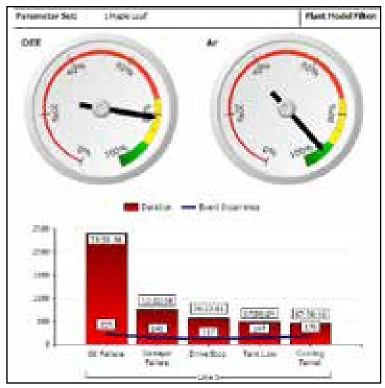

Automation System Optimization

Achieve Superior System Performance After a DCS Migration

By Mike Vernak and Tim Shope

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Many process plants have an outdated Distributed Control System (DCS) currently in place. As a DCS reaches the end of its useful life, an upgrade to a new automation system is required. One of the main factors determining when to upgrade is the expected superior performance of a new automation system as compared to the old DCS. Superior performance results in lower overall plant operating costs, less downtime and lower maintenance costs—providing sufficient return on investment to justify an upgrade.

This white paper will focus on the specific ways in which a new automation system can deliver superior performance as compared to a typical older DCS. Areas that will be covered include but aren't limited to Advanced Process Control, integration with other manufacturing-related software and hardware systems, remote access, data analysis, PID loop control, and alarm and event handling. For each of these areas, this white paper will show why a new automation system is better than an older DCS.

End users should expect much more from their new automation system than from their old DCS, and this white paper will show them how to fulfill those expectations, thereby justifying the decision to upgrade from an old DCS to a new automation system.

Superior Performance

A new automation system will outperform an older DCS in a variety of ways as listed in Table 1, and as discussed below. One of the main advantages will be superior process control, which confers a number of benefits.

Table 1: Advantages of New Automation System over Older DCS

Superior PID loop control and auto tuning
Improved Advanced Process Control
Improved alarm and event handling
More reporting options with easier implementation
Easier integration with third-party software systems
Easier integration with smart instruments, analyzers and valves
Better remote access
Lower support costs
Better access to new features and functions
Easier to find personnel familiar with the system

Controlling a process closer to setpoints and pushing a process to its theoretical limits will result in more throughput, less variability and higher quality. A modern automation system will allow users to implement superior process control in a number of ways.

First, the basic PID control algorithm will be more refined and faster to respond, improving control for all standard PID loops. Auto tuning for PID loops will often be built-in, providing better initial values for the tuning parameters, and allowing continuous adjustments and improvements to be made to these parameters.

In addition to the basic PID algorithm, a modern automation system will also include other regulatory control options, such as PID enhanced and add-on instructions. PID enhanced uses a velocity form algorithm of the PID equation. Essentially, this means that the loop works on change in error to change the output.

Add-on instructions are custom instructions created by users. These instructions are commonly used to create new instructions for sets of commonly-used logic, to provide a common interface to this logic, and to provide documentation for the instruction. Add-on instructions are intended to be used to encapsulate commonly used functions or device control.

For those loops and processes that can't be controlled as required with regulatory control, a number of options will be provided with a new automation system for implementing advanced process control (APC) techniques and technologies. These options will be covered in detail in a subsequent section.

New automation systems provide superior alarm and event handling as compared to an older DCS, improving operator performance and providing better data to plant engineers charged with analyzing plant operations and improving performance.

Alarm handling improvements include the ability to prioritize alarms, thereby reducing alarm flooding and making it easier to determine root causes. Reducing alarm flooding allows operators to respond more quickly, improving safety and reducing incidents. Other advanced alarm features include alarm rationalization, alarm shelving and state-based alarming.

