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Fieldbus improves control and asset management

Substantial benefits are realized from increased diagnostics and process data

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With the "enabling technology" of FOUNDATION fieldbus, intelligent field devices are able to go far beyond providing an accurate process variable. Information generated by smart field instrumentation in hydrocarbon processing plants can significantly improve production efficiencies, enable open field-based control architecture, drive cost-saving asset management solutions and enhance enterprise-wide information technology systems.

Since development of intelligent field instrumentation more than 10 years ago, growth and utilization of the capabilities and data available from these devices have been limited, largely by widespread proprietary digital communication standards. The introduction of device communication technologies and standards—such as FOUNDATION fieldbus—is now enhancing the value of information delivered from field devices throughout process industry facilities.

This "enabling technology" is based on open, continuous communication of information between other intelligent field devices and application-specific hosts—such as process automation and asset management systems. Openness of the architecture protects the interests of the end user, but it also provides manufacturers access to a larger number of potential customers without being locked out by proprietary protocols.

This trend toward interoperability—replacing different vendors' products easily and effectively—encourages field device suppliers to find new ways to add value to their products. Efficient use of device data is the basis for a revolution that is expanding the role of intelligent field devices to meet the business needs and marketplace challenges of the hydrocarbon processing industry.

A new model. The field device revolution is centered on reducing process variable uncertainty and enhancing device functionality and diagnostics while providing more integrated solutions around the desired process measurement. Fig. 1 illustrates the relationship between these four key areas of intelligent field device development.

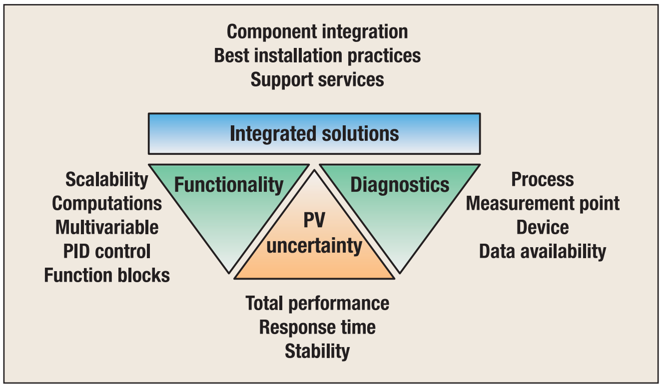

Fig. 1. The new model shows the relationship between four key areas of intelligent device development.

To fully utilize functionality and diagnostics improvements in a field device, new emphasis must be placed on reducing process variable uncertainty. There is no sense in having an instrument capable of performing complex calculations, such as dynamically compensated mass flow in a differential pressure transmitter, if the calculation is based on an inaccurate process variable.

Reductions in process variable uncertainty go beyond general improvements in accuracy. They encompass:

- Minimizing all sources of measurement error under actual field conditions
- Improving device stability to ensure desired performance is maintained over extended periods and changing field conditions
- Reducing response time to generate a representative process variable signal.

By minimizing process variable uncertainty in this fashion, manufacturers are able to use the base sensor measurement as a platform to develop functionality and diagnostics capabilities that further enhance process performance, reliability and availability.

Added functionality simply means getting the transmitter to do more. A wide range of functionality enhancements can be achieved from highly accurate and reliable sensor signals. The Fieldbus Foundation already defines some 30 discrete and continuous function blocks that can be used for various control activities including PID control. This does not, however, prevent manufacturers from generating even more advanced functionality. Multivariable technology, for example, increases the number and type of measurements that can be achieved with a single field device.

The role of the microprocessor in intelligent field devices can also be expanded to incorporate complex computations and data management. More advanced functionality can include scalable field device designs that allow the end user to match a device's performance to the requirements of the application and easily upgrade it to changing requirements in the future. Recent release of mass flowmeter electronic sets that allow users to select and upgrade performance level, number of process variables and desired diagnostics is one of the first examples of scalability.

With a field device network, device data are more readily available for analysis and interpretation to help support cost-effective predictive and preventive maintenance programs. Internal diagnostics can encompass more detailed analysis at an electronic board and component level to identify intermittent or potential failures before they impact the device reliability. The diagnostics role can even be extended to include external components associated with a measurement point such as temperature sensors and impulse lines.

With reduced process variable uncertainty comes the ability to expand the diagnostics capability of the field device into the process. Research shows that what was once considered sensor noise is actually an indicator of conditions that exist within the process. By analyzing specific characteristics and trends in noise, field devices can identify and signal potential problems with process variability or other physical assets (pumps, valves, etc.) in a control loop.

To help ensure that desired performance, functionality and diagnostics within critical measurement and control loops are realized under field conditions, device manufacturers are providing a more integrated approach to applying the technology. Easy-to-use application and engineering software, integration of critical measurement point components, and development of new "best practice" installation designs and procedures are offered to ensure measurement integrity. Taking a more integrated approach to the entire measurement point helps simplify the application engineering process, delivers a more cost-effective packaging of components and expands the manufacturer's responsibility to include the entire measurement point. This is a significant step by vendors toward assuring measurement point reliability versus just assuming field device reliability.

