Emerson Process Management's Human Centered Design Philosophy: Conquering Complexity

This document describes how Emerson Process Management has used innovation and the philosophy of Human Centered Design to overturn 35 years of industry thinking

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Introduction

Human Centered Design

In 2005 Emerson began investing in Human Centered Design based on the trends we were hearing from customers. They were saying they didn't have the people to take advantage of some of the innovations we were developing that would benefit them. So we started thinking differently about how we develop our technology. As a result we pioneered the concept of Human Centered Design in our industry. We have formally introduced our Human Centered Design Institute. Emerson's focus with Human Centered Design (HCD) is to deliver three essential benefits:

- Eliminate Unnecessary Work
- Reduce the Complexity of Technology
- Embed Knowledge into Technology

Human Centered Design is not just about making products easier to use: it's about products making customers' jobs easier to do. There is an important distinction. As part of the Human Centered Design Institute, Emerson studied everyday tasks done by people that use our products. This information was used to build a huge library of roles and responsibility maps.

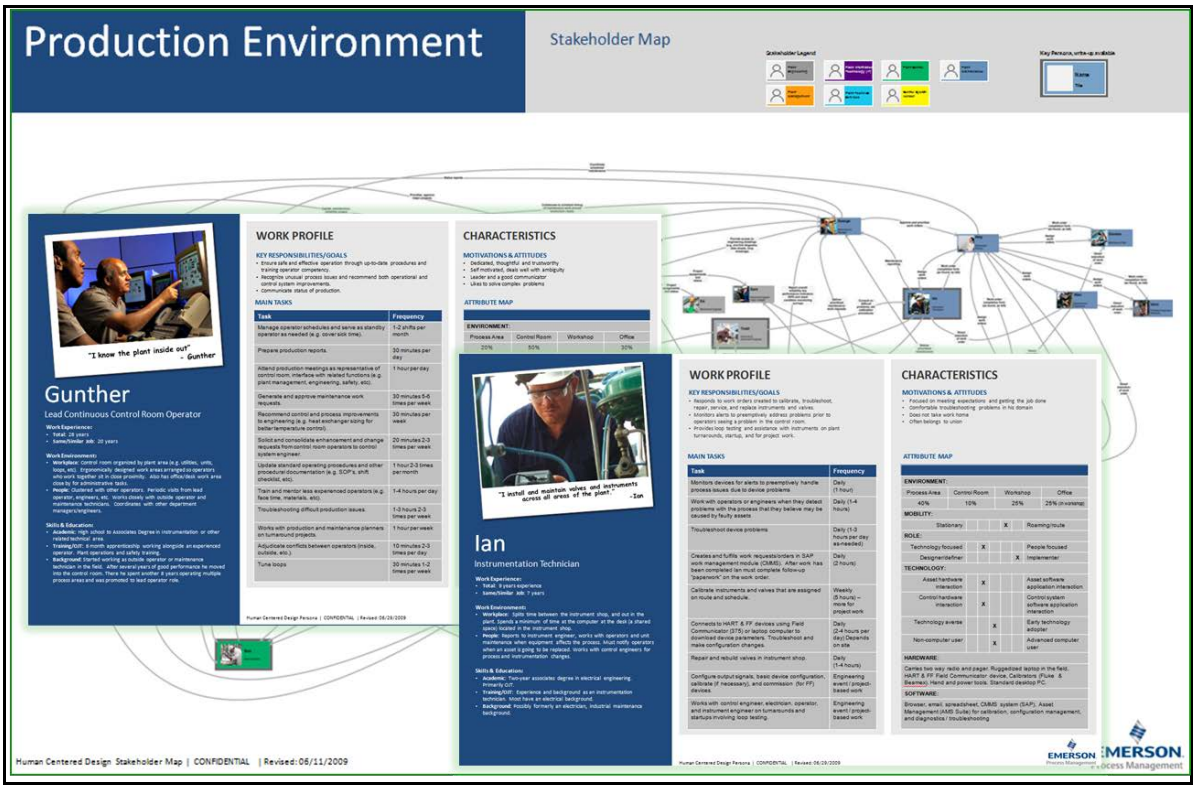

Figure 1 – Example Stakeholder Map with User Profiles

The library of information provides details about the role – for example: main tasks performed, use of process automation or other technologies, use of tools or other equipment, and area(s) of the plant where work is done.

Complexity Paradox

With HCD in mind, Emerson studied the challenges process industries are facing. Global pressures, regulatory (including health and safety), environmental are long-standing issues in our industry. However, technical people skills issues are emerging as critical to being able to operate safely and efficiently.

There is a geographic paradox due to a shift in the labor force; while plants are becoming more complex, the new work force has less experience. Plants are scaling larger and larger and expanding to new locations, single facilities are becoming more efficient, integrated complexes –this way one process area feeds directly to another on the same site rather than transporting fuel or feedstock to another location- and process automation technology is accelerating. At the same time, much of the workforce at the original North American facilities is retiring, while there is a lack of experience in developing areas where new plants are located. The result of all this is a knowledge and experience void.

In addition to this, the total number of staff is being or has been reduced, increasing the amount of responsibility on every employee.

Computing power availability throughout the process automation system and field devices provides flexibility with control strategies. However, it can add complexity when there is a lack of user experience and knowledge.

Our investment in Human Centered Design is enabling our users to reach their goals of safety, reliability and efficiency. We do that by understanding the barriers and challenges that keep them from meeting their goals. We are pointing our technologies at those challenges to make it easier for our users to be successful. First we are eliminating work. Whenever possible, the most important thing we can do to help users is to engineer the work out of the process. As a next step, for the work that remains we are removing the complexity, making it as simple as possible. Finally, embedding knowledge of those experienced workers that are leaving or who were never there: we are working to institutionalize the specialized knowledge so that even less experienced staff can become more effective sooner.

Challenges Solved Using HCD

The development of DeltaV version 11 was based on using Human Centered Design to address concerns that are facing process industries today. Changes have been designed around the user, instead of the user having to change and adapt to new technologies. Initial system installation, expansions, operations and maintenance have all been viewed from an HCD perspective.

Operator Experience

Operator roles are expanding – both with an increase in the process area he/she is responsible for, as well as an increase in the amount of data that is presented. Operators are more effective when they do not miss important information/alarms and when they have the right knowledge at the right time. A combination of the right display colors, pattern recognition and knowledge management have been added to DeltaV™ version 11 to reduce operator errors and embed knowledge in the system.