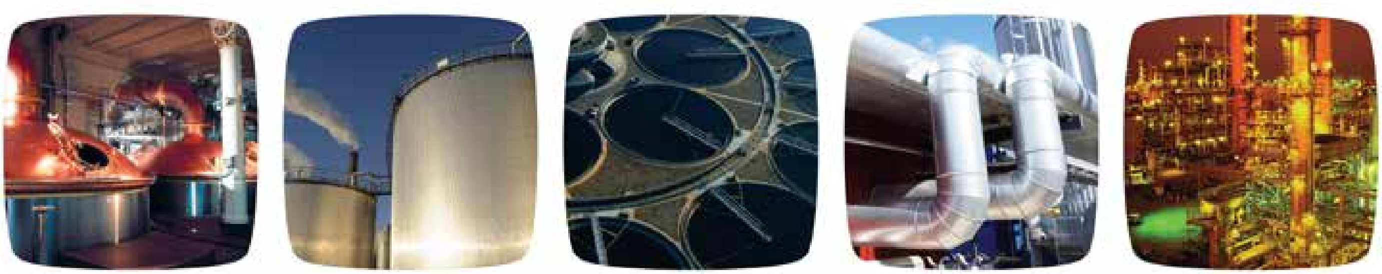
Detailed listings of alarms and events with time stamping can be used by plant personnel to analyze process upsets and other abnormal conditions. This type of analysis can lead to faster determination of root causes, allowing maintenance staff to correct problems at the source.

With an older DCS, it's often very difficult to create reports. New automation systems allow non-programmers to create a variety of reports, providing superior data in easy-to-understand formats. Better reports allow for improved visibility into plant performance, and for more opportunities to improve operations.

A new automation system will experience fewer failures than an older DCS, and it will be easier to find the parts to get the system back up and running in the event of a failure.

Suppliers are continually adding new features and functions to their latest automation system offerings, and often making these additions available at low or no cost, particularly for software-related upgrades. By contrast, an older DCS will only be supported by a vendor at a cursory level, if at all.

An older DCS will not only have inferior support from the supplier as compared to a newer automation system, it will also be harder to support with internal resources. An older DCS will often be built around obsolete hardware and software, making it hard to find support personnel. A new automation system will be designed using the latest technologies, making it easier to support with both internal and external resources.



A modern automation system allows process plants to deliver full value by increasing throughput, reducing downtime and improving quality.

Advanced Process Control

Process control is the main function of an automation system, both via standard regulatory control and APC. A modern automation system will provide superior APC functionality as compared to an older DCS in a number of ways.

First, many new automation systems have built-in APC functionality such as a model-based function blocks and fuzzy logic.

Second, newer automation systems provide tools to allow users to create their own APC applications. Key components of these tools are standard and custom function blocks that can be interconnected in a variety of ways to create an APC application.

Function blocks based on modern, model-based algorithms such as Internal Model Control (IMC) can be used for basic regulatory and advanced process control. The IMC algorithm has a single process variable (PV) and single controlled variable (CV), and can be used as a direct replacement for a PID block in many cases. The model used by the IMC algorithm includes used-entered values for process gain, time constant, and, most importantly, process dead time—as excessive dead time often makes it challenging or nearly impossible to use PID control.

This same IMC algorithm can be combined in various ways to offer more advanced process control capabilities. A single block that incorporates multiple IMC controllers provides an easy way to handle control problems with multiple CVs like a flow controller with split range valve configuration, and even feedforward interactions. Users can even create a single function block to do simple multivariable control with two PVs and two CVs that interact with each other, all without the need to write complex logic to interconnect multiple PID loops.

Custom function blocks can be created from compiled higher level code such as C++ or Visual Basic. These custom function blocks can incorporate a very wide range of APC functionality, limited only by a programmer's expertise. Custom function blocks are often used to perform high-level math functions such as curve fitting.

Combining standard and custom APC function blocks gives users the power to control loops that can't be regulated to an acceptable level by simple PID, or by other regulatory control methods such as PID Enhanced or add-on instructions.

Another way to perform these high-level control functions is to exchange data with an external program that executes the APC algorithms, such as Model Predictive Control (MPC) and returns the required data to the automation system.

MPC is typically a supervisory control application in that it reads process values from the automation system, and then returns setpoints to the automation system for the various control loops under its supervision. A modern automation system will make integration with external applications like MPC much easier. Instead of writing custom data exchange and integration code, standard data exchange protocols like OPC can be used.

