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# Justifying DCS upgrades or replacements

## Doing something different is required



— 01 Operator effectiveness is one of many areas that can be cost effectively improved when upgrading and can help justify capital expenditures. Shown is an operator controlling multiple plant areas using System 800xA's High Performance HMI displays through an ergonomic Extended Operator Workplace (EOW).

But those benefits cannot be realized unless the upgrade or replacement also includes taking advantage of doing new or different things than the existing system was capable of. Doing a “replacement in kind” provides little or no benefit. There is a popular saying that states, “Doing the same thing over and over again and expecting a different result is the definition of insanity.” It is “insane” to think a replacement or upgrade project is going to provide financial benefits if it is not expected to do something different than what the current installation does.

In almost every case of automation system replacements or upgrades, the installed system is reaching its “end of life” where replacement parts are becoming difficult to find and their cost is increasing. This generally leads to a “shock value” approach to justification where a “risk” is identified for a failure leading to lost production or other potential economic impacts to the business. This type of justification normally does not find support among those holding the financial purse strings of the organization because it is “too soft” as the timing and degree of risk of a failure cannot be well defined. The argument against such a justification is simply that the system is working today and has a high probability of working tomorrow. From one day to the next, the risk is very low and so the urgency to fund such a project is also very low.

The reason this “failure mode” justification is used so often is that most enterprises approach an automation

Searching for economic benefits to justify a DCS upgrade or replacement has been a major issue for most enterprises since the first generation of control systems needed to be replaced with the next. The key is to recognize that a change of one or more generations in hardware and software brings with it the opportunity to make an investment leading to future financial benefits.

system replacement as one being done “in kind”, where little or nothing is to be changed other than the automation system hardware and software. In a high percentage of cases, the requirement is literally to “copy” the existing control logic and graphics as best as possible and get the system up and running as fast as possible. This approach is missing the key component of making an investment for improvement.

Opportunities fall into the following general categories (referenced later in the document by corresponding numbers; i.e. [1]):

- 1) Increased asset utilization
  - a) Often tracked as Return on Net Assets or RONA
- 2) Reduced maintenance costs
  - a) Contributions from ease of maintenance or improved practices and procedures that all reduce costs
- 3) Improved operator effectiveness leading to better decision making and fewer operational errors
  - a) System features that aid in access to information and recommended action
  - b) Adopting new practices, procedures or workflows that that increases automation and offloads many of the standard actions required of the operators
  - c) Opportunities for improved operator training.
- 4) Visibility of plant floor data upwards into the enterprise for accurate and timely decision making.
- 5) Improved cyber security protection over previous generations of systems

The latest generation of automation systems provides capabilities that reach far beyond their predecessors, creating a variety of benefit opportunities with features such as:

#### **Advanced alarm handling and analysis features [3]**

This is part of an Alarm Management Strategy to significantly reduce unnecessary alarms and place key situational information at the operator's fingertips. This improves the speed and accuracy of dealing with abnormal situations. These features contribute significantly to avoiding product quality or production losses, or minimizing the periods of time, and therefore cost impact, when disturbance do occur because the operators have a much higher awareness and alert level plus situational instruction information to assist them in making better decisions and faster responses.

- A Hydrocarbon Processing article from 2008 includes material that identifies emergency alarms that escalate to emergency shutdowns (i.e. unplanned shutdowns) cost industry 2-5% of production annually. The same article provides a reference to frequently quoted material from the Abnormal Situation Management Consortium (ASM), that a lack of alarm management strategy costs the US Petrochemical Industry \$10-\$20 billion USD per year.
- Features included in the base System 800xA licensing that assist users in executing an alarm management strategy include the standard alarm and event display aspects (various configuration options, filtering, and aspect list access to key information), Alarm Hiding, and Alarm Response (up to 4 aspect call-ups at once).
- System 800xA optional features that aid an alarm management strategy include Alarm Operations (alarm shelving, alarm grouping, basic alarm analysis, and alarm help aspects) and Alarm History and Reporting.

- In addition ABB provides long term alarm historization, analysis and management tools that can be applied against multiple alarm sources. Other expertise groups can provide consulting to aid our clients in establishing and executing an alarm management strategy.

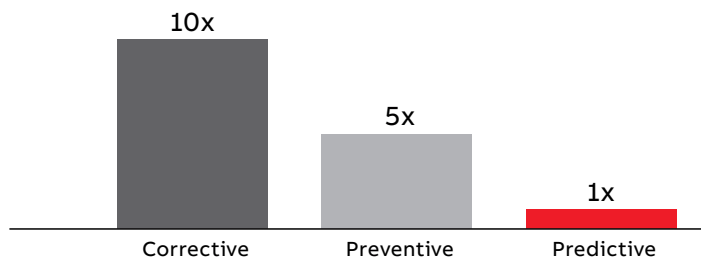
A lack of alarm management strategy costs the US Petrochemical Industry \$10-\$20 billion USD per year.