Much of the research used for optimizing the operator experience was gained by working with the Center for Operator Performance. The Center for Operator Performance is an alliance of academic and process companies to increase the research specific to the Process Control Industry.

Center for Operator Performance
An Industry/University Center for Excellence

Permanent Members	Charter Members	Sponsoring Members	Guest Members
Wright State University, Beville Engineering, Inc.	Flint Hills Resources, Suncor, NOVA Chemicals, Marathon Pipe Line LLC, Chevron, ABB, Emerson Process Management	PAS, bp Texas City	Regulatory Agencies (DOT, OSHA) Universities (Penn State, Louisiana State, Georgia Tech) TBD
Manage center Direct research	Suggest, choose, and review research Set budget/fees Determine IP allocation Participate in studies Share in results	Suggest research Share in results Participate in conferences Volunteer to participate in studies	No fee Participate in conferences

Figure 2 – Center for Operator Performance Membership Types, Duties and Members

Color Theme Graphics

After investigating the best colors to use for operator displays, there is not one right answer. However, in general, research has found lighter display backgrounds to be better than dark (unless the control room is dim, in that case, dark is better) and that the use of bright colors should be minimized.

In version 11 of DeltaV, there are themes that take these findings into consideration and make it easy for implementation. There are four “out-of-the-box” HCD themes for operator displays. The themes are Silver, Tan, Light Blue and Dark Blue (for dim control rooms) – named according to the background colors.

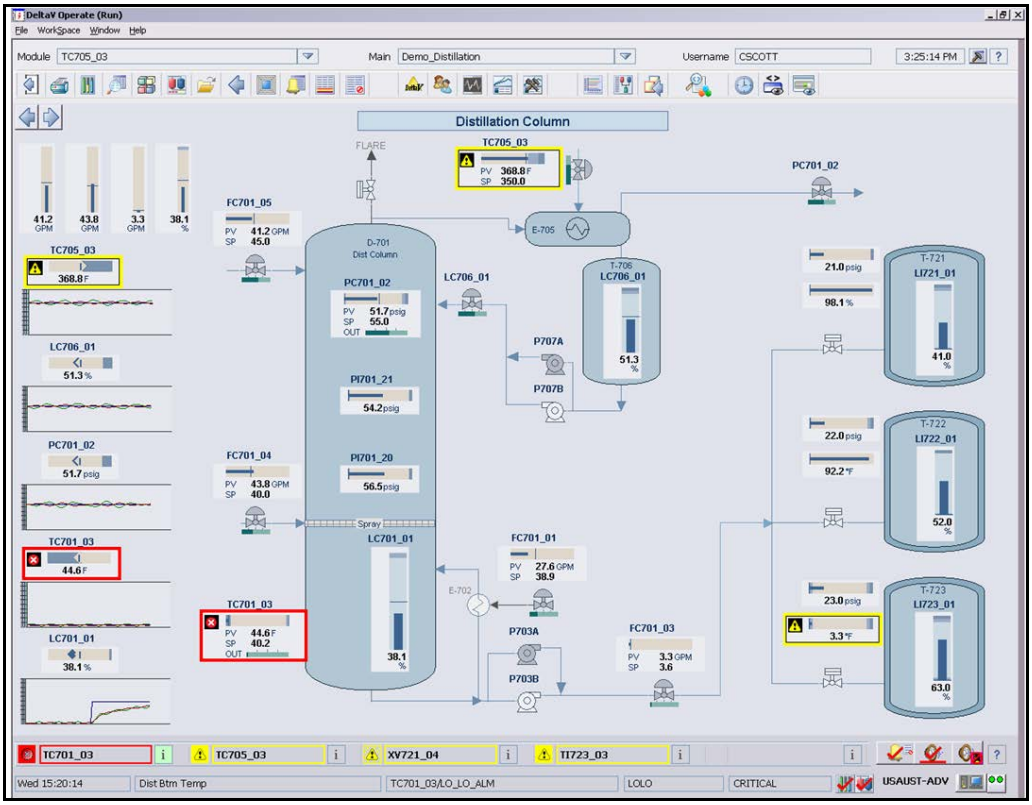

Figure 3 – Example of HCD Silver Theme Display

The alarm colors are the same for each theme, but the pipes, tanks, etc. are in the same color family as the background. Contrasting colors are used for text and abnormal situations. The themes are based on the global color tables, so the colors are easily modified for specific situations.

Pattern Recognition

Typical operator displays use numbers for operators to read and compare process values – Are the values deviating from setpoint? Are they in range? Are they near an alarm limit? Comparing numbers takes focus and makes it difficult for operators to simply scan a display. Using shapes or patterns to graphically view the data enables operators to easily scan the process values without having to read and analyze all of the values.

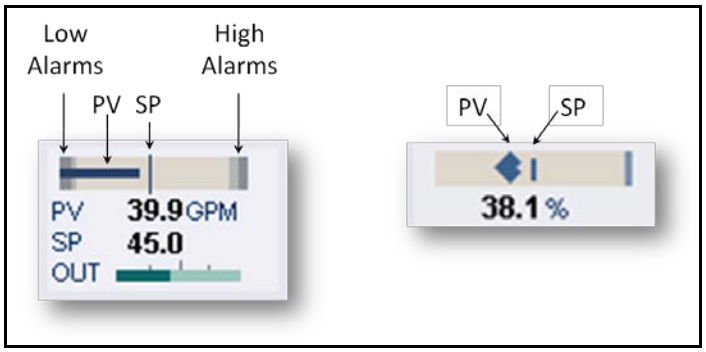

Figure 4 – Examples of Pattern Recognition for Process Values

Having bar graphs or other shapes clearly define where the values is in relation to setpoint, alarm limits, etc. is also very useful for new operators, support staff and others that are not immediately familiar with the process area. Pattern recognition is also used to make alarm presentation and important status information (such as on/off, open/closed, abnormal, simulation mode, bad I/O, etc.) obvious and consistent.

