POWER Engineering®

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DIGITAL LEVERAGE

Technology advances that dramatically improve control loop design and function at nuclear plants can raise productivity and lower costs.

The nuclear industry is, as they say, on a roll. Availability, reliability, and capacity are way up compared to a few years ago. The safety record is impeccable and the plants are making money given the relatively low marginal cost of production. Most plants are re-licensing to run another 20 years and there's even talk of adding new capacity to the North American grid. The current administration obviously feels that nuclear needs to be part of our future energy plan and is working to solve the long-term storage issue and simplify the licensing process so that can happen. All in all, some great news for an industry that has been on the back burner for some time now.

Tempering this rosy outlook, however, are some storm clouds on the horizon that the industry must recognize and address if it is to continue the positive string of wins seen recently. This article will examine some of the looming challenges and discuss how taking advantage of new developments in digital process control technology could help end-users craft a plan that will keep them successful and set the stage for a whole new round of performance improvements.

Before discussing these issues, a little background is in order. When one discusses process control, it is generally understood to mean automated process control that takes advantage of process controllers, measurement devices (transmitters), and final control elements (control valves) to reduce the man-hours and expense needed to produce a unit of output, in this case, the megawatt-hour. Power plants – in this instance nuclear plants – must control process variables like flow, temperature, pressure and level in order to maximize yield and minimize the cost of inputs, labor and materials.

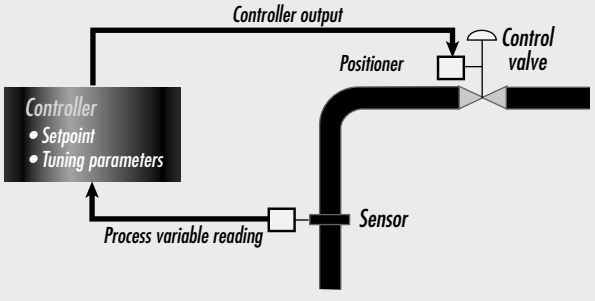
Until about 30 years ago, the basic process control structure consisted of local pneumatic controllers linked to a process sensor of some kind that measured process variables, including flow, temperature, pressure, or level in a vessel (Figure 1). The controller reads the process variable and compares it to the desired reading (setpoint), then modifies the output signal to the final control element in an effort to reduce the error between the process variable and the setpoint. In theory, all setpoints in the total process are optimized so that the end result provided the desired results, meaning maximum yield at minimum cost.

While the basic structure and operational goal of the process control loop has remained the same over that 30-year period, technology advances have totally transformed the execution of the process control strategy. The complete list of advances is much too long to detail here, but among the more significant developments is the replacement of pneumatics with electronic controllers. Equally significant, centralized process control systems have provided much better visibility to the process and improved coordination of various setpoints. Process optimization software has enabled the end-user to model the process from start to finish, further refining the way the process is controlled. All of these changes, and more, have combined to greatly improve the productivity of the typical process plant and expand the universe of automation.

But about 15 years ago came another major leap in potential performance with the advent of two-way digital communication between the control system – typically located in some central location – and devices in the field that were sensing and controlling the process itself.

These smart field devices, built on digital platforms, certainly improved performance of the devices themselves, offering better accuracy, improved dynamic response, lower hysteresis and dead band, and providing self-diagnostics. More importantly, they also opened a whole new window on the methods that have transformed, once again, how processes are managed. The advent of two-way communication now allows the field device to be identified, set up and calibrated from the central control panel, greatly reducing the time and chance for errors in the start-up phase. The digital structure can also reduce cabling and wiring needed for a typical instal-

FIGURE 1
OLD PROCESS CONTROL



lation because digital signals can travel over the same twisted pair to multiple field devices (Figure 2).

However, the biggest advantage of the new digital structure in process control instrumentation revolves around signals that field devices can send back to the process control system. These field device signals can be used to alert the end-user to situations developing in the process and/or in the devices themselves, which could impact overall operational performance. In essence, this sets up an early warning system that can drive the operation and maintenance of the process, and transforms the maintenance approach from reactive or preventive to an on-line, condition-based predictive maintenance approach that is the Holy Grail for most maintenance personnel.

