Chemical Processing

The SAR unit at BASF's Hannibal, Mo., plant required only 10 hours to cut over to the new automation system.

Automation Vision Comes to Life

Digital automation helps BASF save time and money, achieve goals and improve loop checking

By Carl Stumpe, BASF Corp.

BASF'S AGRICULTURAL CHEMICALS FACILITY IN Hannibal, Mo., produces active ingredients and formulations for pesticides and herbicides using mostly batch-oriented operating units. Its existing digital control system (DCS) had become a barrier to applying advanced and cost-effective automation technologies. The system was more than 15 years old and the controllers and consoles frequently failed. In addition, the manufacturer no longer supported many of its DCS components.

The company's slogan, "Helping Make Products Better," encourages the use of technology to improve chemical processes. With this in mind, the Hannibal plant commissioned a DCS team to develop an automation and controls vision for the site. The team knew it couldn't meet its goals with the seven existing DCS local control networks (LCNs). Replacing these systems with leading-edge equipment and software would be a time-consuming and costly endeavor.

The team needed to find the best, most cost-effective automation architecture available. It also had to develop a strategy for replacing the old DCS control networks several at a time, rather than all at once. The team needed to accomplish these goals under tight time schedules, and to minimize production downtime, decrease startup time, overcome resistance to new work practices, and ensure adequate training for affected employees.

Four units' DCS were recently replaced with the DeltaV digital automation system from Emerson Process Management, Austin, Texas.

Technology leaps forward

Although it was challenging to abandon preconceived notions about DCS architecture and function, the DCS team at Hannibal decided to start with a clean slate and evaluate all automation options. They wanted to identify the most capable and cost-effective automation system available; one that would be compatible with future upgrades.

Careful evaluation yielded two potential paths:

1. Upgrade to the existing vendor's latest DCS equipment and gain an incremental process control benefit, or
2. Install a new system based on proven technologies in process automation.

The decision was affected by economic factors and a desire for a less hardware-intensive DCS with integrated Foundation Fieldbus, Hart and Profibus DP technologies. BASF also wanted the life cycle cost efficiencies that come with using standardized PC platforms, which communicate with controllers through TCP/IP Ethernet networks.

After a thorough evaluation, BASF decided that replacing the existing DCS with a DeltaV digital automation system from Emerson Process Management would provide the greatest benefit.

Hardware differences

Once the team chose its automation strategy, implementation was the next step. Complicating the effort was that the new and old DCS were of different manufacture and vintage.

The Emerson DeltaV has a simplified structure: off-the-shelf workstations, standard IEEE Ethernet for the network, and rail-mounted backplanes with plug-in

The decision to go with a new DCS platform proved to be the most cost-effective option by a 2-to-1 margin.

CPU, power supply and I/O cards. These features helped minimize purchase cost and provide flexibility, future compatibility and upgrade paths not available in a proprietary architecture.

The legacy DCS consisted of numerous gateways, nodes, termination boards, I/O boards, controllers, communications cards and consoles. One of the primary drivers for moving to a new system was to eliminate as much legacy hardware as possible. The team developed a modified version of Emerson's Flexconnect, which connects DeltaV I/O directly to the existing DCS termination panels using pre-built cables.

Automated configuration

Configuration of the DeltaV automation system was largely automated. The team developed a program to convert point parameters into a flat file, which was imported into standardized DeltaV modules. One of the challenges with this approach was that the new modules had many more features than the legacy system. For example, Hart data are brought into the modules at a channel level, so transmitter range and diagnostic information is tied to the analog input signal. Default module settings were set up to uniformly act on these additional data.

Process control configuration, including interlocks, also posed a challenge since many people had worked on the existing programs in the past. Determining the original programmer's intent was critical to ensuring that the new code had the same functionality. The process had to be studied in detail to reestablish which actions should occur and why.

The legacy system relied on separate text and logic block code for interlocks, whereas the DeltaV interlocks are built into the device control modules. The operators can easily view them from a module faceplate. The new DCS's ability to show the current status of interlock initiating variables and to see the "first out" condition has proved to be very helpful.

Financial ease

The decision to go with a new DCS platform proved to be the most cost-effective option by a 2-to-1 margin. In prior DCS retrofits, instruments were rewired to new controllers. Designing and installing new marshalling panels, loop diagrams and I/O terminations was expensive and, after the conversion, existing controllers, termination boards and cabinets had to be ripped out. In addition, each device required a thorough loop check.