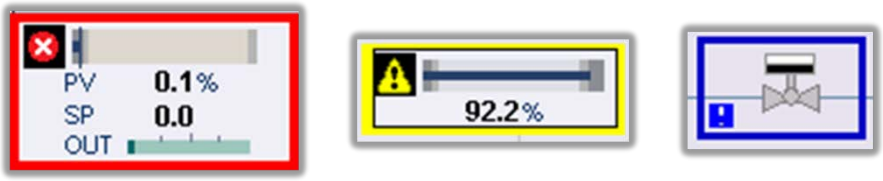

Figure 5 – Examples of Abnormal Situation Presentations

Contextual Alarm Knowledge

Human Centered Design operator displays make it easier for operators to identify abnormal situations, but once they are identified, will the operator know what to do? Again, we are looking at a workforce with less experience and more responsibility. By embedding knowledge into an alarm or other abnormal situation, a more experienced (and authorized) operator is empowered to modify the alarm help at the operator station, in order to help less experienced personnel.

The alarm properties in DeltaV are designed for an ISA-18.2 compliant alarm database. Alarm properties include functional classification, recommended action, time to respond, probable cause and consequence of inaction. This provides best-in-class rationalization for the operator.

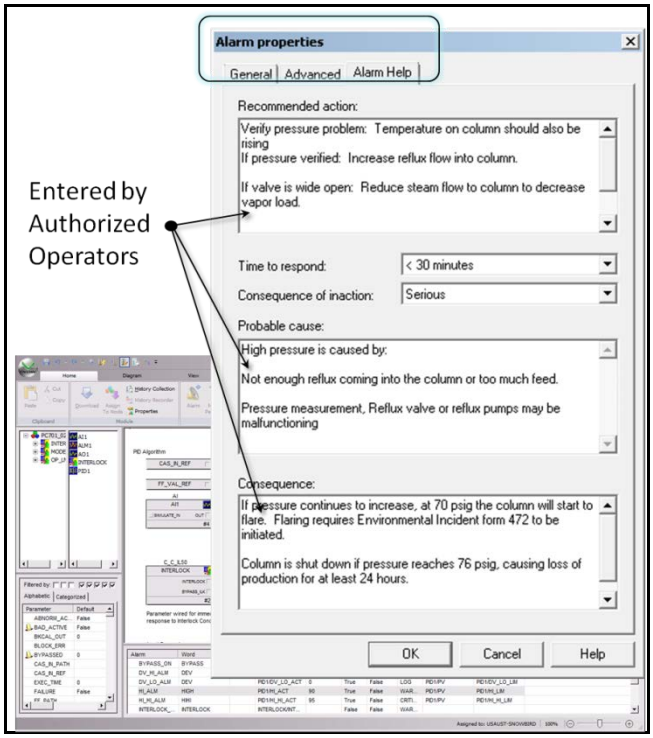

Figure 6 – Contextual Alarm Help

Maintenance Experience

Plant personnel, such as the Plant Manager, Instrument and Electrical Engineer, Maintenance Manager and the Reliability Engineer know that improving a facility's availability and performance, key to achieving business results, are dependent on managing production assets. The human centered design concept is aimed at identifying the information most needed by plant personnel and getting to them in an easy-to-use format. The goal is to make technologies that aren't just reliable, compatible and cost-effective; they can also improve usability and increase productivity so users see a real impact on business results.

Human centered designers worked with marketing and technology people to create prototypes screens that were introduced to customers. Through usability testing, we evaluate the product and determine which designs were most helpful to users in completing common maintenance tasks easily and in minimum time.

AMS Suite

The first Human Centered Design project was the development of the new dashboard structure within AMS Suite. These intuitively designed interfaces known as Device Dashboards for AMS Suite software present workers with an instant view of the critical items they need to evalute, diagnose, and configure each device. Expert guidance is also provided to streamline the most important and frequently performance tasks by plant operations, maintenance, engineering and maintenance personnel.

Before HCD the Asset Management screens in AMS Device Manager were designed to display information, but not in a way that made clear sense to the users of the software. There were many redundant terms and acronyms that were not always very intuitive to read and comprehend. There hadn't been much thought to where information was put on the screen and sometimes the layout of information and graphics could be cluttered. The dashboards have common tasks front and center, with wizards to aid infrequent or inexperienced users. Users do not have to search around for information being in a different tab or format for different devices

Built-in Dashboards

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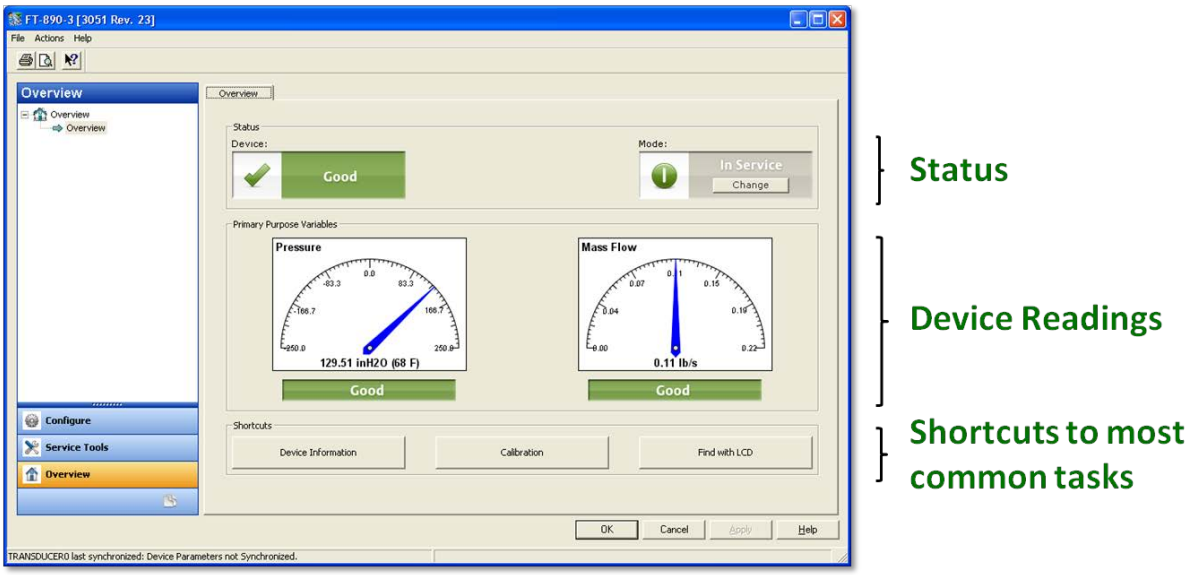

Figure 7 – AMS Device Manager Device Dashboard

The dashboards are available for over 50 different devices and built around user tasks – with all devices having the same layout. Regardless of device type or protocol (PROFIBUS DP, Fieldbus, HART, WirelessHART), you get the exact same look and feel.