These protocols greatly simplify the integration task, and often improve data exchange performance. Some automation system suppliers have very close partnering arrangements with third-party software providers, allowing truly seamless integration.

Improved access to external APC applications is one of the main reasons to integrate an automation system with third-party software, and there are many others.

Why Integrate?

A new automation system will make integration with third-party applications such as APC much easier because industry-standard data exchange protocols and interfaces will be used, such as EtherNet/IP and OPC. This is in contrast to an older DCS, where integration often requires custom coding, and the purchase and implementation of expensive hardware communication gateways.

Integration with third-party applications provides a number of advantages as listed in Table 2 and as detailed below.

Table 2: Why Integrate?

Allows improved operation of third-party applications
Makes data immediately available to all relevant parties
Simplifies remote access
Provides data for real-time analysis
Enables proactive maintenance
Eliminates manual data entry
Improves security by reducing interfaces to outside world

Integration makes data immediately available throughout the enterprise via a variety of methods. One of the most popular is browser-based access, with the automation system acting as a web server.

Users can access automation system data through any browser, without having to install software on their PC or mobile device. The automation system can tightly control such access, allowing only authorized personnel to view and change data.

Levels of access can be different for various groups of users. For example, upper management may only want to view certain high level operating parameters, while plant engineers might require full access including the ability to make changes to the automation system settings.

Browser-based access can be either local to the plant or remote, as all that's required for access is an Internet connection and proper login credentials. Another popular type of remote access is via thin clients, providing many of the conveniences of browser-based access, but with a higher level of security, and often with higher performance.

Quickly providing automation system data to all relevant parties in the formats they prefer allows for superior data analysis, which can directly lead to improved plant performance. For example, data can be analyzed by an asset management package to predict when a failure might occur, allowing proactive maintenance to be performed.

Another important reason to integrate third-party applications with a new automation system is to eliminate manual data entry. With an older DCS, integration among applications is often so difficult and expensive that manual data entry is instead used as the method for transferring data from a third-party application to the DCS.

Moving from manual to electronic data entry reduces labor costs, increases accuracy and greatly improves the speed of data exchange. Improving data exchange speed allows for the integration of real-time control applications into the automation system, such as an external APC application.

Another key advantage of improved integration is better security. If all third-party applications are electronically integrated with the new automation system, then most users will only need access to the automation system, and not additional access to a host of third-party applications. Allowing access to only the automation system greatly simplifies security, and reduces the cost of implementing and maintaining secure access.

Integration to third-party software applications is much easier with a modern automation system as compared to an older DCS—as is integration to field devices such as smart instruments, analyzers and valves.

Getting Full Value from Smart Devices

One of the major advances in automation over the past decade has been the proliferation of smart instruments, analyzers and valves. These smart devices are replacing traditional devices that used a single 4-20mA output to indicate the value of the process variable. Other widely used smart devices in process plants include motor starters and drives.

Smart devices such as this differential pressure level transmitter can provide a wealth of information to a modern automation system through a high-speed two-way digital data link such as EtherNet/IP.

Smart devices include a high-speed two-way digital data link such as EtherNet/IP, and this link allows these devices to exchange multiple data points with an automation system. In addition to the process variable, a smart device can also transmit information concerning device health, diagnostics, and calibration information. In turn, the automation system can send commands to the device for calibration, and for other actions such as opening and closing a smart valve.

Most new process plants design and specify smart devices to the greatest extent possible, only using non-intelligent devices when no smart alternative exists. Many existing process plants have replaced non-intelligent devices with smart counterparts, and these upgrade efforts continue.

Smart motor starters and drives are similarly linked to the automation system via high-speed two-way digital data links, and these devices communicate information regarding status, operating variables and diagnostics to the automation system. The automation system can also send commands to these devices for stop-start, and for speed control in the case of variable speed motor drives.

