Machine building & Automation

Machine Control

New approach to machine control boosts performance

Can you add value to your machines, perhaps adding greater sophistication and complexity, without impacting on development time and programming cost? Robert Brooks looks at the evolution of a new breed of machine controllers.

At the heart of every machine is a machine controller. That might seem an obvious thing to say, but what exactly do we mean? And how do we specify the controller? And how much of an impact might that controller have on the performance of the machine or on the opportunities to add value? In this age of global competition and ever greater pressures on price and functionality, is it time to challenge common perceptions and approaches?

The traditional heart of the machine has been the PLC. What started as a simple logic and sequencing controller has evolved into an incredibly sophisticated piece of hardware capable of addressing almost every aspect of machine control, including motion, vision, safety, robotics, communications and more. By and large it has seen off the threat of the soft PLC for machine control, and today most of us are probably pretty comfortable that when it comes to PLC specification, we're making the most of what's on offer. Certainly specification has moved well beyond the days when a PLC was selected almost exclusively on its I/O count and on its price. We all know just what the modern PLC can do, and standards such as IEC 61131 have dramatically simplified programming.

So it may come as something of a shock to discover that the PLC may well be limiting the performance of your machine, may be a communications bottleneck, and may be costing you dearly in programming effort and configuration time, whilst compromising your ability to add value.

In these days of high performance processors and open Ethernet communications, that's quite an assertion. But let's open up the PLC and see what we find. Perhaps on a single backplane you'll have the controller itself, a motion module, a robot controller, an I/O master and a communications module. Being on the backplane, they appear to be part of a highly integrated package. And indeed, in terms of getting them all to talk to one another, they are. But actually they are all separate CPUs, with some memory of their own and some shared memory. And all of these separate CPUs have to communicate with one another. Headlines will focus on the speed of those communications, but actually what is important is synchronisation. Communication speed is irrelevant if synch-ronous control cannot be guaranteed, and synchronisation between, say, the PLC CPU and the motion control CPU is very hard to guarantee at the very highest machine speeds. In other words, the PLC itself is a bottleneck, either compromising machine speed or impacting on finished product quality.
However, there is a new breed of machine controllers which eliminates these problems by taking a different approach to integration of the different functional modules. And interestingly it achieves many of these benefits by mirroring some of the developments in soft PLCs. Indeed, in many ways, this new machine controller represents the logical convergence of the hardware PLC and the soft PLC.

In the conventional hardware PLC, each CPU uses ASIC technology to realise its functionality, all packaged into the familiar ruggedised controller. The soft PLC on the other hand performs this same functionality in software, and runs it on an industrial PC. Many things hampered the adoption of the soft PLC for machine control, not least question marks over the environmental robustness of the PC itself, the reliability of the operating system for critical control, and the longevity of support for any given generation of product. But suppose in a conventional PLC, instead of separate CPUs for different functions, we could perform all of those functions as software blocks within a single CPU. Package this up with the reliability and ruggedness of a conventional PLC, and equip it with a dedicated software control engine, and you would have a machine controller that could truly become a performance enabler rather than a performance limiter. This is a growing trend in machine control, typified by products such as Omron's Sysmac NJ controllers. Communications bottlenecks are eliminated at a stroke, and control systems can finally realise their potential.

It also means that the controller can evolve in situ. A conventional PLC, once designed, typically remains unchanged until the day it is discontinued. With the new machine control model, however, new functionality can be quickly and easily added without the need to change anything in the hardware. Programming is simplified, too, since everything can be programmed, configured, simulated, tested and monitored within a single programming environment, using IEC 61131-3 standards and making use of PLCopen-certified function blocks. Not only does that save time and cost, it also enables machine functionality to be optimised.

Having taken advantage of these developments in controllers, we can now look further out into the machine to see how this might impact on other automation components – such as drives, servos and vision systems – and the machine I/O. As machine builders look to take advantage of best of breed components while standardising on network choices, industrial Ethernet has come to the fore. But what does standardisation mean? Not every vendor implements every aspect of a given specification, and some specifications are somewhat open to interpretation. The result is that is two devices seemingly using the same communications technology may actually represent something of a communications headache.

Also, not all Ethernet variants are equal when it comes to different applications. Requirements for data/information exchange are very different to those for real-time control. Omron's approach is to adopt EtherNet/IP as standard for data/information exchange (PLC to PLC, and PLC to higher level systems) and EtherCAT for real-time, high-speed control. EtherCAT's 'distributed clock' technology ensures that critical messages are synchronised with 1µs. Again performance bottlenecks are removed, but users still have the freedom to choose best of breed components. The same networks also lend themselves to distributed I/O, and indeed to safety I/O, enabling best of breed products to be connected via 'slice I/O' systems, and again enabling configuration from within the one programming environment.

With this new approach to machine control, machine builders have it within their grasp to achieve new levels of performance and sophistication within their designs – adding value in an ever more competitive market.

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