Reducing costs with PlantWeb® digital plant architecture:
Safety, Health, & Environment

Safety, health, and environment are top priorities in every operation. PlantWeb digital plant architecture helps reduce SH&E costs by enabling you to *predict and prevent* abnormal situations instead of simply reacting to them. With PlantWeb's predictive intelligence and information integration, you can maintain the mechanical integrity of equipment, improve operational procedures for dealing with potential problems, and streamline regulatory compliance.

The challenge: Don't let bad things happen

There are two reasons that a strong safety, health, and environment (SH&E) program is "Job One" in virtually every plant: the risks are real, and the consequences serious.

Many products and feeds are volatile, toxic, explosive, or otherwise harmful. The high temperatures and pressures involved in many processes carry their own risks. And conditions that cause problems can be hard to detect – until they result in a process upset or equipment failure. What you don't know *can* hurt you…and your employees, your business, and your community.

Recent trends in plant operations can potentially increase these risks unless other changes are also made to maintain safety, health, and environmental compliance:

- Staff cutbacks, for example, make it harder for operators and maintenance personnel to keep up with process and equipment conditions, especially when changing market conditions result in frequent feedstock and process changes.

- Markets and competition can also drive increased production, leading some plants to push processes and equipment to the limits of safe operation – or even beyond.

- Extended periods between turnarounds can mean fewer opportunities for traditional offline testing and inspection of equipment, including safety-related instruments.

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For these reasons, it's essential to have an effective program for managing safety, health, and environmental risks and costs – one that goes beyond *abnormal situation management* to *abnormal situation prevention*.

Preventing problems pays off

Such a program is also good for your bottom line, although it's hard to quantify how much you save (or gain) because of a problem you *didn't* have.

Clearly, there are costs associated with on-the-job injuries and other safety, health, or environmental incidents. For example, employers and their insurers pay more than $40 billion annually in Workers' Compensation benefits – an average of $500 per covered employee.[1] Civil liability damages and litigation expenses can also be significant.

These costs are undoubtedly among the reasons employers surveyed by the National Federation of Independent Business ranked "**increases profitability**" among their top motivations for taking safety actions.[2]

But ranked even higher in the same survey was that such actions were "**the right thing to do**." A company that does the right thing to protect the environment as well as its employees can build a favorable reputation that makes it the first choice of customers, investors, suppliers, and potential employees. A strong SH&E program with top-down leadership can also pay off in employee morale and productivity.

However, even the **costs of avoiding problems** can be significant. In 2001, for example, the U.S. oil & gas industry spent $8 billion on environmental programs.[3] And one global chemical maker recently devoted 18% of its annual capital budget to SH&E.[4]

Fortunately, programs that also take advantage of recent advances in technology can **reduce the costs** of compliance.

Areas for improvement

Every facility strives to be as safe and environmentally responsible as possible -- which means constantly looking for cost-effective ways to do even better. Key areas for improvement include
1. Maintaining the mechanical integrity of plant equipment
2. Improving operational procedures
3. Streamlining regulatory compliance

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1. Maintaining mechanical integrity

When process equipment, mechanical equipment, or instruments fail to perform as expected, the results can have both safety and environmental consequences -- especially if the problem isn't discovered quickly.

In the hydrocarbon-chemical industries, for example, the most frequent cause of accidental release is **mechanical failure**.[5]

One study of accidental releases in hydrocarbon-chemical operations found that more than half resulted from mechanical failures or operating errors.[5]
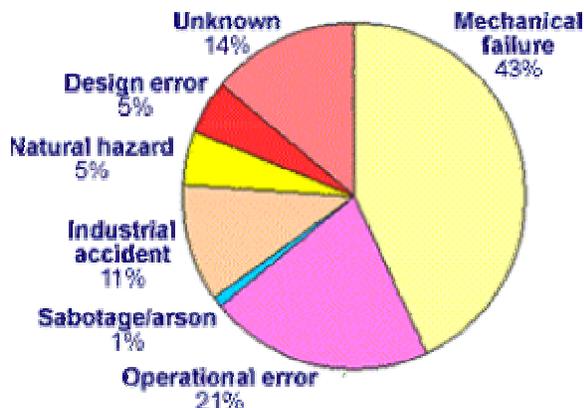
Many of these mechanical failures are due to "wear-out," which highlights the shortcomings of typical **preventive maintenance** programs. Because such programs are typically based on calendar or runtime schedules rather than actual equipment condition, two situations can occur:

- Service may come **too late**, after damage that can lead to safety, health, or environment problems has already begun.

- The work may be done **too early**, when it's not needed and maintenance errors can *create* problems…as well as SH&E incidents.

Both situations also **increase costs** – by performing maintenance that's not needed yet, or by allowing problems to grow until more expensive repairs are required.

To reduce these costs as well as the risk of failures, plants need to make greater use of **predictive maintenance** that's based on actual equipment condition. Equipment monitoring and diagnostic technology can detect potential problems – from a worn pump bearing to a sticking valve, from a fouled sensor to a failing heat exchanger -- *before* they affect process operations or safety. As a result, maintenance teams can prioritize repairs for the equipment that needs it, *when* it needs it.[*]

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[*] For a more extensive comparison of preventive and predictive maintenance strategies and their economic impact, visit **http://plantweb.emersonprocess.com/Operational_Benefits**, click on "Operations & Maintenance," and download the free white paper on reducing operations and maintenance costs.