#### **A High performance operator environment [3]**

A High performance operator environment provides visual tools that aid an operator to understand the plant and product performance health rather than simply viewing "a bunch of numbers" on the graphics. Every facility has one or maybe a few operators that "know" when the plant is "good" or have a "sense" when the plant is "not good" by watching the numbers on the screens. But less experienced operators do not have that sixth sense. By providing visual, graphical tools to show that critical performance values and in range or trending toward conditions that might lead to poor quality or other less than optimal conditions, every operator can maintain the process at higher performance levels leading to real economic gains for the enterprise. The table below provides some information on the impact of a high performance operator interface.

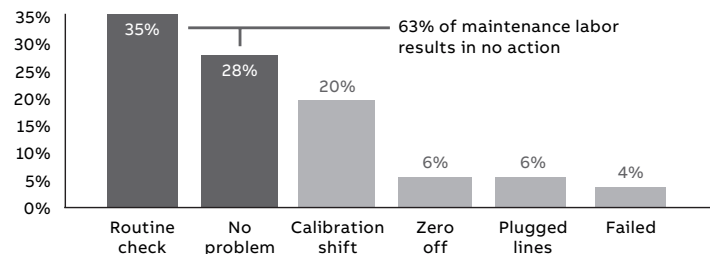
Task	With traditional HMI	With high performance HMI	Result
Detecting abnormal situations before alarms occur	10% of the time	48% of the time	A 5x increase
Success rate in handling abnormal situations	70%	96%	25% increase
Time to complete abnormal situation tasks	18.1 min	10.6 min	41% reduction

## The cost of maintenance



Corrective maintenance can cost ten times as much as a predictive maintenance strategy.

## Potential for Predictive Maintenance with pressure transmitters



Potential for predictive maintenance with pressure transmitters. Source: Shell Global Solutions

### Asset management capabilities [1][2]

Asset management capabilities for smart instrumentation, the automation system itself, control loop performance, and potentially for key equipment and mechanical assets. Utilizing asset management is a critical first step to changing maintenance practices and procedures to move away from reactive or corrective repair workflows to best in class predictive procedures resulting in significant reductions in maintenance costs.

- One measure of the impact on an individual plant is that a corrective maintenance program costs the plant the equivalent of the net profit of the facility on an annual basis. So moving to a predictive maintenance environment can have the effect of doubling the plant's net profit.
- A DOE study reported in 2012 that a predictive maintenance program can result in 8-12% cost savings of the entire maintenance program. That same DOE study found the elimination of 70-75% of breakdowns, downtime reductions of 35-45%, and a resulting production increase of 20-25%.

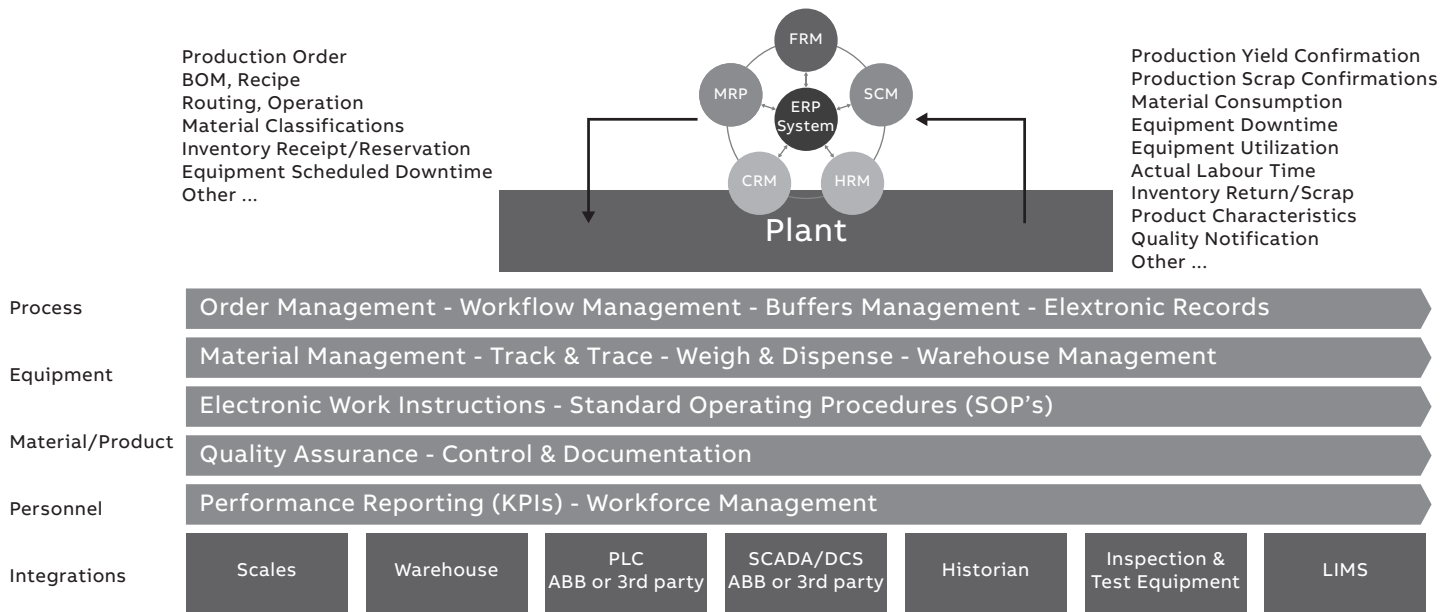
A predictive maintenance program can result in 8-12% cost savings of the entire maintenance program.