So What?

Why is all this important to the nuclear industry? To answer that, let's review some of the major issues facing the industry and how the technology described can have an impact on each one.

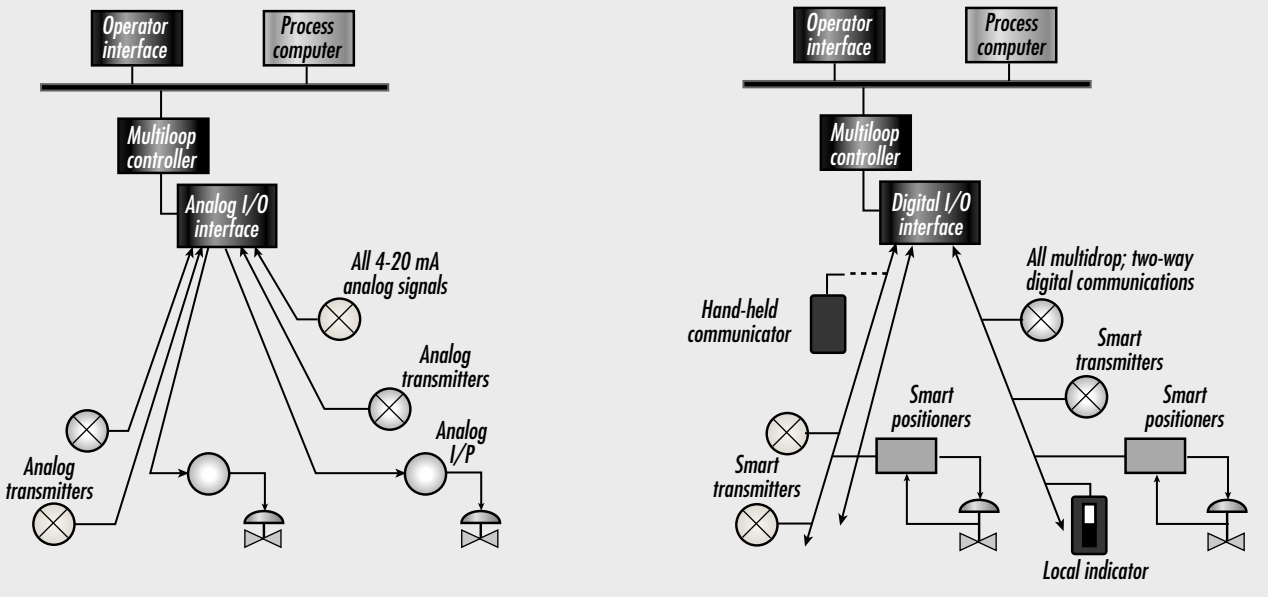
Staffing — As electric markets in more states become deregulated, utilities are challenged to find ways to reduce costs. Staffing is one area targeted for cost cutting at many plants. Cuts are made and many sites are forced to do the same amount of work – or more – with fewer employees. This establishes a dynamic where the existing staff does not have the time or inclination to explore ways to improve operations since they must concentrate on just keeping the plant running.

As a result, opportunities to improve operations may be overlooked. Also, a significant number of personnel in the existing U.S. nuclear workforce started their careers in the 1970s and will soon reach retirement age. This impending mass attrition is one of the biggest challenges facing the industry. Convincing recent engineering graduates to work and stay in the commercial nuclear field has proven difficult in all parts of the country. Each of these issues can, in ways, be helped by digital technology. One of the fundamental principles of automation is that it can reduce the amount of human resources needed to support a given business process. Optimizing automation using the new digital structure will improve productivity of the existing staff, and actually provide time to consider more extensive changes in the process to boost productivity even further.

> CONVINCING RECENT ENGINEERING GRADUATES TO WORK AND STAY IN THE NUCLEAR FIELD COULD BE DIFFICULT. SUCH ISSUES CAN BE HELPED BY DIGITAL TECHNOLOGY.