In all cases, these smart devices must be interfaced to an automation system to realize full value of the extra available data. An older DCS may not have the capability to interface to a wide range of smart devices, particularly if these devices feature different communication protocols. In many cases, a communications gateway will be required, adding considerable expense and offering relatively poor performance.

By contrast, a modern automation system will typically have a wide variety of modern communication protocols built-in and tightly integrated. In addition to having built-in hardware communications capability, a modern automation system will also have support for FDT.

FDT is a software model that standardizes the communication and configuration interface between field devices and host automation systems. FDT's Device Type Manager (DTM) provides a unified structure for accessing device parameters, configuring and operating the devices, and diagnosing problems.

Many popular process automation field buses are supported by FDT including but not limited to EtherNet/IP, Foundation Fieldbus, HART, Modbus TCP/IP and Profibus PA.

Integrating smart devices into a modern automation system enables a wide range of features and capabilities. Many calibration activities can be performed electronically and remotely, with appropriate calibration data and records automatically saved to memory.

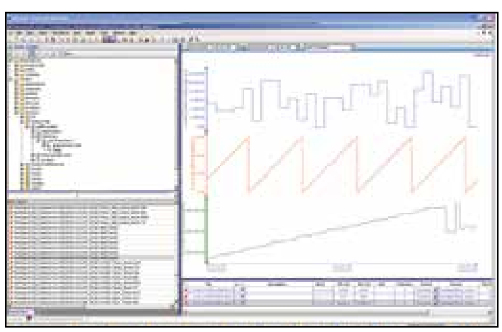
Smart device health data can be analyzed by an asset management system to perform predictive maintenance; that is, predicting when a device is likely to fail. Predictive maintenance allows plant personnel to service or repair smart devices only when needed, instead of on a rigid schedule. This not only saves money in terms of maintenance and repair expenses, but also avoids costly device failures and associated downtime.

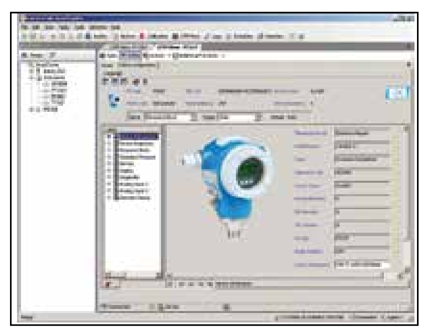
Smart device diagnostic data can be used for remote troubleshooting, expediting repairs and cutting maintenance costs. Partial stroke testing can be performed on smart valves electronically and remotely, at a considerable savings as compared to local and manual testing.

Smart devices can seamlessly provide a wealth of data to a modern automation system, and this data can be used by an asset management system as described above. A modern automation system can not only easily connect to smart devices, but also to other typical process plant software applications.

Maximizing MES Performance

A modern process plant will include a host of Manufacturing Execution System (MES) software applications including but not limited to HMI, database and historian, asset management, alarm and event handling, data analysis, simulation, non-linear loop tuning, plant performance monitoring, and specialized vertical market process control packages such as distillation column control.





A modern process plant will include a host of Manufacturing Execution System (MES) software applications including but not limited to HMI, database and historian and asset management.

Seamless high-speed two-way digital communications with these applications is a must in order to fully maximize the return on investment in a new automation system. A modern automation system is designed with built-in support for modern communication hardware and software standards. For example, multiple Ethernet ports will typically be provided, with support for protocols such as EtherNet/IP and Modbus TCP/IP. In addition, these ports will typically support modern high-speed Gigabit Ethernet communications.

By contrast, an older DCS will often not even include Ethernet communication ports, relying instead on outdated and slow-speed serial interfaces. Even when Ethernet is supported, it is generally only at slower speeds, and support for multiple modern protocols is virtually non-existent. Solutions such as communication gateways are expensive, are unwieldy to implement, and offer poor performance.

The importance of integration was discussed to some extent in preceding sections, particularly for asset management systems. Integration with other software applications is equally important, even more so for applications such as HMIs which are critical to real-time control.