### Fieldbus technologies that allow the use of fully digital instrumentation [2][3]

Fieldbus technologies that allow the use of fully digital instrumentation that eliminates the need for calibration typical of analog devices and in some technologies allows for control, alarming, and other features to be executed by the devices directly without the need to use controller resources. Digital devices provide "full device scale" information all of the time regardless of the 0-100% scaling of the faceplate bar value. Unlike analog devices that need to be ranged for "low scale" at 4 mA and "high scale" at 20 mA, digital fieldbus devices will read accurately beyond those limits within the full capable range of the device.

Additionally, digital fieldbus devices increase the value of an asset management program because their status information is generally available at higher frequencies than can be managed with the polling systems that acquire similar information from analog HART devices.

There is "speculation" that had the bottom level device for the distillation tower involved in the BP Texas City disaster been a FOUNDATION Fieldbus device instead of an analog device, the severe overfilling of the tower may have been noticed, and the disaster averted, as the indication would have been available for the extreme high level instead of simply being more than 100% (an operator would still have needed to notice the value being well beyond the alarm limit).



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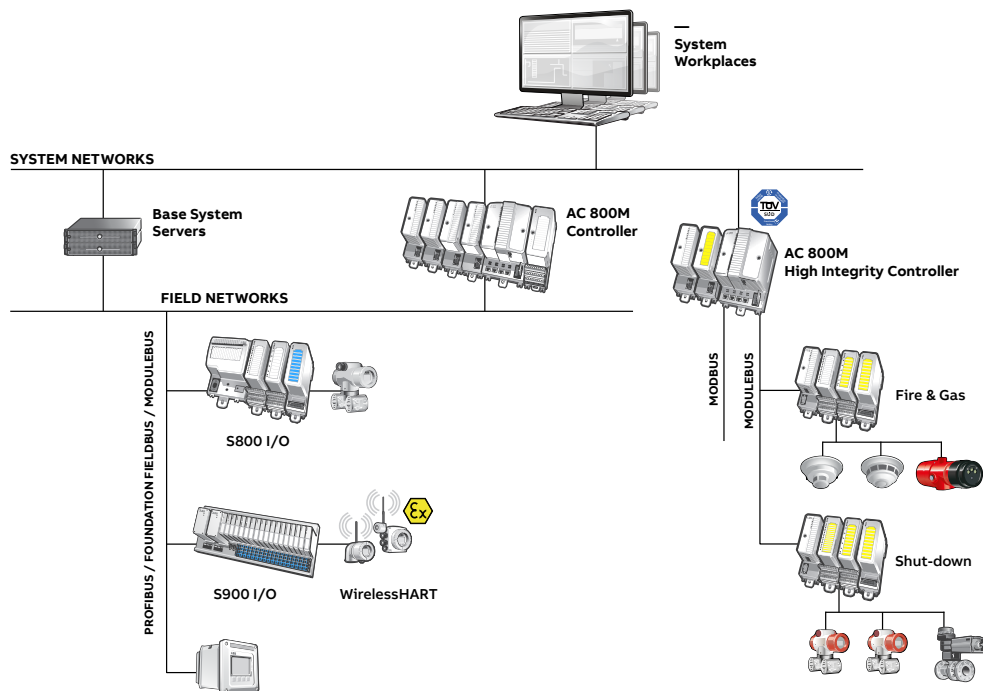
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01 Where an ERP system is in place, many manual operations normally take place that can be automated.

#### Built-in collaboration with plant and enterprise MES or ERP systems [2][4]

Built-in collaboration with plant and enterprise MES or ERP systems as a means of closing the gap between plant floor and board room with real time data and information for decision making requirements. Previous generations of automation systems generally required custom interfaces in an attempt to move plant floor data into higher level decision and information systems. Many of these interfaces required frequent maintenance to keep them current with changes to either side of the interface. The latest generations of automation systems now offer options that are much more “off the shelf” in nature, taking advantage of the specifications and requirements called for in ISA95 and utilize many of the latest connectivity interfaces to commonly used MES or ERP software packages.

- The actual integration timeframes for first implementation can be reduced from many months to just a few months or even just weeks for each interface that is needed. Additionally the lifecycle costs to maintain these interfaces may be reduced by several orders of magnitude since the standardized versions are not impacted by changes in either the automation system or the MES/ERP system as long as both continue to support the standardized methodology.

- Where an ERP system is in place, many manual operations normally take place that can be automated such as downloading of production orders, downloading batch processing entities (bill of material, recipes, product configurations), and confirmations of production responses. Automating these and similar requirements creates benefits by eliminating transcription errors, labor reductions for all of the manual entry and paper/electronic document management, and timely notifications of production compete or delayed status. Every business is different in the current performance in these areas, so typical values are not available.
- In cases where a well deployed MES system is not already in place, there are generally significant opportunities for supply chain improvements. Improving the visibility of production information with real time access increases predictability of manufacturing related information providing opportunities to lower raw material inventories and better manage shipping and handling costs (vehicle availability, demurrage, etc.), and can typically improve these cost areas by 1% or more and provides faster delivery to shorten the order-to-cash cycle for the business.