The Flexconnect approach allowed BASF to reuse legacy DCS cabinets, I/O termination boards and wiring. The marshalling system was untouched, and the new, compact controllers were installed in cabinet space vacated by the legacy controllers. This greatly reduced the engineering and construction labor required for the installation.

The DeltaV digital architecture is designed to accept I/O from digital bus networks directly into modules as native I/O.

Prior DCS retrofits required a long time for cutover and startup, resulting in substantial downtime. On projects of similar size, DCS conversions took about three weeks. Retrofits for the DeltaV conversions took substantially less time — 10 hours for the Sulfuric Acid Regeneration (SAR) unit and eight hours for the incinerators.

The Flexconnect approach meant BASF did not need to construct a new rack room. The approach allowed use of low-cost DeltaV and Phoenix Contact Profibus I/O and reuse of existing control cabinets. The costs associated with electrical design and wiring were reduced by 75% and 80%, respectively. Loop checkout was reduced to a few days, and the number of engineering documents was reduced by 50%.

The reduction in spare parts inventory will result in future savings. BASF used to maintain thousands of dollars in spare parts to support the legacy DCS. The value of the DeltaV spare parts inventory is 90% less than that of the legacy DCS. As a result, future expansions will be less costly.

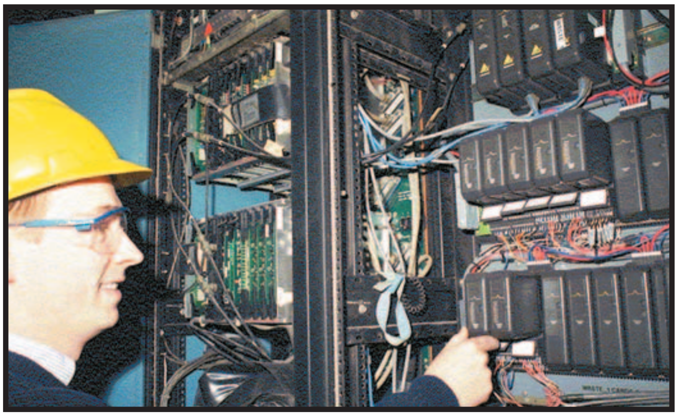
These are the DeltaV PC-based operator workstations from Emerson Process Management, Austin, Texas, in the SAR/incinerators control room at the BASF agricultural chemicals plant in Hannibal, Mo. Author Carl Stumpe (left) points out a graphic to operator John Calhoun.

Other advantages

Cost was only one factor in selecting a new DCS platform. Another factor was the ability to mount small, powerful controllers adjacent to the equipment being controlled.

The DeltaV digital architecture is designed to accept I/O from digital bus networks directly into modules as native I/O. Additional interfaces, lookup tables and subroutines are not needed to communicate with Foundation Fieldbus, AS-I bus, Devicenet, Profibus DP and Hart digital signals. The digital architecture provides easy access to information present in BASF's existing HART transmitters and new Foundation Fieldbus devices.

A surprisingly high percentage of existing instruments were Hart Smart. Using Hart communication, the team extracted 70 new measurements from existing transmit-



Carl Stumpe checks a DeltaV controller's analog I/O module. The controller is mounted in cabinet space that used to hold DCS equipment.

ters. Each Coriolis flowmeter, for example, now reports flow, density and temperature.

In addition, 350 Hart instrument configurations were automatically backed up in the asset-management database. BASF chose Emerson's AMS since it easily integrates into the DeltaV network. Past calibrations are maintained, and new calibrations are easily downloaded. While the new features were a factor in the decision to move to a new DCS platform, the company initially underestimated their usefulness. The new automation system's advanced control options, better diagnostics, superior analysis, optimization and asset-management software are being used to reduce variability and maintenance costs, and speed troubleshooting.

With the VFAT technique, spot-checking of instruments took just four hours per controller.

DeltaV's peer-to-peer communication between controllers and operator stations allowed consolidation of existing LCNs into a single, facility-wide control network. Power failures or disruptions in one unit do not affect another unit on the same network. By combining multiple networks, BASF reduced system administration and upgrade expenses.

Virtual FAT developed

Factory acceptance testing (FAT) procedures have not changed significantly since the introduction of DCS. The classic technique of hardware checkouts at the vendor's site, followed by extensive loop checking at the customer's site, is inefficient for large-scale DCS retrofits. An efficient FAT is essential to speed startup and reduce project cost.

