

It's definitions that count with PCs in control

THE TERM PC CONTROL CAN HAVE VARIOUS MEANINGS FOR PACKAGING MACHINERY. SIMON MARSDEN REVIEWS THE VARIOUS CONTROL OPTIONS.

Packaging machines are increasingly described as PC controlled but what, exactly, does this mean? The term 'control' inevitably needs much closer definition.

Take, for example, the simple analogy of a car driver.

When a driver is in charge of a car he reads the instruments, takes in the road conditions and makes constant adjustments to the controls to change the car's speed and position. So the driver is in direct control of the car.

If however, on the advice of a passenger, the driver slows down, the driver is under the 'supervision' of his passenger. There is a subtle difference, but in both cases the driver remains in direct control of the car.

However, suppose the driver simply passes all the driving variables, speed and position and so forth, onto his passenger, who then processes the information and calculates what control actions the driver needs to make. The driver is then a 'slave' to his controlling passenger or 'master'.

So on machines described as PC controlled, what is the control strategy? Is the PC the 'master' making all the decisions and in direct control of events, although some control tasks or actions may be carried out by other 'slave' equipment, such as a programmable logic controller (PLC). Or, as in most typical cases, is the PC simply an observing passenger that interacts with the machine's PLC?

Typical functions performed by PC systems include monitoring and displaying production variables such as speeds or volumes and to compile reports and log production information into a spreadsheet for later use.

Additionally, PCs can be used to configure and download batch data ready for the next run, and issue instructions to start and stop the process.

This could be done locally on the machine or

communicated to it via some form of Manufacturing Enterprise System.

In this situation a PLC is used to get on with what it is good at – handling all the time critical processes of machine control – while the PC takes care of the background tasks, which are less time critical.

Additionally, because PCs have more programming options than PLCs, they tend to be more suitable platforms for developing and running complex calculations and algorithms, such as those used in vision systems.

In applications that will anyway include PCs, the possibility of using them also to handle machine control is often considered. "If we were to eliminate the PLC," goes the question, "could we then design the control system into one 'box', reducing component and support costs?"

Not necessarily, is the short answer. One of the main issues associated with using PCs for control functions is the robustness of their operating system – we have all experienced the frustration of untimely PC crashes!

Lack of determinism

In addition, many operating systems lack determinism, which is the guaranteed time taken to react to events. In machine control applications, missing a critical control input could have disastrous consequences.

Past PC systems overcame these timing issues using real time operating systems running under MS-DOS. However, while MS-DOS is quite functional, machinery users increasingly demand that any PC involved in their equipment is able to harness all the features and benefits of more modern operating systems, such as Microsoft Windows.

So with Windows systems being so widespread and familiar, it makes sense for software specialists to develop ways of making these

operating systems work in a deterministic way.

For example, VenturCom offers what is termed 'real time extension' packages, with its RTX package providing determinism and ensuring program scans are predictable and repeatable in specific timeframes, irrespective of the demands that other background tasks place on the operating system. This means that equipment manufacturers can now develop high-performance applications running on Windows platforms.

However, it could be argued that modifying the operating system by adding real time extensions creates a non-standard system, with implications in terms of compatibility. One of the main benefits of PC-based systems – their 'openness' – would then be lost.

The controlling options

There are a number of options and variations that can be used for machine control, each with its benefits and limitations.

Conventional PLCs are by far the most common form of machine control and, with a large installed base are well understood by engineers at all levels. They are extremely reliable – largely due to the manufacturers designing rugged 'closed' or 'constrained' operating systems – and also offer the high levels of determinism needed for high speed control.

However, for more specialist applications – such as process control tasks and vision systems – independent PLC co-processor (even PC based) modules running higher-level programs such as C/C++ can extend the PLC system's capabilities.

PLCs are becoming smaller and more powerful. High-level options such as Ethernet, e-mailing functions, remote i/o and co-processor modules are now becoming the norm on even small systems.

Larger PLC systems, such as Mitsubishi's Q

range and Omron's CS1 range, are capable of having multiple central processor units, each running individual tasks such as motion, process control and so forth, while with CPUs communicating across a common backplane some of the issues associated with networking and co-ordinating different tasks are removed.

With single programming and configuration environments based around the IEC 61131 programming standards, manufacturers are able to provide greater integration and flexibility between applications. Siemens WinAC, Allen Bradley's RSlogix, Omron's CX-Smart suite and GE Fanuc Automation's CIMPLICITY are good examples.

Some of the limitations of PLCs stem from the need for manufacturers to design systems with wide appeal, which may make it difficult for machinery manufacturers to match their specific hardware requirements precisely and so end up paying for features that are not needed.

Being a 'closed' operating system places some restrictions on how PLCs are programmed and configured, which can prove too limiting in some instances. Additionally, there is a possibility of feeling 'tied in' to one particular PLC manufacturer due to the outlay needed for programming tools.

For despite IEC 61131, programs are not interchangeable between PLC manufacturers, although a common programming structure goes some way towards standardisation.

Even with some of the limitations, the trend for greater functionality, flexibility and support, at reduced size and price seems certain to give PLCs a good future.

Using PLC control

For a current example of PLC control consider the four-side-seal wrapping machines built by Doyen Medipharm. These are used typically for sterilised medical devices, often where regulations dictate the need to guarantee the safety and integrity of each pack. Validating these processes is time consuming and costly, so Doyen uses proven modular designs that are flexible and can cope with easy modification when developing new solutions.