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01 System 800xA  
High Integrity  
Integrated Safety  
for SIL 1, 2, and 3,  
Burner Management,  
and Machine safety

### Built-in safety functionality [2][3]

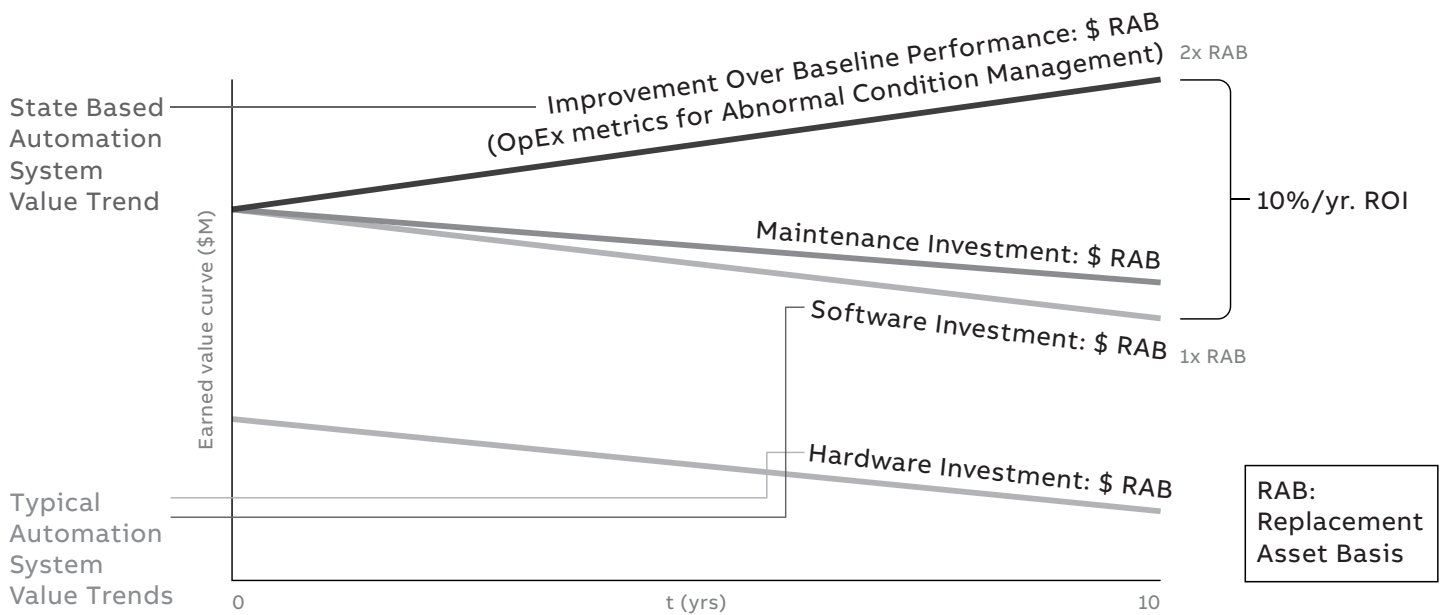
Built-in safety functionality for SIL safety, burner management (BMS), and even machine safety can provide many benefits ranging from common visualization for all appropriate users, common engineering tools for better skill utilization, to similar hardware components to simplify maintenance practices. Additionally, common event and alarm management, time stamping and historization of data, reporting methodologies, common asset management, and many other basic system features are shared between the Basic Process Control System (BPCS) and the Safety Instrumented System (SIS) that reduces system administration and other lifecycle usage costs.

### System 800xA High Integrity Integrated Safety for SIL 1, 2, and 3, Burner Management, and Machine safety

At project implementation, it is possible that the cost of SIS portion of the project using AC 800M HI logic solvers integrated into a larger System 800xA BPCS could be reduced by more than 50%. Identifiable items where the savings can occur are:

- Price of the safety logic solver and software licensing may be less for AC 800M HI than a typical third party system.
- Product lifecycle support costs (Automation Sentinel add-on for HI is minimal compared to separate system support programs)

- SIS overall physical footprint may be larger compared to compact AC 800M HI and S800 design (cabinets).
- Engineering required to provide “safe-online-write” capability that is standard in AC 800M HI.
- Reduced design and documentation costs by avoiding redundancy with similar requirements when using a separate SIS.
- No interface software or interface engineering costs required due to integration being designed in.
- No additional PCs required. Servers and clients use the same PCs as the BPCS.
- Significantly less cost for Bypass Management, Management of Change and other activities with the integrated design and testing already complete.
- Built in Asset Management capability and supported in standard hardware avoids HART MUX interfaces, cabinet space, and design and documentation costs.
- Lower training cost
- Lower engineering cost (alarms, historization, reporting, etc.)



