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PLC VS CNC: IS THERE ROOM FOR BOTH IN THE FACTORY OF THE FUTURE?

As greater automation becomes the focus of UK manufacturing, control systems are having to become increasingly complex and efficient. However, in order to make the most of these technologies, manufacturers need to understand what their options are, and how these control systems can play their part in the factory of the future.

The automation of industrial processes is hardly a product of the last few years, but the concept of automation is changing as Industry 4.0 and the Internet of Things become more prevalent. Alongside the picking, packing, palletising and conveying of former years, automation now encompasses concepts such as zero-downtime, increased precision, high speeds, efficiency and proactive maintenance. All of this is powered by digital, programmable systems that have been developed and perfected over more than 60 years.

The first of these is Computer Numerical Control (CNC), a technology that facilitates the automation of machine tools by means of computers that execute pre-programmed sequences.

"CNC was developed during the 50s and 60s as a logical progression from Computer Aided Manufacturing (CAM) and tracer-based automation," says Ian Baird, CNC Applications Manager for FANUC's Factory Automation Division. "Established alongside computer and servo system developments, CNC helped manufacturers to meet their increasing requirements for repeatable, high-precision production. Today, it's formed of five main parts – a sequencer, interpolator, servo controllers, logic controller and operator control interface – and is synonymous with precision and control."

Twenty years after CNC was first introduced, a cheaper and simpler form of computer-aided control was developed: Programmable Logic Controller (PLC). Ian says: "It's strange that the less sophisticated version of machine control was developed 20 years after its highly technical predecessor, but PLC certainly served, and still serves, a purpose in factory automation.

“PLC was developed in the 1980s to supersede relay logic control systems, which were often less cost-effective, flexible and easy to use because they relied on hardware to perform their key functions. PLC has input and output functionality and can be programmed to perform sequential operations, data processing, or simple axes control.”

Despite the two-decade age difference, PLC has never been intended to replace CNC, as Ian explains. “Both serve very different purposes and marketplaces, with their own advantages and disadvantages. Therefore, it would be limiting for anyone in industry to say: ‘I’ve invested in CNC – there’s no room for PLC here’, because they are two entirely different controls.”

CNC is more frequently associated with the concept of automation because the scope of its use extends beyond a simple input-output algorithm. Ian says: “Modern CNC is a flexible, digitally-controlled system that can be tailored to suit a manufacturer’s needs without needing to re-programme the entire system.

“Most modern CNCs also include user interfaces with built-in operation, maintenance and diagnostic screens. For this reason, CNC is popular with people who want full control over their machines, because its functionality does allow you to fly solo after a bit of training.”

The flexibility of CNC lends it perfectly to complex, multi-axis machining in almost any industry.

“A CNC’s applications are limited only by your imagination,” says Ian. “Any application that requires precision motion control needs CNC, whether that be the manufacture of watch parts and medical devices, or reactive atomic plasma etching.”

PLC, on the other hand, is the perfect solution for simple control tasks. Ian says: “If you’ve got an application that doesn’t need a high level of accuracy or flexible motion control, such as an AC motor conveyor, then PLC is often the best choice. It’s cheaper than CNC, which would arguably be better invested in more complex applications.”

There are some disadvantages to the simplicity of PLC, as Ian explains. “PLC does not have the flexibility of CNC. This means that, if you need to change the programme even slightly, you have to re-programme it entirely. It also doesn’t offer the precision of CNC and is therefore best used as a low-cost solution for basic tasks.”

Despite PLC's low cost, many manufacturers are choosing CNC over PLC, due in part to its lower total cost of ownership. Ian says: "It is interesting to see many designers turning to CNC after investing in PLC, largely for reasons of flexibility, reliability and cost.

"The initial cost of CNC is higher than that of PLC, but your return on investment can be higher in the long term because of the CNC's higher reliability and control. It also gives system designers the flexibility to dictate how much control they want users to have over their machines."

The long-term cost-effectiveness of CNC can be attributed to its advanced user-programmable features, which can minimise downtime and control the energy usage or output of the machine.

Ian says: "A lot of CNCs now come equipped with AI contour control. This means you can control the machine to be within a certain workload, or adaptively control the machine for working overnight. For example, you can programme it so that it only works at 80 per cent load, allowing you to be more economical with your energy usage.

"CNCs also come equipped with energy efficiency functions, such as energy charge modules. These help you to size your machine equipment to the average power duty of the machine, thus reducing factory overhead."

The added safety functions of CNCs lend themselves well to collaborative working with humans. Ian says: "CNCs come equipped with a digital algorithm that looks after the motion control. This digital system is formed of two parts: a real digital data system and an observer digital system. The observer acts like the "ideal", providing the machine with the parameters in which it should be working. The real and the observer are both driven by the same command, so they should be working in exactly the same way.

"If the real system encounters a disruption, such as an unexpected load, then this causes the real data to deviate from the observer data. The machine will translate this as a collision and respond in one of two ways. If it's moving slowly, it will stop, and if it's moving quickly, it will perform a 'vectored back-off', where it will retract any moving machinery to avoid damage.

“For high-end machines, you can also incorporate 3D technology, which stops five-axis machinery from moving outside of its pre-determined work envelope.”

Alongside safety, zero-downtime is an important consideration for manufacturers looking to automate their processes. Ian says: “Unplanned downtime is expensive: it can halt production for days, weeks, or even months. An undetected fault could cause irreversible damage to machinery, and even be hazardous to human operatives.

“Although it’s unrealistic to expect factories to work seamlessly 24/7, we can aim to minimise downtime caused by minor faults or errors.”

This is where the concept of predictive maintenance comes into play, which, as Ian explains, is facilitated by CNC control technology. “Predictive maintenance allows us to spot potential problems before they occur, and act accordingly before they become serious”, he says. “We do this by employing the automation technology that controls the machine as a kind of watchman.

“For example, a CNC can monitor the components it controls and alert the user to any anomalies in their performance. This allows the user to get spare parts and service organised. In this way, any downtime is planned in advance, and won’t impact production.”

With all of these advantages over its younger sibling, is CNC destined to become the sole tool of the factory of the future? Ian says: “It’s tempting to dismiss PLC as cheap and cheerful, but it still has a vital part to play in automation.

“The best example of this is a production line. CNC may be controlling the robot arms, the tooling, milling, grinding, and so on, but PLC is powering the belt that takes a product or material from one part of the line to the next. The complexity of CNC does not lend it well to such tasks and would be wasted. As part of a factory floor, where simple and complex tasks are done simultaneously, CNC and PLC work perfectly together.”

With CNC and PLC both maintaining a place in manufacturing’s tool-kit, it is now important to look at how they can be developed. For Ian, the world of Big Data and collaboration beckons.

“Industrial control systems will continue to evolve, and this will largely come in the form of specialisations suited to specific industries”, he says. “Third-parties will also exploit the

concept of an open interface in order to integrate the factory with the Internet of Things. With this will come intelligent machines and data collection and analysis on a vast scale, which will help us to identify further process improvements."

Only time will be able to tell how CNC and PLC adapt to the factory of the future, but it is clear that they will both form a part of it, if not always working in collaboration.

Ian says: "It's horses for courses really, and there will be instances where one is better than the other. When all's said and done, it's a case of choosing the right tool for the right job, which is essentially what engineering is all about."

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