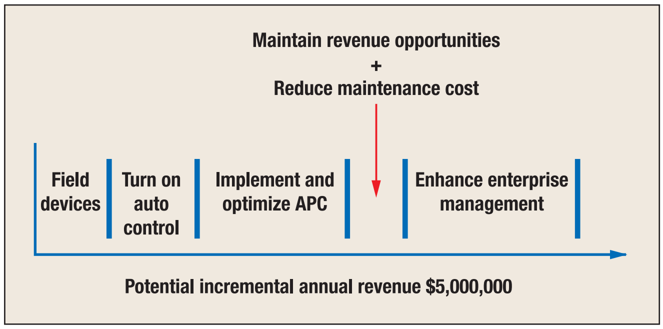

Fig. 2. Recent developments in intelligent field devices relate to a facility's potential to generate annual incremental revenue.

Stepping into reality. When viewing a model, it is always interesting to assess it against what's happening in the real world. Surprisingly enough, intelligent field device developments based on the model proposed in this article are well underway. The best instrument manufacturers recognize the need to reduce process variable uncertainty and already publish total performance and stability specifications for various field devices. Resulting improvements in pressure and temperature transmitters have demonstrated 3% to 4% reductions in process variability and up to 80% reductions in field device calibrations. Improvements in control valve technology and addition of digital valve controllers (DVCs) have resulted in 10% increases in throughput, with over a twofold improvement in controllability performance.

Functionality enhancements are also prevalent within currently available intelligent field devices. The added functionality in digital control valve positioners means they can be field calibrated within five minutes compared to previous methods that required one to three hours. It is even possible for a pressure regulator to indicate flow in applications that would normally use flow recorders. Appearance of more and more multivariable devices for industrial processes attests to the ability of manufacturers to add functionality once they have confidence in the process variability of their products. Multivariable technology allows differential pressure, absolute pressure, process temperature and dynamic mass flow compensation to be consolidated into one field device. This has contributed to reductions of as much as 42% in capital and installed cost while obtaining a 1% of mass flowrate accuracy over a wider turndown ratio. Field-hardened temperature transmitters accommodate up to eight temperature inputs (RTD and/or thermocouple) with a variety of function blocks for averaging or differential temperature calculations. Field bundling of several temperature points can reduce the cost per installation point by as much as 50% to 65%.

As the ability to self-diagnose device health and integrity improves, available information is too valuable to ignore. Standard temperature measurement options offering hot backup redundancy are being expanded into detecting sensor drift and predicting when a temperature sensor will fail.

Pressure transmitters now detect plugged impulse lines and inform the operator that an apparently good measurement is, in fact, not valid. Interestingly, most of these developments do not require additional sensors or electronics. They simply utilize existing information or measurements within the field device itself to improve availability of the device for process control. Control valve diagnostics and the ability to generate valve signatures for online diagnostics allow many valve problems to be easily isolated and remedied without the cost associated with pulling a valve out of service and unnecessarily rebuilding it.

All of these developments in advanced field device diagnostics help hydrocarbon processing facilities practice more preventive and less reactive maintenance. With approximately 50% of the work accomplished in most organizations being reasonably preventable maintenance,[1] potential cost savings from utilizing field device diagnostics data are tremendous.

According to a study by Dow Chemical Company,[2] prior to installing smart field devices, 63% of trips to the field by maintenance technicians responding to requests from an operator found "nothing wrong" with the installed instruments. Today's communications and remote diagnostics with intelligent field instruments can eliminate much of this wasted time. Current advances in device diagnostics have the potential to reduce maintenance activities by another 32% by minimizing or eliminating problems associated with drift, plugged impulse lines and zero shifts in the field device. This proactive approach to maintaining field device availability to provide a reliable measurement for control also improves process availability while drastically reducing maintenance costs.

The most exciting aspect of advanced diagnostics is the ability to look into the process to diagnose control loop and other physical and/or process anomalies. Field device information can readily be shared on a fieldbus network. This data sharing makes it possible to monitor and diagnose the health of a complete loop through statistical process monitoring (SPM).

Field devices can statistically process internal information or data from other devices in a control loop and use the information to establish a set of base conditions. Operator configurable alarm points are then set against the base conditions to alarm potential problems that could have a serious impact on the process. Employing SPM in this fashion has the potential to improve mass/energy balances; indicate fouling, leaks or obstructions in the process stream; or detect variability problems within a control loop or a number of loops. Software packages are already under development to help interpret SPM data to assist operations and maintenance personnel in identifying the root causes of process problems within regulatory flow and level control loops.