Earlier machines used dedicated in-house designed PC controllers. However, these proved increasingly difficult to maintain, mainly due to the complexity of programming and validating the control software. A decision was therefore taken to split the machine control strategy into a PC for the operator display and PLC for machine control.



Combined system: Doyen Medipharm 4SS uses a PC display and PLC machine control

Doyen now uses a Windows based SCADA package, running on an industrial flat-panel PC for the operator display and to provide access to additional services. The PLC handles machine control and uses standard flash memory cards to hold recipe data, production variables, error codes and so forth. Independent PLC co-processors control the various servo motors, temperature zones and remote i/o.

This approach allows Doyen to use industry standard software techniques and to generate modular control software that can be efficiently validated.

Enter the softPLC

Meanwhile, softPLC is a term increasingly heard when discussing PC control systems. As the name implies, this takes the control functions found in a PLC and incorporates them into a software package that runs under a commercial operating system, such as Windows NT.

Common programming methods, using IEC 61131, allow engineers to design systems regardless of whether the end platform is a soft-PLC or 'hard' PLC.

For example, Allen-Bradley's SoftLogix 5800, which is based on the company's Logix PLC family, runs under Windows NT. Determinism is solved using their 'virtual backplane'.

Siemens offers its WinAC Basis for less time-critical applications and its WinAC RTX uses VenturCom's RTX real time extensions, to provide guaranteed determinism. Similarly, GE Fanuc Automation's softPLC – CIMPLICITY Machine Edition – offers real time options using VenturCom's RTX extension to Windows. These systems are suitable for speed-intensive real-time control applications.

The advantage of a softPLC is of course its openness, allowing the user to run standard software under a familiar Windows environment with the system programmed and configured to his exact requirements.

However, this comes at a price. Its very openness places the responsibility firmly on the designer to ensure the system's sturdiness and reliability. Indeed, the designer will need a good understanding of operating systems and to be aware also of possible conflicts and viruses that some software packages could have on his system.

In industrial environments where electrical noise, shock, vibration and extremes of temperature are present, commercial PC equipment is likely to fail. So many controls suppliers install softPLCs on industrial PCs, often as a package that includes a suite of application software giving analysis, communications, graphic functions and so forth.

Alternative solutions for integrating PLCs into PC systems include slot-PLCs which offer all the advantages of conventional PLCs but in the format of a plug-in PC card. They are independent of the PC's operating system and are therefore highly reliable. Good examples are seen in Siemens' WinAC Slot range and Omron's C200PC range.

Using softPLC control

Cartoning machinery manufacturer Bradman-Lake employs both PC and PLC-based systems for machine control, with touch screens providing operator access to machine functions, fault diagnosis, production data and so forth.



Soft control: Bradman-Lake SL9000 end-load cartoner is under softPLC control

Their high-performance machines use a PC display for the operator, with the real time machine control carried out by a softPLC. The display runs under Windows using an in-house Visual Basic program or a standard SCADA package, depending on the complexity and amount of information required.

The PC contains various control interface cards, a high-speed Sercos card for networking and controlling all the servos axis, remote i/o masters for controlling machine mounted sensors, actuators and so forth.

Custom solutions

In certain situations that may be complex or cost sensitive, standard off-the-shelf PCs or PLCs could prove too limiting and expensive.

Therefore many machinery manufacturers design and build their own bespoke control systems using custom electronics with embedded software. These systems are typically programmed in high level programming languages, such as Basic, C/C++ or increasingly the platform independent language, Java.

This implies that design engineers will need different programming skills than those of conventional PLC programmers.

Additionally, the knowledge and experience of these designs within the machinery manufacturer will typically reside with only a few individuals, which could have long-term support issues.

The main goals of bespoke systems are to offer increased reliability, flexibility at reduced cost. However, the cost of developing and supporting these systems means they are best suited to manufacturers building standard machines in high volumes.

To overcome some of these concerns, designers can now opt for a number of standard off-

the-shelf components that are ideally suited to bespoke solutions.

For example, PC/104 single board computers are widely available which, combined with the latest Windows XP Embedded and Windows CE operating systems, means it is possible to design real-time control systems with very capable graphical user interfaces.

These operating systems are particularly appropriate for industrial use since they run from EPROM or flash memory and remove the need for a hard disk – the source of many problems in the industrial environment.

Other hardware solutions using real time operating systems include Omron's Open Network Controller, an industrial PC running QNX – a real time operating system. It features built-in industrial networking and internet capabilities to allow process and machine data to be readily accessed.

Custom solution with PC/104

Ink jet printer specialist Videojet Technologies undertook a development using Arcom's PC/104 compatible range of single board computers.

The requirement was for a high-resolution



Single board: Arcom's SBC-GX1 high performance fanless single board computer

printer to identify cases travelling on a conveyor. The solution had to be capable of processing serial information from upstream equipment, such as checkweighers, and to communicate this to other control boards linked to the ink jet printhead. This is a high-speed operation that needs to process 50 images a second reliably with a minimum consistent interrupt latency of 100 microseconds.

In terms of control strategy, Videojet felt the most reliable technical solution offering a good basis for future developments, came from a combination of PC/104 technology combined with a Windows CE operating system. ■