BASF's answer to overcoming the FAT problem was to develop a two-stage, software-based method. In the first stage, control module functionality was tested using Chesterfield, Mo.-based Mynah Technologies' Mimic simulation software. During this phase, items checked out included new controllers; a workstation loaded with Mimic simulation software; the network linking the controllers; and the workstation.

The second stage of FAT testing used a BASF-designed test fixture to assist with the point-by-point checkout of each module's I/O connections, thereby taking the place of field loop-checking. Art England, instrumentation engineer, designed the fixture. "We knew the wiring connections from the existing instruments to the termination panels were working with the previous DCS. So, we just had to confirm that the Flexconnect cable between the DeltaV and the Termination panels operated properly," he says. To do this, he designed a test fixture that simulated a termination panel with instruments attached.

A classic loop check requires a board engineer and field technician. Oftentimes, the board engineer will be waiting on the field technician, or vice versa. With England's technique, one person in the test lab can efficiently conduct loop checks. The tester confirms that the module responds properly to changes made at the adjacent test fixture. Since field devices and associated wiring were untouched by the retrofit, there was no need to perform field checks after the system was installed. This method was effective, with only two valves found to be operating improperly during startup.

In other words, FAT and traditional loop check were never conducted. Simulation software and Flexconect testing were combined to efficiently replace the classic FAT and loop check. The testing allowed for trouble-free startup immediately after the DCS installation. BASF calls this multi-stage technique "virtual FAT," or VFAT.

In new construction, loop checking requires about one to two weeks per controller. With the VFAT technique, spot-checking of instruments took just four hours per controller. Use of VFATs and Flexconnect technology guaranteed the quick cutover the company required.

Self-directed operator training

Plant personnel had become comfortable with the existing DCS, so there was some concern about switching to a new control system. The Mimic simulation software played a role in allowing personnel to become familiar with the new automation technology. This was essential for a smooth startup. Areas of special concentration in simulation training included pulling up interlocks; navigating between graphics; simulating equipment shutdown; and alarm management.

To assist in a smooth transition, new graphics were designed to look as much like the old graphics as possible. During training, operators suggested improvements, including better module descriptions, improved alarm schemes, more descriptive graphics names, minor graphic modifications, etc.

Operations personnel received only three hours of formal instruction. The remaining class time allowed the operators to train themselves on the process by running the Mynah simulation.

Simulation also ensured that the interlocks performed properly. Many of the interlocks at SAR are built around a specific startup sequence and they change as the sequence progresses. Using the simulator, the team tested interlocks for each phase of the startup. To test the first-out functions, several extensive, multiple-initiator trip scenarios were simulated. In the past, interlocks would have been checked during water batching, which is expensive and time consuming. The Mynah simulation software provided a convenient, inexpensive alternative.

Simulation also helped BASF optimize certain control schemes. The configuration of five cascade loops were changed because they never had worked well, but were too difficult to modify on the old system. The new control schemes were tested with Mimic before they were implemented.

Reaping the benefits

Using FlexConnect and simulation software, the team was able to rapidly cut over processes with thousands of I/O points. Preplanning and support were critical to the project's success.

At press time, the DeltaV system has replaced three LCNs with a single distributed Ethernet network that connects 17 controllers and 15 consoles. As more of the BASF site is converted to DeltaV, the layout will expand, change and be integrated to best fit the site's requirements.

Complete replacement of the legacy control system has enabled BASF to implement modern technology in any area of the converted plants. The Hannibal site is taking advantage of DeltaV's integrated asset-management, controller-resident model predictive control, and advanced diagnostics to improve efficiency. The new control system's compatibility with Foundation Fieldbus, Profibus DP, Devicenet, AS-I Bus and Hart technology have cut new project costs. The adoption of digital automation technology has allowed BASF's Hannibal facility to meet all three of its original goals of boosting output, cutting costs and improving quality. **CP**

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SAVINGS IN TIME AND MONEY

BASF's decision to install Emerson's DeltaV digital automation system resulted in startup, time and inventory savings.

Thousands of dollars in startup savings

- Fast and easy cutover using modified Flexconnect approach
- No new control building needed
- Less expensive control hardware
- Control cabinet reuse
- More efficient two-step Virtual Factory Acceptance Testing (VFAT)
- Reduced wiring, loop checking and documentation
- Compact, inexpensive Profibus DP I/O blocks

Time savings

- Estimated cutover with previous DCS – three weeks
- Actual cutover times with new system
  - 10 hours for SAR unit
  - Eight hours for incinerators
- Control of critical process quickly restored

Reduction in spare parts investment

- Lower price of spare components for new system
- Reduction in the number of spare parts needed in inventory

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