It would be extremely counterproductive to allow application or installation procedures to diminish the added performance, enhanced functionality and advanced diagnostics of these revolutionary field devices. It would also be wasteful not to take advantage of newer integrated designs that this type of field device can offer. Several developments are taking place to deliver a more integrated approach in supplying intelligent field devices. These developments range from applications support software, to better methods of integrating existing measurement point components, to radically redesigning how field devices are mechanically connected to the process.

Integral manifold designs reduce potential sources for leakage by 5%, provide a pressure transmitter that can be installed "out of the box," and deliver installation savings in the range of $80 to $250 per device. Studies of the impact of impulse tubing on device performance, availability and cost-to-maintain have led to some creative new practices for installing pressure transmitters. These preengineered, preassembled and pressure tested direct-mount packages standardize installation practices to eliminate plugging problems and measurement errors associated with impulse turbines. Studies show that such designs reduce installed costs by 30% to 50%, while reducing impulse line-related maintenance for 3,000 installed devices over a three-year period to a total of just six work orders. Multivariable technology also promotes new designs that integrate sensors and mechanical components to reduce the number of pipe penetrations, thereby reducing capital and installation costs by as much as 40% per device.

What's the benefit? Quantifiable benefits of the smart field device to overall process operations vary with the type of process, production capacity and products being manufactured. However, it is possible to model contributions of intelligent field devices in relation to key factors that inhibit process facilities from generating incremental revenue.

Fig. 2 is a generic depiction of how recent developments in intelligent field devices relate to a facility's potential to generate incremental revenue on an annual basis. An annual incremental revenue contribution of $5,000,000 is offered as a benchmark value only. Actual value realized is process-dependent and typically goes well beyond the benchmark level for complex processes.

As previously outlined, intelligent field device performance and functionality directly contribute to process variability reductions. As a result, associated increases in capacity and the production of more on-spec product generate incremental revenue that ordinarily would not be realized using conventional technology.

One of the first hurdles to countering lost revenue and exploiting profit opportunities is the ability to actually *use* the automated control capabilities of a process automation system. Various studies indicate that 20% to 40% of control loops are typically in manual mode and up to 80% demonstrate excessive, correctable process variability. Enhanced functionality and performance of intelligent field devices help minimize these problems, allowing operators to turn on "auto" control.

Properly tuned control loops are vital for advanced process control (APC) to function effectively. Reliability and performance of field devices are the most significant elements in implementing and optimizing APC. Refineries that are not properly maintained and monitored can show significant performance degradation in APC initiatives. Diagnostics and maintenance data help keep field device performance and availability at the levels necessary to maintain long-term APC benefits. Asset management systems (AMS) enhance profitability associated with these revenue opportunities by reducing instrument maintenance costs by as much as 50%. Use of AMS software also provides added insurance that the physical assets within the process will be available more often to generate the desired incremental revenue.

The impact of intelligent field devices on enterprise management is not easy to quantify. However, we know the value of enterprise management programs is significant, and return on investment (ROI) can be restricted by the process automation system and field devices. Inability to maintain and optimize APC initiatives limits benefits achieved with enterprise resource planning (ERP) directed manufacturing applications. The same holds true for ERP applications that do not incorporate accurate and real-time information from the process. A 1998 report by the Gartner Group stated that the ROI from enterprise management programs can be reduced by half if they fail to provide accurate and real-time process information.

End-user acceptance. Ready accessibility of reliable field-based information is starting to ignite the imaginations of business managers, who foresee integrating field-generated data with higher-level management systems as the means of controlling overall costs and enabling the enterprise to compete more vigorously in the worldwide marketplace.

A recent study[3] stated that users recognize the need to upgrade field devices to get the most of their system network investment. The same report refers to a study conducted by a leading control industry trade publication that revealed over 60% of respondents in the south central U.S. are considering implementating field networks in the next two to three years.

The report cited a recent poll that "indicated 71% of the users were planning to place control locally in lieu of in-system controllers." This significant trend toward integrating field device networks is taking place to capitalize on the advanced capabilities of intelligent field devices.

Obviously, there is growing acceptance of intelligent field devices in process facilities. Benefits of asset management systems are becoming too great to ignore and have resulted in an increased demand for AMS software in new and existing process facilities. Rapid acceptance of fieldbus technology is another strong indicator. Combine this with increasing demand for advanced field device functionality and diagnostics, and it is evident that users are starting to recognize the true value of intelligent field devices. ■

LITERATURE CITED

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2 Sinclair, H., Site Maintenance Process Leader, Texas Operations, The Dow Chemical Company.

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J. Denver Smart, C.E.T., has over 20 years of experience in process measurement technology involving control instrumentation and continuous process analyzers. His responsibilities have included sulfur plant optimization studies, managing pilot plant research projects, environmental quality control monitoring and gas chromatography applications research. Mr. Smart is currently director, PlantWeb marketing—Asia-Pacific for Emerson Process Management.