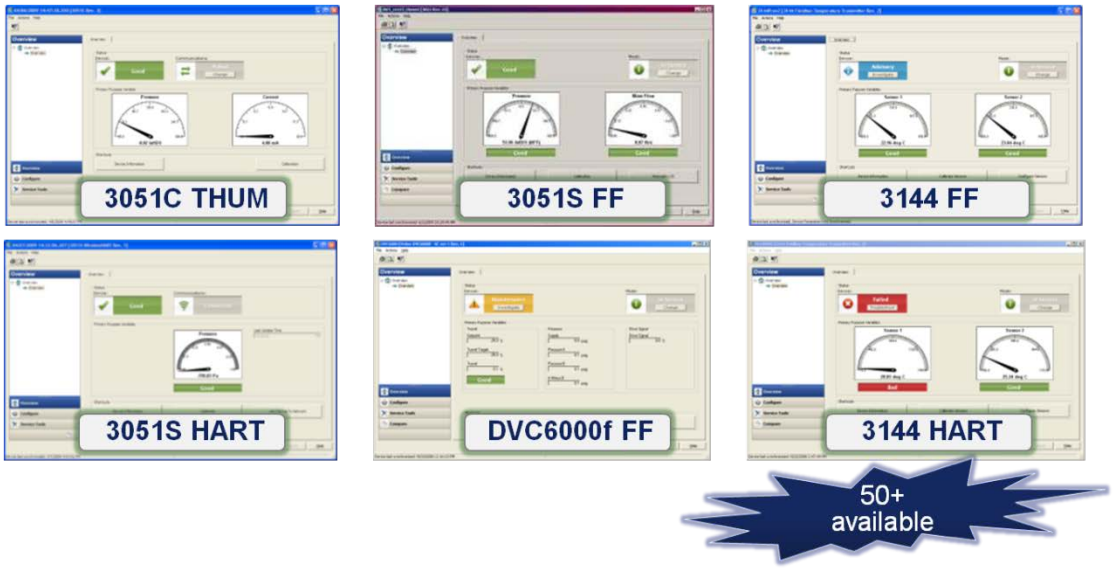

Figure 8 – Dashboard Examples of Different Protocols

Drives Integration

With the addition of PROFIBUS DP device configuration and diagnostics in AMS Device Manager, there is particular benefit with drives and motor starters. Diagnostic information from these plant assets is valuable, but previously tedious to acquire. Previously, to get diagnostics into a control system required either hard-wired or serial connections. For either option, additional work is required in engineering, drawings and configuration upon installation, as well as for any changes that are needed after installation. With AMS Device Manager and DeltaV, PROFIBUS DP drives and starters are simply part of the system. To prevent abnormal situations, diagnostics can be easily integrated into control strategies, just like any other tag in the system. Alarms and alerts will be sent to operator stations for enhanced troubleshooting capabilities for AMS Device Manager users.

Integrated Machinery Protection

Nearly half of equipment breakdowns are related to poor operating practices, because operators lack feedback on the effect of operations on machinery health. Turbomachinery and mechanical equipment breakdowns are costly in both equipment repair and lost production. Therefore, providing operators with visibility of the performance of these critical assets, they can make process adjustments and reduce process disruptions.

Previously, to provide operators with this information, more than 30 setup and configuration steps were required for each parameter that you wanted to bring into the control system. So, even bringing over 4 out of 24 possible parameters would require 120 steps. Integration with machinery health diagnostics would take days. Often, plants do not have the time or staff to complete the integration, leaving plant operators without key machinery health diagnostics, including overall vibration levels, thrust position, and eccentricity value.

With DeltaV, AMS Machinery Manager, and the CSI 6500 Machinery Health® Monitor, users will have Integrated Machinery Protection and Prediction within minutes. The complex, expensive, time consuming task of bringing machinery diagnostics into the process automation system is gone. Users have out-of-the-box machinery health diagnostics, complete with pre-configured graphical elements to present the data at the operator workstation.

Adding machinery health information to the DeltaV Process Automation System takes three easy steps:

- From AMS Machinery Manager, initiate scanning of the CSI 6500 for available properties, parameters and alarms.
- Select the parameters and alarms that are relevant, and enter the DeltaV Controller and Area names.
- A configuration (.fhx) file is created and imported into DeltaV. Control modules and function blocks are automatically built during the import.

Through the AMS Suite, the turbomachinery diagnostic information is also easily accessible to maintenance and reliability engineers and managers. These plant personnel can analyze data from machines along with other plant assets to prioritize maintenance and repair activities to mitigate risk and optimize maintenance costs.

With Emerson, machinery health data is easy to access and present to plant personnel. The turbomachinery information that is available enables users to avoid catastrophic failures, reduce maintenance costs and maximize production. For more information on easily integrating machinery diagnostics into DeltaV, please refer to the Integrated Machinery Protection and Prediction with Process Automation whitepaper

Easy Asset Performance Management

Emerson has reduced the complexity of the plant environment through tools that help plant management make better business decisions. AMS Suite Asset Performance Management, based on Meridium's APM software, combines predictive intelligence with asset reliability information and decision support for smarter business decisions. It adds real-time analytics and reporting that enable new levels of insight into asset performance for continuous improvement.

AMS Suite now streamlines the identification of bad actors, eliminates repetitive tasks, and highlights opportunities for new operating practices. Maintenance and reliability mangers receive more integrated, real-time information to determine that maintenance dollars are being spent in the most critical areas for the greatest business return.