01 Cumulative 10% per year improvement above baseline on Replacement Asset Base (\$ RAB) for 10 year project life accredited to improved Abnormal Condition Management with State Based Control. Numbers courtesy of The Dow Chemical Company, 2009.

Moving many of the standard situational procedures into the control platform and potentially increasing the degree of automation in the facility creates a more profitable and safer facility.

### Procedural control [3]

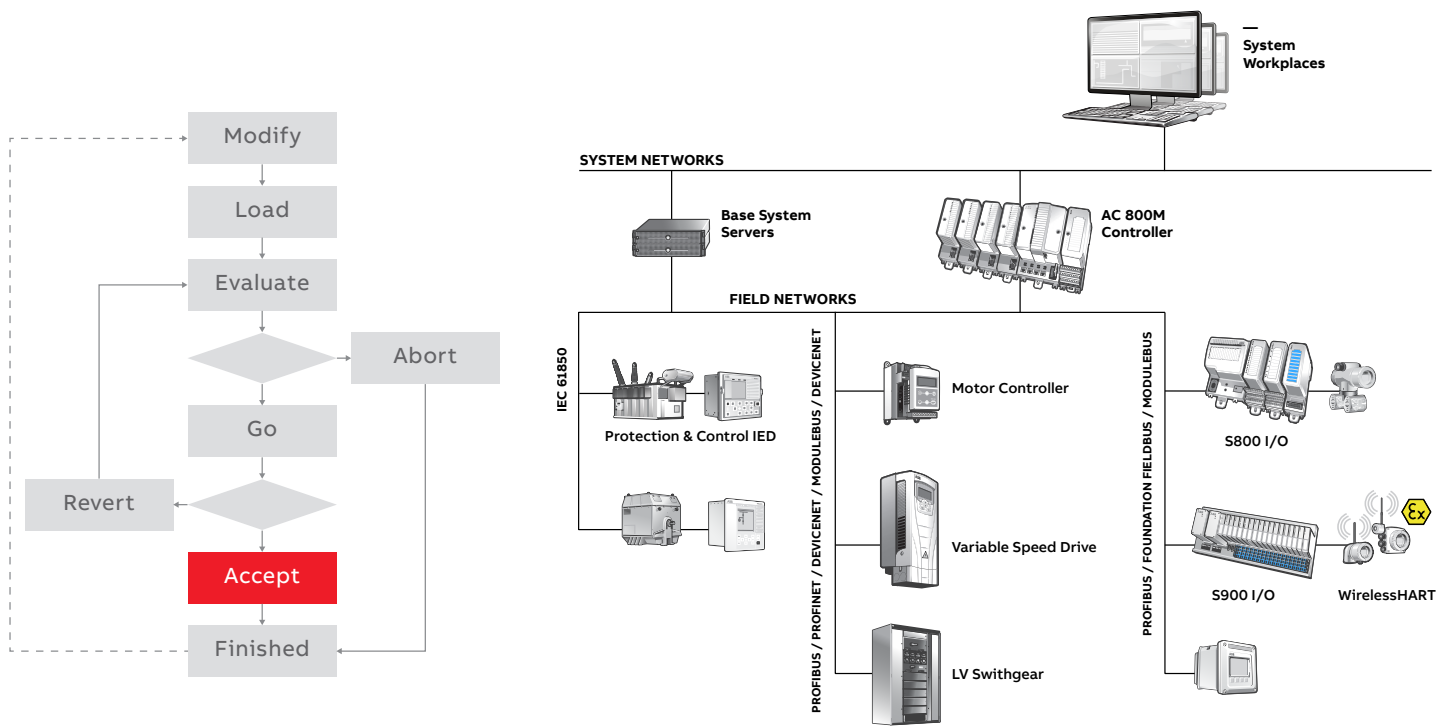
Upgrade your continuous process automation to procedural control. Batch manufacturers that have adopted the concepts and methodologies presented in ISA88 have benefited for many years over those that have not. Similarly, continuous operations can benefit from using procedural automation to embed functionality, safety, and operational knowledge directly into the control logic running in the DCS controllers. The concepts behind this "innovation" will be released this summer (2013) from the ISA106 committee in the form of its first Technical Report. ABB's implementation is called State Based Control (SBC).

There are no true continuous processes. Every process has at least a few "states" of operation (a shutdown state for maintenance or other reasons, starting up, running – which can actually be many different states, and shutting down). Operators follow "procedures" (usually written and stored electronically or in binders of operating manuals or simply "implied" by years of practice) to properly control the plant during all of these states.

In most facilities today, this is done by the operator interacting individually with all of the control functions (typically PID or discrete operations). The operators are expected to know or find proper instructions for these procedures for hundreds or maybe thousands of devices and utilize them accurately in every situation. Moving many of the standard situational procedures into the control platform and potentially increasing the degree of automation in the facility creates a more profitable and safer facility.

The Dow Chemical Company has internally documented the economic impact of nearly identical processes with and without SBC. The results are shown in the graphic below. Over a 10 year period, the typical investments made in hardware and software decline in value when only traditional control techniques are used. However, with the addition of SBC, the investment value increases at 10% per year when SBC is applied.





