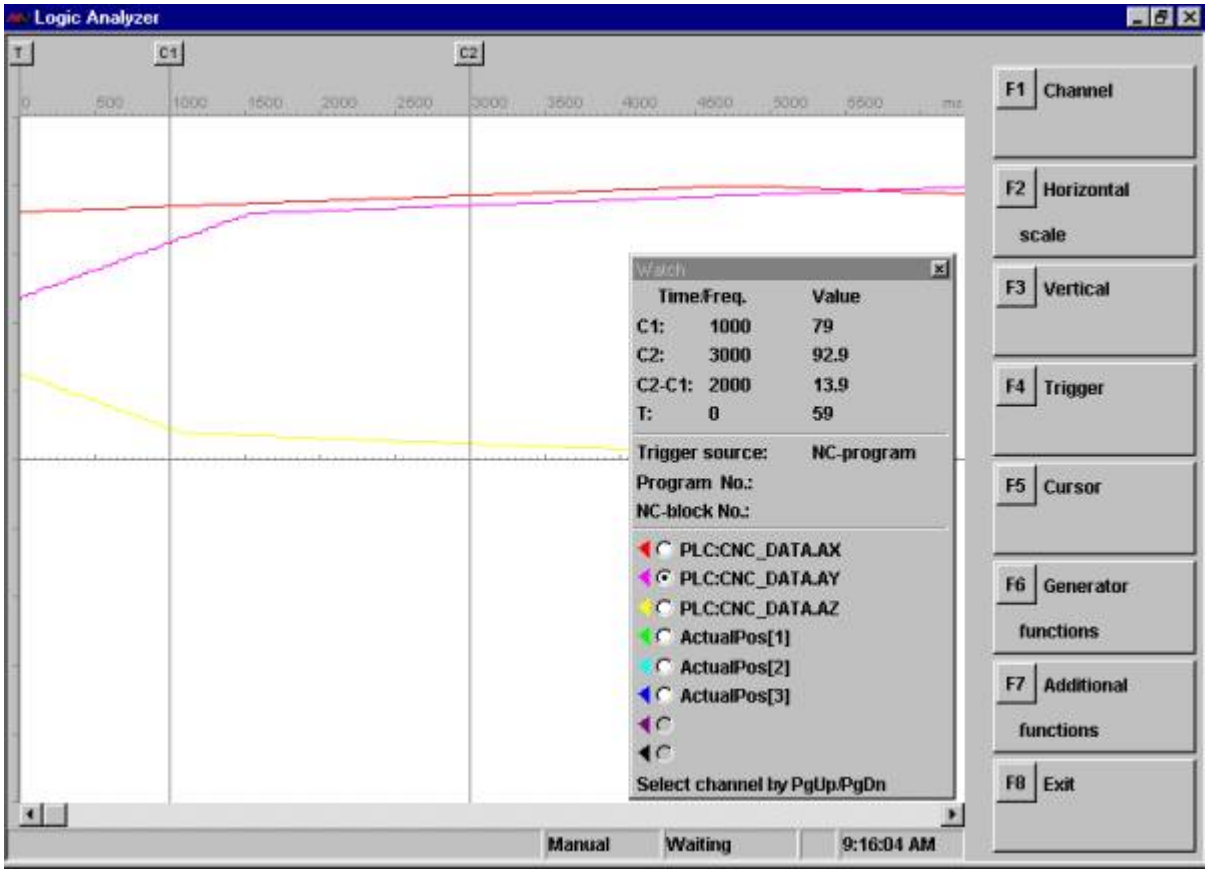

Figure 5. Multi channel oscilloscope can be used for machine setup and maintenance

PC-based CNC technology also takes advantage of other aspects of this mature user environment. Most people are familiar with the PC operating systems and their operator interfaces (such as Microsoftâ Windowsâ) making them easier to use for everyone (including operators and maintenance personnel). Multiple languages can be supported by a single computer. If the operator requires a different language than a part programmer or a maintenance person, the control can switch between those languages. In some industries it may be advantageous to display the operator messages in a bi-lingual format.