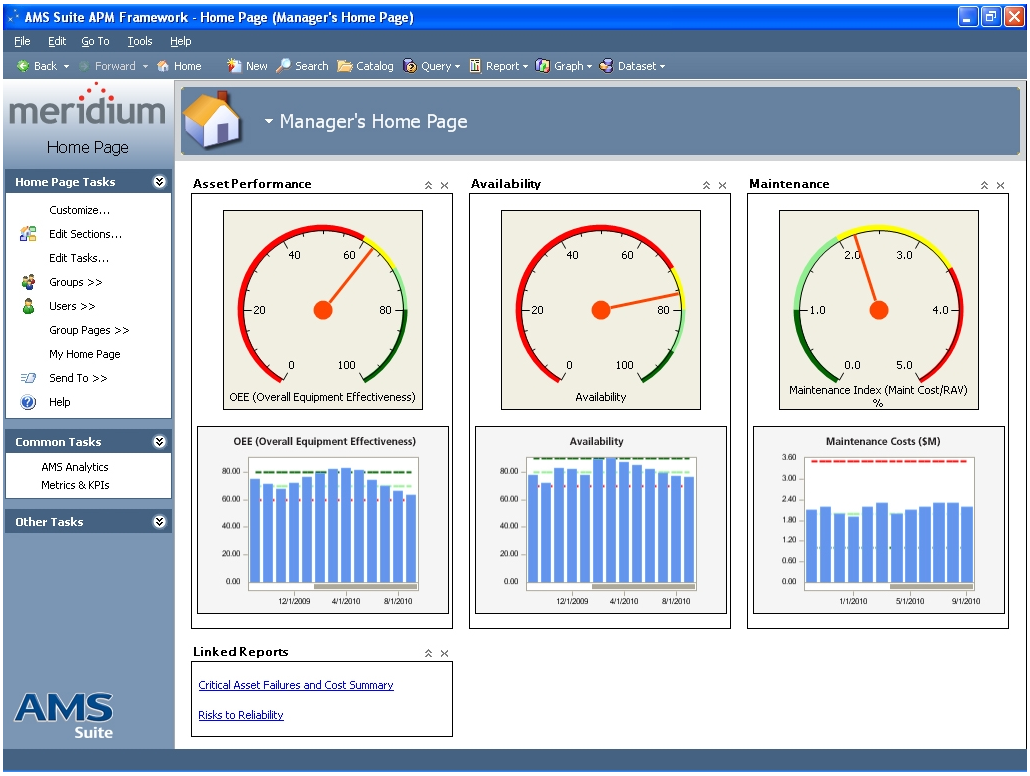

Figure 9 – One Dashboard for Plant Information

DeltaV S-Series and I/O on Demand

S-series Hardware

The new DeltaV S-series hardware is an evolution of the proven M-series hardware. The new design delivers installation and robustness enhancements, while still using the same proven technologies field tested over the last decade. The S-series hardware has been re-designed with a heat dissipation technology that allows for a completely enclosed shell (no vents). This prevents particles from entering the cards and short-circuiting electronics. “Easy-on-Hard-off” technology with the S-series means there are no screws needed when installing the cards onto the backplane, yet to get them off takes a manual action by pushing a button on top of the card.

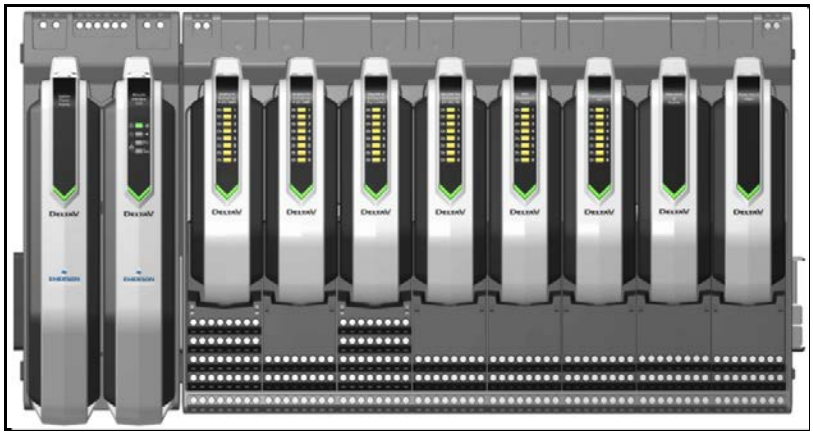

Figure 10 – DeltaV S-series Hardware

I/O on Demand

For several years, the DeltaV Process Automation has had the capability to communicate with different types of field devices – HART, FOUNDATION Fieldbus, traditional analog and discrete, DeviceNet™, PROFIBUS DP, and AS-i bus. More recently, communication with wireless devices has added another option. This has made it possible for DeltaV users to select the appropriate technology for the application, budget and user preference.

With the release of version 11, there is an additional option for connecting field devices to DeltaV, called Electronic Marshalling, which will significantly reduce installation time and money. I/O on Demand incorporates all of the options for field devices connections to DeltaV, enabling users to have what type of I/O they want, when they want it, where ever they want it, or, more simply—I/O of any type, anytime, anywhere.

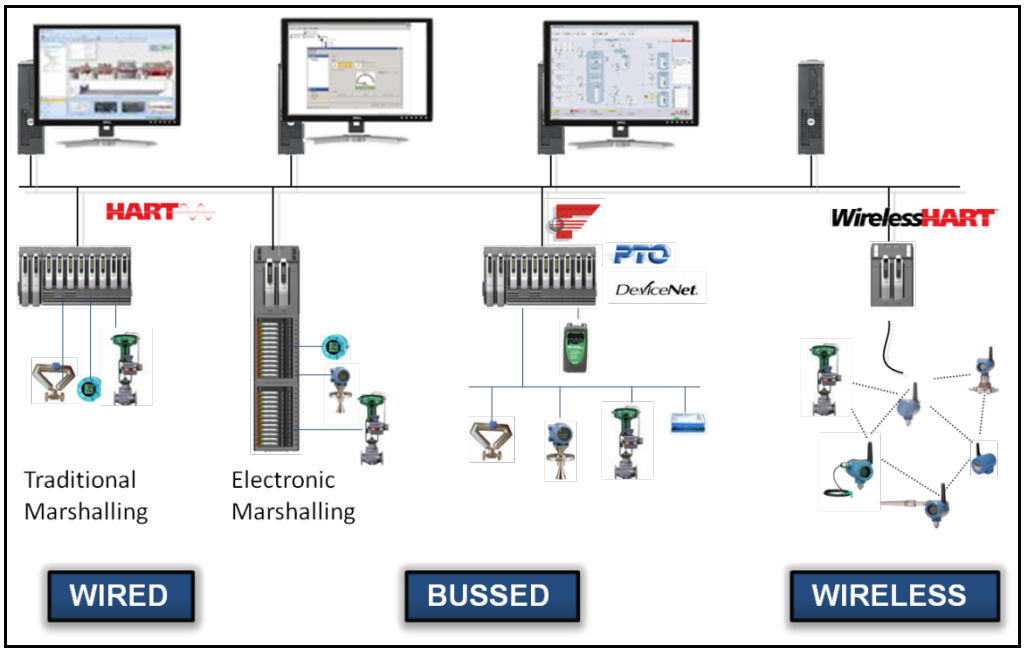

Figure 11 – DeltaV I/O on Demand

With I/O on Demand, a project can bring the I/O into the control system in one of four distinct ways, selecting the best, most cost effective approach in each case.