Imagine the ability to “see” the actions of logic and have the ability to reject logic that is improperly configured and that would have resulted in immediate equipment shutdown.

#### High availability control logic management [2][3]

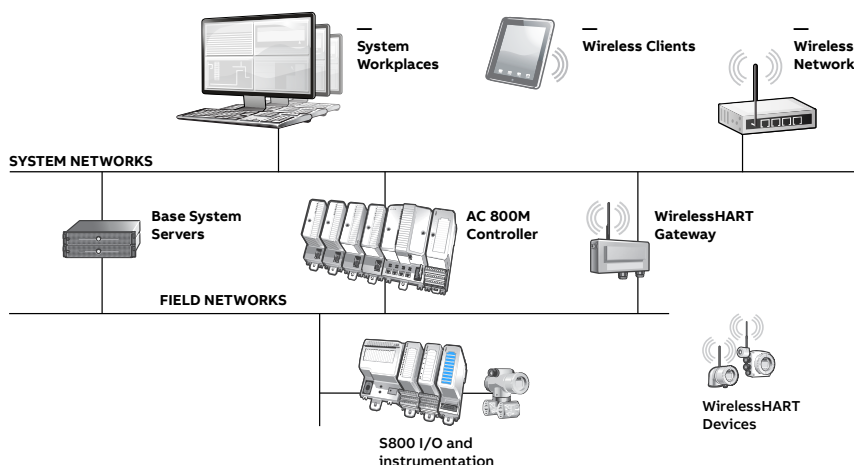
The feature within System 800xA identified as Load-Evaluate-Go (LEG). If your process has experienced severe disturbances or even complete outages caused by a control logic update that went wrong, then this item could provide significant justification for your project. LEG is a feature that provides the capability to have both the current control application and modified version of that application resident in and AC 800M controller at the same time and be able to view the resulting control actions of the new code versus the existing code with the ability to switch between which version of the code interacts with the actual control output channels and creates the ability to either accept the new version, or to reject it and keep the existing version running.

Imagine the ability to “see” the actions of logic and have the ability to reject logic that is improperly configured and that would have resulted in immediate equipment shutdown or control actions that could

have rapidly lead to process changes result in poor performance or may have created an unsafe condition? One such instance could be enough justification for an entire project.

#### Built-in Electrical SCADA functions [2][3]

Built-in Electrical SCADA functions for information, observation, and power management. One of the most costly energy resources most facilities must deal with is electricity. Yet, in nearly all facilities, process operators, operations management, and process support engineering personnel rarely have any visibility into the functionality or health of the electrical subsystems that provide the power to all of the motors that operate the equipment they are responsible for managing. The capability to provide this integration for medium or higher voltage equipment has been simplified with the availability of electrical components that can communicate based on the protocols set forth in the IEC 61850 standard (MMS and GOOSE, both over ethernet). Also contributing to easing the communication voids for lower voltages is the increasing adoption of PROFINET IO into low voltage switchgear and control devices like variable frequency drives and motor controllers. The usage of electrical integration is still in its infancy. The various industries with a high interest in this capability are still learning about the wide scope of benefits it is expected to deliver.



With visibility and knowledge of the conditions in both the electrical subsystems and in the process, logic can be created that intelligently selects the best and most economical result at that time.

#### **(Built-in Electrical SCADA functions continued)**

Built-in electrical SCADA functionality is a new frontier for the process industries. It will provide opportunities for process operators to view and understand the conditions and health of low and medium voltage electrical supply systems that provide the power to run the motors for most of their process equipment. One key benefit will be a quick analytical tool to view the condition of protection equipment, such as breakers, when a motor does not start. Knowing if the electrical supply to the motor is actually available can save valuable time in troubleshooting a problem like this. If the supply breaker is tripped, the operator will know there is no immediate need to call an electrician to work on the motor, but rather to go address the breaker first. In facilities with generating capability, whether it's conventional generation or co-generation, there is always the chance that some or part of the generation will fail. When that happens, intelligent decisions about using purchased power or executing load shedding procedures needs to be made. Today, those decisions are generally made by the electrical group in a predetermined way and operations needs to deal with whatever the results are. With visibility and knowledge of the conditions in both the electrical subsystems and in the process, logic can be created that intelligently selects the best