Predictive maintenance also reduces manpower required, which can improve the plant's O&M cost structure. Better overall process control that

FIGURE 2
TWO-WAY DIGITAL PROCESS CONTROL



comes with digital upgrades will also improve plant efficiency and capacity, placing plants in a better position to compete against other energy sources. And because we must be concerned about where the next generation of engineers will come from, recent graduates will be much more likely to consider the nuclear industry as it catches up with the technology currently used in many manufacturing and fossil generation industries.

Product Obsolescence — The average nuclear plant will run at least another 30 years. And I&C equipment in existing plants gets older by the day and more difficult and costly to support. Eventually, it will not be economically feasible to keep it in operation. Why not replace it now with a strategic program where improvements in financial performance described here will pay for the cost of the equipment upgrades?

If end-users and manufacturers cooperate with third parties like INPO and EPRI, there should be a way to cut down on the costs of design modifications to further increase the opportunity to change toward a more productive future. EPRI, in particular, is well-placed to help the industry find solutions to design modification costs that have kept them from moving forward.

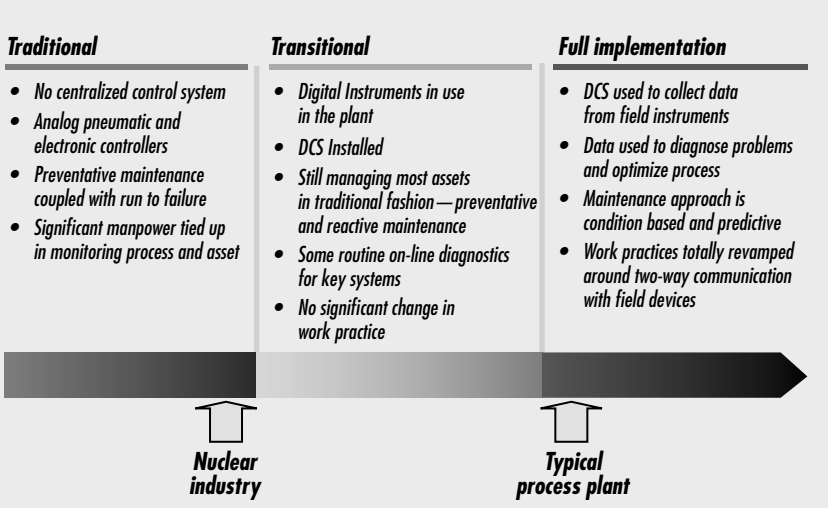
Long-term Safety and Reliability — Because of the strong correlation industry has found between reliability and safety, the nuclear industry has focused on improving the former. Digital field instrumentation, in-and-of itself, will improve reliability because the devices are more reliable and facilitate moving toward predictive maintenance.

But improvement of process control that comes with the switch to a digital infrastructure may be even more important. As process control improves, critical loops in the process swing less around setpoint. Steam generator and feedwater heater levels stabilize. Pressures, temperatures, and flows become smoother and the whole plant settles into a more stable operation. As a result, all plant components suffer fewer service excursions and last longer. Reliability goes up and maintenance costs come down.

> THE BIGGEST ADVANTAGE OF THE NEW DIGITAL STRUCTURE REVOLVES AROUND SIGNALS THAT FIELD DEVICES CAN SEND BACK TO THE PROCESS CONTROL SYSTEM.

Figure 3 illustrates in broad terms the transition described. Note elements of the traditional approach on the right hand side of the graphic. The nuclear industry is somewhere in this traditional range, but is beginning to experiment with digital technology. The average process plant has already made it through the transitional phase and is using digital instruments on a regular basis. But even segments outside the nuclear industry have yet to make the full transition to managing both process and assets using the on-line view that the digital structure affords them. Gains can still be made, even at progressive plants.

FIGURE 3
THE DIGITAL DIVIDE



THE BOTTOM LINE

Leveraging this technology should produce major gains in operational performance that boost earnings per share and utility stock price. But it takes a long-term perspective to implement the plan. It will be interesting to see which of the major nuclear utilities in North America will be the first to recognize the power of this totally revamped automation structure — one which will fundamentally change the way plants are operated with higher productivity and lower costs. PE

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