Wireless

The use of wireless devices networks results in less upfront cabinet design and engineering, lower installation costs, smaller footprint for the process automation system. And there are numerous examples of users taking advantage of these benefits to implementing wireless device networks. However, there have been some cases where wireless didn't work because of either environmental classification or lack of redundancy. DeltaV improves on its wireless capabilities and addresses these issues in version 11, by providing a redundant gateway and a wireless link for Zone 1 environments.

Implementing wireless devices networks with DeltaV will now be done through a Wireless I/O Card (WIOC) and a Smart Wireless Remote Link. This new architecture provides increased availability with full redundancy. The WIOC sits on the DeltaV network, as a redundant pair, with redundant communications and a redundant power option. The redundant Smart Wireless Remote Links are installed in the plant, as close to the devices as possible. The remote links then connect to the WIOC with redundant power and communications.

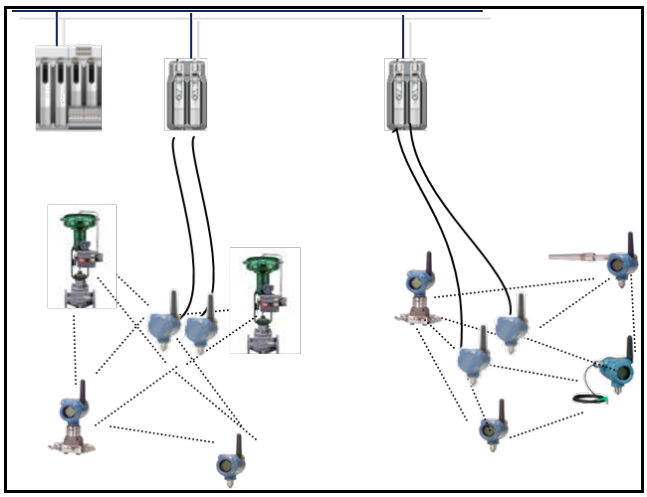

Figure 12 – Wireless Network with Redundant WIOCs and Communication

FOUNDATION™ Fieldbus

FOUNDATION Fieldbus has also provided many benefits to sites that have implemented it. One of the 'sticking points' with installing Fieldbus is the physical layer, where the work process involved:

- Power supplies sized, power distribution engineered
- Power conditioning designed, redundant
- Cabinets designed/constructed to support equipment
- For troubleshooting complex scopes are used or third party diagnostics are connected

The H1 Interface Card in version 11 has Fieldbus power and diagnostic integrated right into the card. This eliminates all the work, equipment, cost and complexity involved with the items listed above. In a large Fieldbus installation, there were about 2,500 segments that required about 5,000 power conditioners. Those power conditioners alone required 32 cabinets. So the engineering, fabrication, shipment, and footprint of the cabinets for the power conditioners would be eliminated, in addition to all of the equipment costs.

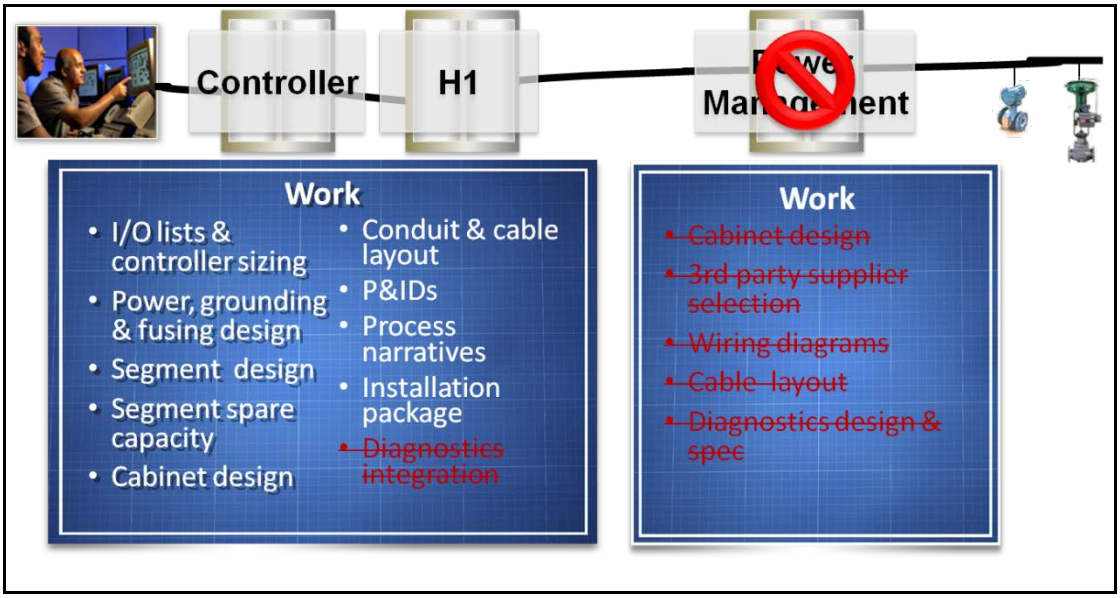

Figure 13 – Fieldbus Work Eliminated by H1 Cards with Integrated Power

Electronic Marshalling

The newest option with I/O on Demand is called Electronic Marshalling, where traditional cross-marshalling of field wires is eliminated. Traditionally, to connect a field device to a process automation system, wires from a home run cable would be landed on terminal strips, and then cross-wired to the appropriate I/O card. This has been a 'necessary evil' – a low-value, pain-staking task that became much worse with any I/O changes or mistakes made with wiring.

The better way – with Human Centered Design – eliminates tedious tasks and is flexible to allow for easy adjustments when changes to I/O are made. Just as with traditional wiring, home run wires are landed in a marshalling cabinet. However, with Electronic Marshalling, a Characterization Module (CHARM) is plugged into a terminal block to characterize the signal and send it to any controller in the DeltaV System. Changes to I/O type are easily made by replacing the CHARM type.