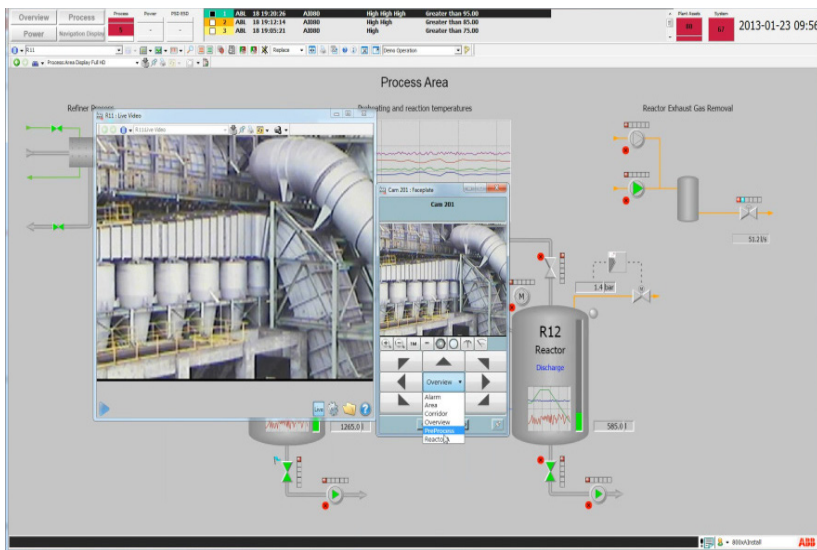
and most economical result at that time. Consider previous situations in your facility where hindsight would have made different decisions if the electrical systems were visible to the process group and the financial benefits that could have been recovered.

Wireless handheld operations capabilities for maintenance, operations rounds, and even localized control are creating benefits ranging from electronic access and time synchronization of operator rounds with normal process data improving troubleshooting and abnormal situation analysis.

#### **Wireless infrastructure opportunities [3]**

Wireless infrastructure opportunities for mobile operations/maintenance and for process instrumentation. Again, this is a rapidly evolving part of the latest generation of automation systems and the quantification of benefits varies widely, in many cases being specific to the facility and the opportunities presented. WirelessHART instrumentation is creating opportunities to extend DCS control into remote parts of the facility that previously were not economical to reach with conventional wiring. Wireless handheld operations capabilities for maintenance, operations rounds, and even localized control are creating benefits ranging from electronic access and time synchronization of operator rounds with normal process data improving troubleshooting and abnormal situation analysis to reducing mean time to repair (MTTR) by placing important maintenance procedures and equipment data sheets at the fingertips of technicians.





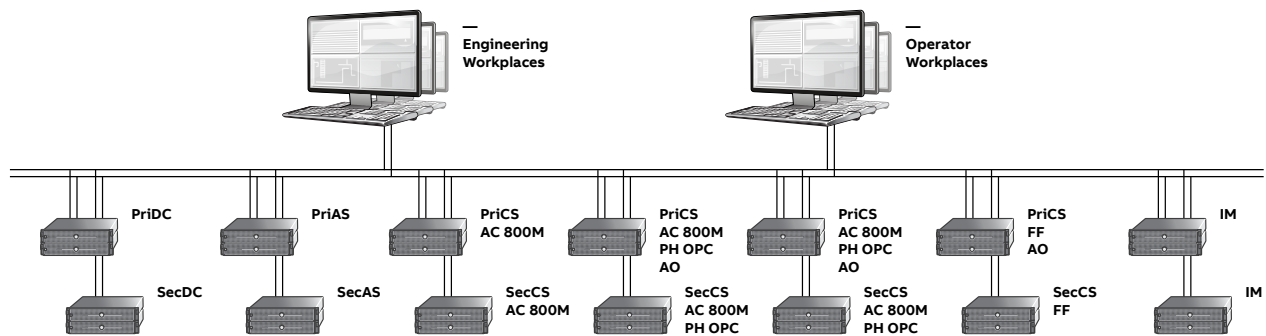
- WirelessHART was introduced into System 800xA as part of SV5.1 and at roughly the same timeframe into offerings from the Measurement Products business unit. Since the devices still need power, either power wiring was still required, or more recently some suppliers have been providing battery-powered options. In addition, ABB has released a fully wireless transmitter that can be powered from a thermal differential power source, opening opportunities to begin an era of truly wireless installations.
- System 800xA has supported wireless operator environments as part of the last several releases. Recommendations have been provided for PC hardware, but if your organization has a preferred supplier for mobile devices, chances are that your choice of hardware will work properly. The preferred implementation is to use the “Remote Client” licensing option that uses Microsoft Server 2008 Terminal Servers and Remote Desktop Services (RDS) functionality at the client.
- ABB has added wireless infrastructure capability into the product portfolio with the acquisition of Tropos, a leader in wireless networking.

Mobile video and audio integrated through a wireless infrastructure can open opportunities to put the eyes and the advice of subject matter experts (SMEs) directly into the field at the point of a problem to be solved.

### Embedded video surveillance [3]

Embedded video surveillance that brings visualization of critical process equipment, remote operating areas, and can be integrated into a wireless infrastructure so subject matter experts, local or remote, can see exactly what an operator or maintenance technician is seeing in the field. Benefits are typically specific to a facility.

- By embedding process-view video into the operator workplace, the visualization is kept in context to the control environment and within the same window where the operator is working rather than requiring a change of focus to a separate video system. When applying the standard functionality of Alarm Response in System 800xA, a video aspect can be one of the four aspects made available to an operator directly within the workplace. For critical items that may need a “visual,” rather than needing to send someone to go to the area, using video can provide the operator an immediate view of plant equipment, saving measureable time in reaching a decision on how to proceed.
- Video may be used as part of a comprehensive plant safety program. Using video to monitor critical process areas that present unusual exposure issues for operators (chemicals, close quarters, heights, etc.) provides a way to view conditions without putting the operator at risk unnecessarily.
- Mobile video and audio integrated through a wireless infrastructure can open opportunities to put the eyes and the advice of subject matter experts (SMEs) directly into the field at the point of a problem to be solved. The SME could be local to the site but the location presents hazards, or the SME could be in a centralized corporate support facility or at another site within the enterprise and still participate in rapidly helping the local technicians identify and resolve problems.
- A complete, integrated solution for video is available with the VideONet Connect addition to System 800xA.



