英文原文：

PLCs --Past, Present and Future
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Everyone knows there's only one constant in the technology world, and that's change. This is especially evident in the evolution of Programmable Logic Controllers (PLC) and their varied applications. From their introduction more than 30 years ago, PLCs have become the cornerstone of hundreds of thousands of control systems in a wide range of industries.

At heart, the PLC is an industrialized computer programmed with highly specialized languages, and it continues to benefit from technological advances in the computer and information technology worlds. The most prominent of which is miniaturization and communications.

1 The Shrinking PLC

When the PLC was first introduced, its size was a major improvement - relative to the hundreds of hard-wired relays and timers it replaced. A typical unit housing a CPU and I/O was roughly the size of a 19 television set. Through the 1980s and early 1990s, modular PLCs continued to shrink in footprint while increasing in capabilities and performance (see Diagram 1 for typical modular PLC configuration).

In recent years, smaller PLCs have been introduced in the nano and micro classes that offer features previously found only in larger PLCs. This has made specifying a larger PLC just for additional features or performance, and not increased I/O count, unnecessary, as even those in the nano class are capable of Ethernet communication, motion control, on-board PID with autotune, remote connectivity and more.

PLCs are also now well-equipped to replace stand-alone process controllers in many applications, due to their ability to perform functions of motion control, data acquisition, RTU (remote telemetry unit) and even some integrated HMI (human machine interface) functions. Previously, these functions often required their own purpose-built controllers and software, plus a separate PLC for the discrete control and interlocking.

2 The Great Communicator

Possibly the most significant change in recent years lies in the communications arena. In the 1970s Modicon introduction of Modbus communications protocol allowed PLCs to communicate over standard cabling. This translates to an ability to place PLCs in closer proximity to real world devices and communicate back to other system controls in a main panel.

In the past 30 years we have seen literally hundreds of proprietary and standard protocols developed, each with their own unique advantages.Today's PLCs have to be data compilers and information gateways. They have to interface with bar code scanners and printers, as well as temperature and analog sensors. They need multiple protocol support to be able to connect with other devices in the process. And furthermore, they need all these capabilities while remaining cost-effective and simple to program.

Another primary development that has literally revolutionized the way PLCs are programmed, communicate with each other and interface with PCs for HMI, SCADA or DCS applications, came from the computing world.

Use of Ethernet communications on the plant floor has doubled in the past five years. While serial communications remain popular and reliable, Ethernet is fast becoming the communications media of choice with advantages that simply can't be ignored, such as: * Network speed. * Ease of use when it comes to the setup and wiring. * Availability of off-the-shelf networking components. * Built-in communications setups.

3 Integrated Motion Control

Another responsibility the PLC has been tasked with is motion control. From simple open-loop to multi-axis applications, the trend has been to integrate this feature into PLC hardware and software.

There are many applications that require accurate control at a fast pace, but not exact precision at blazing speeds. These are applications where the stand-alone PLC works well. Many nano and micro PLCs are available with high-speed counting

capabilities and high-frequency pulse outputs built into the controller, making them a viable solution for open-loop control.

The one caveat is that the controller does not know the position of the output device during the control sequence. On the other hand, its main advantage is cost. Even simple motion control had previously required an expensive option module, and at times was restricted to more sophisticated control platforms in order to meet system requirements.

More sophisticated motion applications require higher-precision positioning hardware and software, and many PLCs offer high-speed option modules that interface with servo drives. Most drives today can accept traditional commands from host (PLC or PC) controls, or provide their own internal motion control. The trend here is to integrate the motion control configuration into the logic controller programming software package.

4 Programming Languages

A facet of the PLC that reflects both the past and the future is programming language. The IEC 61131-3 standard deals with programming languages and defines two graphical and two textual PLC programming language standards: * Ladder logic (graphical). * Function block diagram (graphical). * Structured text (textual).Instruction list (textual).

This standard also defines graphical and textual sequential function chart elements to organize programs for sequential and parallel control processing. Based on the standard, many manufacturers offer at least two of these languages as options for programming their PLCs. Ironically, approximately 96 percent of PLC users recently still use ladder diagrams to construct their PLC code. It seems that ladder logic continues to be a top choice given it's performed so well for so long.

5 Hardware Platforms

The modern PLC has incorporated many types of Commercial off the Shelf (COTS) technology in its CPU. This latest technology gives the PLC a faster, more

powerful processor with more memory at less cost. These advances have also allowed the PLC to expand its portfolio and take on new tasks like communications, data manipulation and high-speed motion without giving up the rugged and reliable performance expected from industrial control equipment.

New technology has also created a category of controllers called Programmable Automation Controllers, or PACs. PACs differ from traditional PLCs in that they typically utilize open, modular architectures for both hardware and software, using de facto standards for network interfaces, languages and protocols. They could be viewed as a PC in an industrial PLC-like package.

6 The Future

A 2005 PLC Product Focus Study from Reed Research Group pointed out factors increasingly important to users, machine builders and those making the purchasing decisions. The top picks for features of importance were.

6.1 The ability to network, and do so easily.

Ethernet communications is leading the charge in this realm. Not only are new protocols surfacing, but many of the industry de facto standard serial protocols that have been used for many years are being ported to Ethernet platforms. These include Modbus (ModbusTCP), DeviceNet (Ethernet/IP) and Profibus (Profinet). Ethernet communication modules for PLCs are readily available with high-speed performance and flexible protocols. Also, many PLC CPUs are now available with Ethernet ports on board, saving I/O slot space. PLCs will continue to develop more sophisticated connectivity to report information to other PLCs, system control systems, data acquisition (SCADA) systems and enterprise resource planning (ERP) systems. Additionally, wireless communications will continue to gain popularity.

6.2 The ability to network PLC I/O connections with a PC.

The same trends that have benefited PLC networking have migrated to the I/O level. Many PLC manufacturers are supporting the most accepted fieldbus networks, allowing PLC I/O to be distributed over large physical distances, or located where it

was previously considered nearly impossible. This has opened the door for personal computers to interface with standard PLC I/O subsystems by using interface cards, typically supplied by the PLC manufacturer or a third party developer. Now these challenging locations can be monitored with today a PC. Where industrial-grade control engines are not required, the user can take advantage of more advanced software packages and hardware flexibility at a lower cost.

6.3 The ability to use universal programming software for multiple targets/platforms.

In the past it was expected that an intelligent controller would be complex to program. That is no longer the case. Users are no longer just trained programmers, such as design engineers or systems integrators, but end-users who expect easier-to-use software in more familiar formats. The Windows-based look and feel that users are familiar with on their personal computers have become the most accepted graphical user interface. What began as simple relay logic emulation for programming PLCs has evolved into languages that use higher level function blocks that are much more intuitive to configure. PLC manufacturers are also beginning to integrate the programming of diverse functions that allow you to learn only one package in configuring logic, HMI, motion control and other specialized capabilities. Possibly the ultimate wish of the end-user would be for a software package that could seamlessly program many manufacturers PLCs and sub-systems. After all, Microsoft Windows operating system and applications work similarly whether installed on a Dell, HP or IBM computer, which makes it easier for the user.

Overall, PLC users are satisfied with the products currently available, while keeping their eye on new trends and implementing them where the benefits are obvious. Typically, new installations take advantage of advancing technologies, helping them become more accepted in the industrial world.