An extensive amount of work – from cabinet design to wiring diagrams – is eliminated with Electronic Marshalling, compared with traditional wiring. The overall system footprint is also significantly reduced with Electronic Marshalling, because eliminating cross-wiring reduces the number of cabinets needed.

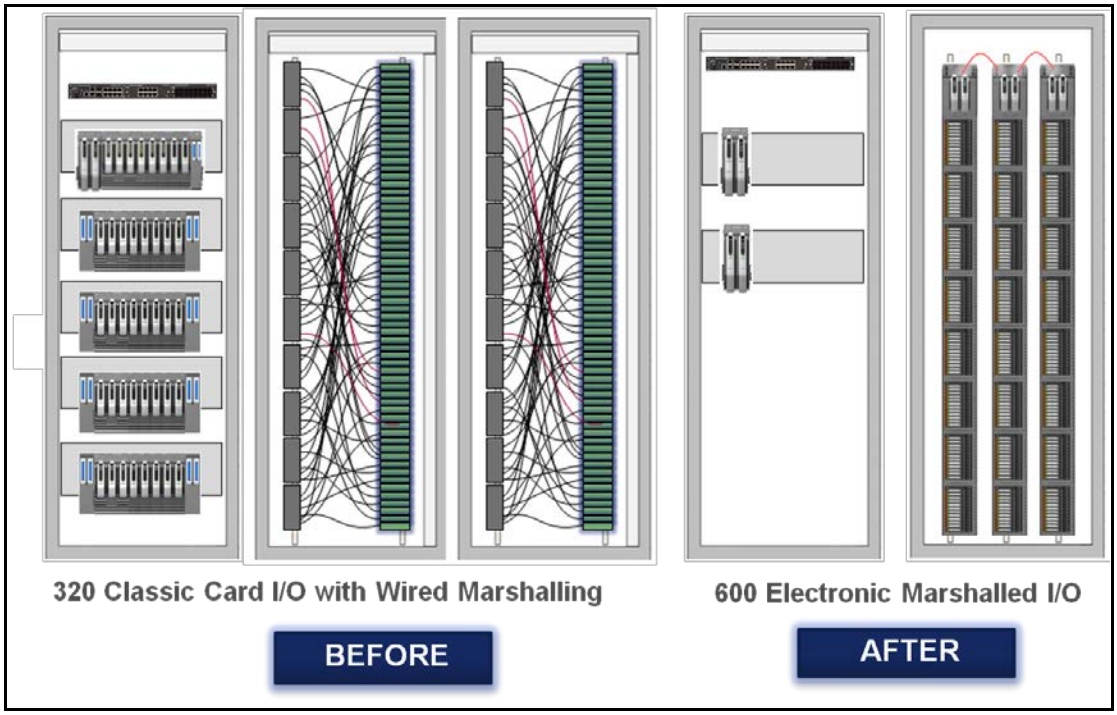

Figure 14 – Comparison of Traditional Wired Marshalling with Electronic Marshalling

For more information and details on Electronic Marshalling, please see the following whitepapers: Electronic Marshalling Overview, Electronic Marshalling Performance, Electronic Marshalling Robustness and I/O on Demand Cost Study.

DeltaV Enclosures

For Greenfield projects or Brownfield expansions, Emerson can now provide cost savings and lower project risk with off-the-shelf DeltaV Enclosures for system hardware. There are three options for DeltaV Enclosures:

- Factory Certified Enclosures
- Configure-to-Order Enclosures
- Design-to-Order Enclosures

Factory Certified Enclosures are either 'I/O room' cabinets or field junction boxes that are pre-designed Electronic Marshalling enclosures, with a very limited number of options. For example, the I/O room cabinets can be either front access or front and rear access. Either way, each side comes with three rows of CHARM base plates. There is neither upfront design/engineering required for these enclosures nor is it necessary to run an acceptance test upon shipment. Factory Certified Enclosures are ready for use, just as a DeltaV Controller is ready for use upon shipment, and they provide significant cost savings over enclosures designed from scratch.

Configure-to-Order Enclosures have a little more flexibility, with a given palate of components from which to choose. Examples of components available for selection are power supplies, network switches, DeltaV controllers and I/O cards. The selected components are then input into an engineering software tool that provides the enclosure layout. The enclosure design is more of a selection process, so upfront engineering costs are very minimal, and Configure-to-Order Enclosures also provide considerable cost savings.

Design-to-Order Enclosures have the most flexibility. These enclosures are fully customized to the project-specific needs. Project engineers will go through the full upfront design, specification and engineering process for these enclosures.

All enclosures will use best cost manufacturing practices from Emerson, follow DeltaV installation best practices, and will include full documentation. A project may not be limited to one enclosure type, and two or more enclosure types may be needed to meet project requirements. Project timeline, budget and system components should be taken into consideration when ordering enclosures. The figure below illustrates options with enclosure components and design, and how there is an increase in amount of testing, cost and time.