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01 Example system  
with standard server  
PC hardware

### Virtualized server and client software [2][3][5]

Using virtual machine (VM) installations creates opportunity to centrally manage all the system software maintenance, reduce computer costs and associated resource costs, as well as improve the physical security of the overall automation system. Virtualized servers generally only require 2 VM server platforms. In larger systems a single VM server can replace up to 12 physical server PCs. This cost savings not only applies to the PC hardware, but also the overall system energy consumption, rack or storage footprint for the hardware, cooling load requirements, and network switch hardware. For the physical server hardware, cost savings can be realized on systems normally requiring four or more physical servers.

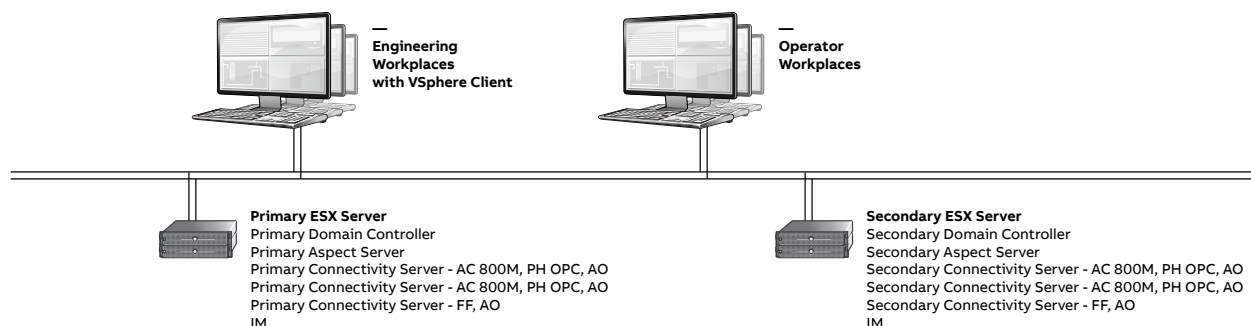
- Virtualized clients allow all client updates to be managed centrally rather than with physical clients distributed across the facility in a variety of control areas. Hardware local to the users is either a simple terminal client or is a basic level PC loaded only with basic software to support a Remote Desktop application. Any failure of the unit the operator is using only requires a direct, easy replacement, without the need to load system software.
- Physical security of the clients is significantly increased, since in either case, the computer hardware used by operators or others has no direct system software loaded to be corrupted by an inappropriate software load. The physical VM servers can be isolated with physical security protection features that prevent unauthorized access.
- Use of VMs can extend the length of time a system version is used for regulated industry installations or for those users that do not require frequent upgrades. At times when new hardware in physical servers no longer supports an older operating system, having the system installed on VMs allows the owner to maintain the installed platform and can significantly delay forced upgrades.

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### Cyber security [5]

Cyber security is becoming an increasing concern of most automation system users. It was common with older systems, at the time of installation, to not have them connected to networks that extended past the control room. Once these outside connections started taking place, concerns over viruses or other unauthorized access became evident. Although most evolutions of the older systems used virus and operating system protections, many owners still remained hesitant at making connections, limiting the timely access to information and similarly limiting its value into the business decision making functions. Connectivity outside the control room is a common requirement, today, and automation systems need to address the wide range of issues this causes for system owners ranging from the impact of security and virus software on their systems to physical network protection products.

- With Automation Sentinel subscriptions, System 800xA owners have access to information about the safe compatibility of Microsoft operating system security patches and service packs as well as appropriate use of virus protection software. All such progressive software releases are tested against and reports released on appropriate use within two weeks of release by the upgrade providers. Not all releases have been found to be compatible and a release that interferes with System 800xA functions could cause problems to users resulting in system performance losses that could propagate to production losses.



### Thinking outside of traditional automation system into physical improvements for the facility

As mentioned above, electricity is one of the highest costs incurred by most production facilities. Changing the process control from traditional control valves and dampers to using variable frequency drives (VFDs) and direct drive motors for pumps and blowers (and compressors that do not already have VFDs) can save 30-50% of the energy used by each application. Potential additional benefits may be available in replacement equipment cost (smaller, less expensive motors and elimination of gear boxes), maintenance costs (gear boxes, valves), process control benefits (linear control, improved process turndown stability), and for process expansions the purchase and installation of control valve stations can be eliminated completely.

None of these benefits come for free with a replacement or upgrade project. They all require additional investment of money and resource time in addition to the purchase and engineering of the basic system functions. However, each one can create value for having made the total investment depending on needs and opportunities your enterprise may have.