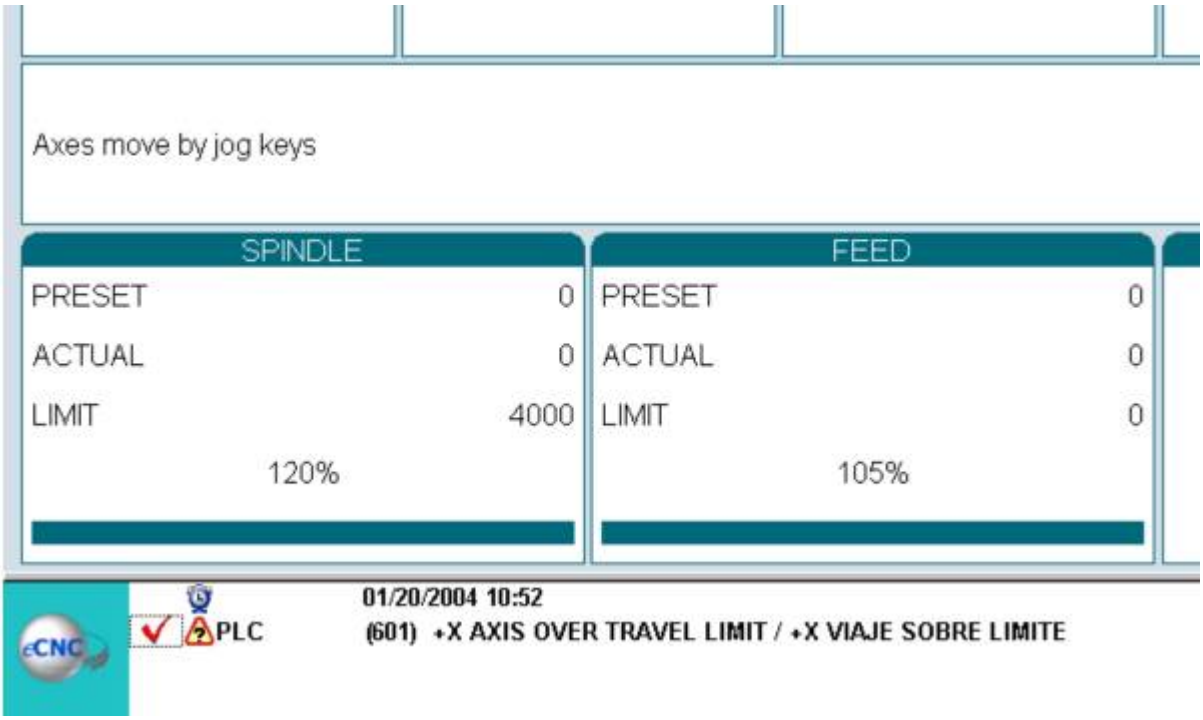

Figure 6. Bi-Lingual Operator Messages

These CNCs will typically included other factory automation standards. The interface to the servo drives will be the conventional analog signals (10V analog velocity signal with 5V encoder feedback) or the international SERCOS digital drive interface (a fiber optic cable between drives and the control; this ring of optic cables is a network among the connected devices). With most analog drives the drive supplier provides PC tools for setup and maintenance. These tools can reside on the CNC PC and allow maintenance personnel to review drive errors or even tune-up axes without having to connect an additional PC and cable. With the SERCOS network, the maintenance person at the CNC display can directly access the respective drive parameters, perhaps including its internal fault history log, during the course of machine maintenance activities (like drive tuning adjustments). The SERCOS parameters in the drives for these activities will be the same regardless of the drive manufacturer, making it that much easier for maintenance to handle a variety of vendors effectively.

The maintenance of the internal hardware with PC-based CNC technology is also convenient. The internal part count is typically very small, with a PC power supply, a standard PC motherboard, perhaps a standard PC VGA card and finally the CNC technology board (to access the machine IO and the machine axis/spindle drives). A standard network PC card, standard PC hard disk drive and perhaps other standard PC hardware (keyboard, mouse, VGA display, etc.) will be used. The replacement of these items is neither difficult nor expensive given the quantity of installed PCs in the world;

the combination of competition and quantity will typically drive down the sales price for anything.

For someone having years of experience in CNC maintenance, this current level of PC-based CNC technology is in sharp contrast to that of proprietary CNC technology of just a few years ago. Not only has the initial cost of CNC's been reduced by about 66% but the total cost of ownership has been reduced through the use of high volume, reliable, and lower cost PC components.

PC based CNCs must be designed to work in the harsh environment of industry. Industrial PCs are designed and tested to meet the stringent requirements of CE for noise immunity and emissions. A single point ground system is available to minimize the current ground loops. A good industrial computer will monitor PC temperature and voltages and take appropriate action if conditions are not correct. Commercial desk top PCs can not provide this level of robustness.

Figure 7. CE Rated Stainless Steel Industrial Personal Computer

An older CNC having no connection to a network required other mechanisms. For example, alarm conditions in the control often resulted in a blinking beacon, perhaps with a buzzer. The only way anyone in maintenance could determine what has gone wrong on a particular control is to actually stand in front of it and check its various displays. Part programs were often distributed by slow serial connections to each control

from a central DNC computer. Part program storage was rather limited on each control so as the machine changed among its parts in production, old programs must be deleted from the internal storage to make room for the next programs. The opportunity for archival of control information was often limited, perhaps restricted to the hardware of the control (like a floppy disk). Each control was provided with a single operator interface, restricted to a single language (making it more difficult for the wide range of people that might have to access its displays to be comfortable with the control). When investigating drive or motor problems, the drive parameters that are required for analysis will vary based on the particular drive manufacturer (and this task will probably require an external PC to connect to the drive itself to obtain that information over a special connection). Since each control had its own proprietary hardware, any failure like an internal circuit board would be expensive and often the original vendor is the only available supplier.

PC-based CNC technology has made many CNC maintenance activities easier than those required for the previous CNC hardware generations. This technology, since it is based on commercial technologies rather than just a small number of CNC vendors, will continue to grow in the future, perhaps to become even easier than now. This is a new era in CNC maintenance since its capabilities are so different than before.

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This article was written and provided by Pete Bartelme and Dave Michalets, Technical Support Engineers at MachineMate, Inc. MachineMate, Inc. supplies a family of premier PC-based CNC products. The MachineMate CNC family is the recognized leader in PC-based CNC technology. The use of Windows (NT or 2000), a standard PC motherboard (Pentium or Celeron), standard PC components, an IEC-1131-3 conformant integrated soft PLC and the capability of Ethernet and standard field bus systems give this system the utmost flexibility and openness available today. For more information on MachineMate, please visit their web site at www.machinemate.com.

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