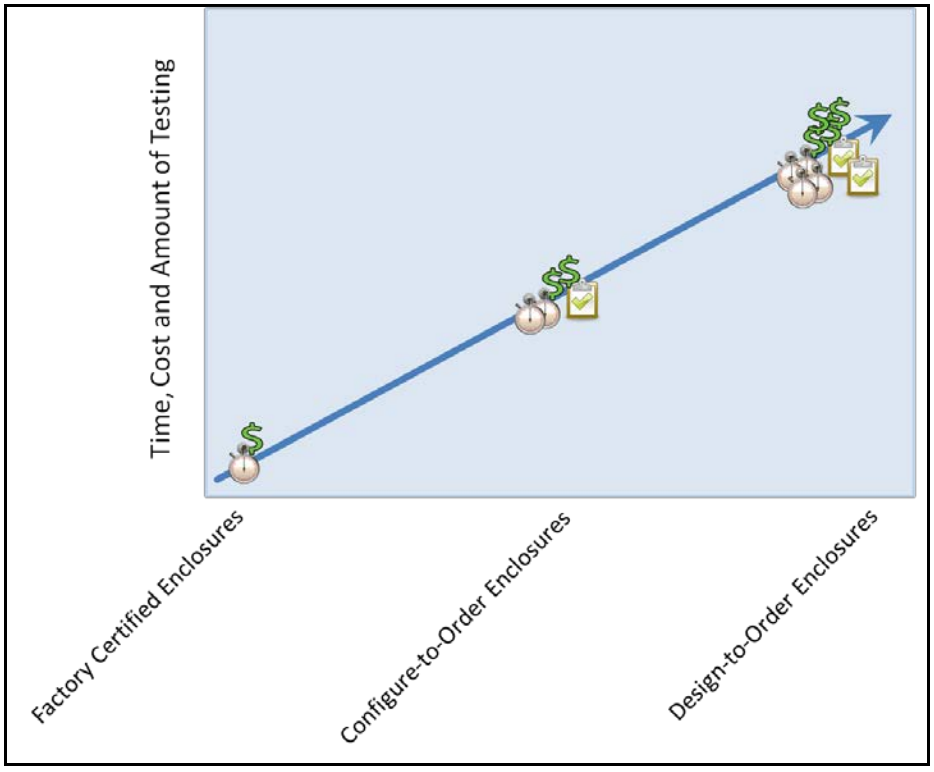

Figure 15 – Comparison of Investment in Time, Cost and Testing for Enclosures

For more details on DeltaV Enclosures, please see the DeltaV Enclosures whitepaper.

Built for Purpose

Over the last ten years, commercial off-the-shelf technologies (COTS) have provided tremendous increases in functionality and cost advantages to end-users of today's automation systems. The DeltaV system was the first such system on the market, and continues to provide open, proven products to its process manufacturers. However, while COTS has given many advantages, it has also come with expensive administration and life-cycle costs requirements. A better approach is to take advantage of the cost benefits and open standards of COTS, but then add functionality that allows the equipment to function much more like other parts of the system (plug-and-play, full lifecycle support without upgrades, built-in security, etc.). We call this balance "Built for Purpose", and the DeltaV system is the first automation system to address this critical need in many of the most important facets of the system.

DeltaV Smart Switches

Built for Purpose can be seen with the recently introduced Smart Switches – network switches specifically for use with DeltaV. Having these switches gives process control engineers and technicians direct access to the network for installation, setup and maintenance. Smart Switches eliminate the need for IT personnel help with network setup, because all of the setup is done through DeltaV. The network setup includes the ability to secure the network by easily locking out unused ports, but giving the ability to still easily re-enable the ports when needed.

While the setup and security for network switches has been fully integrated into DeltaV, so have diagnostics. With a third party switch, there is no indication on a DeltaV workstation to alert personnel of a problem or pending problem. With Smart Switches, PlantWeb Alerts will be generated and sent to the operator and maintenance consoles if there is a port or other hardware failure, communication error or if someone tries to access a locked down network. This gives process automation personnel the information they need to quickly fix any problem.

For more information and details on DeltaV Smart Switches, please see the Smart Switches Product Data Sheet.

DeltaV SIS™

Emerson has extended its digital PlantWeb™ architecture to safety systems with Smart SIS, which provides new value to customers by making plants safer, enabling regulatory compliance, increasing reliability and lowering lifecycle costs. With on-board computing power, intelligent field devices have become an integral part of the Safety Instrumented System and made systems safer because device health is known. DeltaV SIS provides a separate safety system, with common operations, maintenance and engineering platforms. This lowers installation and lifecycle costs because DeltaV SIS eliminates mapping of tags between the basic process control system and the safety system, OPC or serial links, and the use of additional engineering tools.

With version 11, DeltaV SIS has the ability to handle large projects with the introduction of SISNet Domains. The limits with SIS are now based on the DeltaV System limits. One system can have 30,000 DSTs – with a maximum of 15 SISNet Rings, each of which can have as many as 100 nodes. The rings can remain completely independent of each other, or they can be connected together via a redundant Ethernet bridge for global communications between rings. SISNet Domains further increase design flexibility, provide improved support for large projects, easier expansion of existing systems, and easier isolation of separate SIS applications.

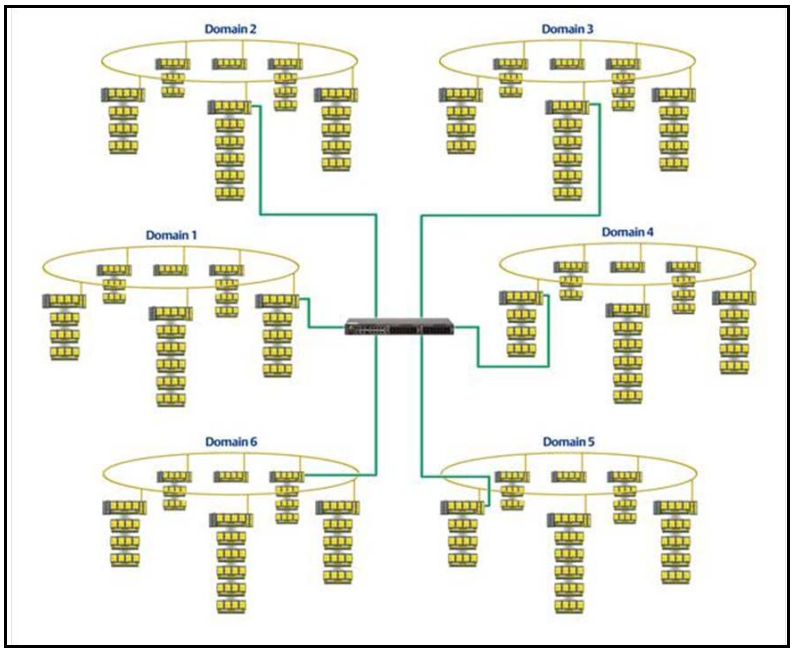

Figure 16 – SISNet Domains

For more information and details on SISNet Domains, please see the DeltaV SIS – Large Systems whitepaper.

Summary

Emerson strives to develop new technologies that focus on making tasks easier to accomplish, less complex and that adapt to the human using the technology, instead of the other way around. The benefits that can be seen in the version 11 release of DeltaV due to HCD include:

- Operators more focused and productive based on industry standard “color scale” graphics
- Cost savings on graphic implementation due to “out-of-the-box” color themes
- Alarm based help allows for less training and best practices to be shared across operations
- Reduction in training required around device commissioning and maintenance with new HCD Device Dashboards and wizards
- Wireless points available through redundant gateway save all field wiring costs and associated work
- H1 card with integrated power removes the cost, design, and complexity (failure modes) of 3rd party power supplies and conditioners on Ff segments
- Substantial savings in wiring, termination, design, and FAT associated with marshalling

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