With an older DCS, the HMIs are often the first components to become obsolete due to phase out of the underlying hardware and operating system platforms. Upgrading to new HMIs can greatly improve graphical capabilities and plant performance. High performance graphics improve operator efficiency, and large screen monitors help operators view the overall process. Additionally, multiple monitors per operator station are deployed to view many function areas of a process at once. The full value of new HMIs will only be realized if connections to the automaton system feature the latest communication technologies.

For example, a high-speed Ethernet link greatly increases response times for operators interacting with HMI screens. This provides a host of benefits, including faster reaction to process upsets and alarms.

Alarm and event handling in many older DCSes is limited by a lack of on-board memory and other hardware resources at the HMI level. These functions require extensive data storage and manipulation, and are thus hard to properly execute with an older DCS.

By contrast, a modern automation system will feature an HMI with access to virtually unlimited PC-based computing resources, allowing the implementation of very sophisticated alarm and event handling features.

A modern automation system can provide tight integration to the databases and historians employed by many process industry firms. These applications are used by many companies to store and display relevant data throughout the enterprise.

For example, a modern HMI can save all alarm and event data at a very high frequency right after a critical alarm is activated. Subsequent analysis of this data can help reveal the root cause of the alarm.

A modern PC-based HMI will not only handle alarms and events better, it will also be superior when it comes to making this data available to other MES software applications, such as databases and historians.

Databases and historians are employed by many process plants to store and display all relevant data related to the process. In many enterprises, these software applications are the main tool used to distribute data throughout the corporation.

Many modern automation systems feature very tight integration with databases and historians, a crucial feature as these software applications are constantly exchanging large amounts of data at high frequencies with the automation system.

Once data is supplied to databases and historians, it's available for analysis, often leading to improvements in plant performance. For example, historians can be used to compare current and historical data to help optimize plant operations.

Many other specialized data analysis and plant performance MES applications are used by modern process plants, including simulation software, non-linear loop tuning software and plant performance monitoring software. Specialized vertical market process control packages such as distillation column control are also widely used.

All these specialized software packages need to communicate data with the automation system, usually at high speeds. These packages will invariably be PC-based, as will the modern automation system's HMI. The controllers in a newer automation system may not be PC-based, but they will be optimized to communicate with PC-based applications.

The HMIs and the controllers will both typically feature multiple high-speed Ethernet ports. Popular communication protocols such as EtherNet/IP and OPC will be supported, enabling plug-and-play communications with external applications.

For example, a plant performance monitoring software application will need to analyze large amounts of data from the automation system, and then return suggested actions to the automation system. The higher the speed, the quicker the action can be implemented, immediately improving plant performance.

Improving ERP Access

Many modern process industry firms employ some type of an enterprise resource planning (ERP) system, typically Oracle or SAP. Most modern automation systems will have a built-in interface to leading ERP systems, greatly reducing integration implementation and maintenance costs.

Access to the ERP system is usually corporate-wide, so linking the automation system to the ERP system is often the best way to provide plant performance data to a wide range of users. In addition to performance data, information related to inventory levels and other financial metrics can be provided to the ERP system.

The ERP usually contains data concerning orders from customers, and this information can be transmitted to the automation system to drive production. When the ERP system is connected to a modern automation system across all of a company's process plants, then decisions can be made concerning what products should be produced in what quantities at each plant, optimizing the production process of the entire enterprise.

Conclusion

An older DCS will typically not be capable of running a modern process plant at optimum levels. This sub-optimum performance imposes many costs on a plant, including some obvious ones such as excessive downtime, and many other costs that aren't so apparent.

Some of these hidden costs include less than maximum designed throughput, poor quality, excessive energy consumption, longer response time to alarms and incidents, and excessive demands on plant operating and maintenance personnel.

A modern automation system can more than justify the required investment by eliminating all of these costs—and by adding other benefits such as improved security, better remote access and predictive maintenance.

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