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Integrating equipment-condition information with control systems also gives operators early warning of potential problems, so they can make appropriate process adjustments.

A special case of maintaining mechanical integrity involves **safety instrumented systems**, which are designed to initiate a shutdown if the process becomes unsafe. This safety-related equipment requires periodic testing to ensure it will work when needed most.

For example, emergency shutdown valves stay in one position during normal operations. Stroking the valve to verify that it works may require total shutdown of the process – causing a significant loss of production -- or use of separate (and expensive) bypass lines and field-mounted test panels. The challenge is to find a way to confirm such valves will work when needed, but without undue cost or impact on the process.

2.   Improving operational procedures

According to the hydrocarbon-chemical study mentioned earlier, the second most frequent cause of accidental release is **human errors**. Accident investigations also show that human error results in 70-90% of all industrial accidents.[6]

Some of these are simple slip-ups, but others may be facilitated by system design or **by insufficient or ineffective training, procedures,** and **work practices**.

Because control systems are typically designed, programmed, and tuned for normal or near-normal operation, it's particularly important that operators and other personnel have **easy access to the information they need** to manage the process when it deviates into abnormal situations.

Even better, of course, would be to move from abnormal situation management to **abnormal situation prevention** by enabling your team to spot potential problems and take corrective action before they grow. With remote equipment monitoring, for example, maintenance technicians can detect a dirty air supply before it affects valve performance and causes a safety or environmental problem.

Remote monitoring also reduces the need for technicians to go into **hazardous environments** for routine equipment checks.

3. Streamlining regulatory compliance

Complying with environmental, safety, and other regulations is essential – and often expensive. The challenge is to find the most cost-effective ways to meet these important requirements.

For example, frequent process changes and production rates that push equipment limits can increase risks of **exceeding allowable emissions levels**. While pollution prevention and abatement technologies can ease the task of compliance, so can **better process measurement and control**.

Tight, accurate control not only reduces the chance of process excursions that could increase emissions, but also reduces waste and off-spec material that must be reworked or disposed of safely. **Optimization software** can also identify setpoints that maximize throughput without violating constraints.

For most operations, regulatory compliance also means **documenting engineering, operating, and maintenance activities**. This is especially true for processes that face validation requirements like FDA 21CFR Part 11.

In a typical plant, for example, maintenance personnel average only 30% "wrench time." The rest of the time they're doing paperwork.[7] Documenting process and equipment changes can also add to costs.

Automated tools for tracking and documenting changes can greatly reduce these costs – as long as all the needed information is readily available in a compatible digital form.

What's missing?

If these methods can improve SH&E programs and reduce costs, why aren't more process operations already using them?

Too often, plants are hampered by an automation architecture that can't supply the **breadth and depth of real-time information** needed to predict and prevent potential problems -- information about what's happening not only in your process, but also in the **thousands of pieces of equipment** you depend on to keep things running smoothly and safely.

That's something traditional automation architectures can't easily provide. The control system can't show you much more than the process variable and any associated trends or alarms. It doesn't know – **and can't tell you** – when equipment conditions indicate a potential problem.

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For example, most traditional systems assume that any instrument signal between 4 and 20 mA is good, when in fact such a "good" signal could be hiding a sticking valve, a fouled pH sensor, or a plugged impulse line to a pressure transmitter. Or a bearing in a critical pump or motor may be going bad – but the control system has no way of knowing.

What's needed is a way to **get a better view** of what's happening throughout the operation, detect conditions that can lead to problems, and deliver the information where it's needed for corrective action – *before* those conditions turn into safety, health, or environmental incidents.

The answer: Digital plant architecture

What makes PlantWeb different from other automation architectures?

- It's engineered to efficiently gather and manage a new wealth of information -- including equipment health and diagnostics – from a broad range of field devices and other process equipment.

- It provides not only process control, but also asset optimization and integration with other plant and business systems.

- It's networked, not centralized, for greater reliability and scalability.

- It uses standards at every level of the architecture -- including taking full advantage of HART and FOUNDATION fieldbus.

- It's the only digital plant architecture with proven success in thousands of projects across all industries.

For more about the architecture and what it can do for you, visit **www.PlantWeb.com.**

You can get that better view with Emerson's **PlantWeb digital plant architecture**. PlantWeb's digital technology enables you to access and use new types of information that go far beyond the process-variable signals available through traditional automation architectures. With PlantWeb, both the breadth and depth of this information are unprecedented.

New insights. The difference starts with intelligent **HART and FOUNDATION fieldbus instruments** – including transmitters, analyzers, digital valve controllers, and other devices – that use onboard microprocessors and diagnostic software to **monitor their own health and performance**, as well as the process, and signal when there's a potential problem or maintenance is needed.

But PlantWeb doesn't stop with instruments and valves. It also captures information on the condition of **rotating equipment** such as motors and pumps. And it monitors the performance and efficiency of a **broad range of plant equipment**, from compressors and turbines to heat exchangers, distillation columns, and boilers.

Information where it's needed. PlantWeb uses communication standards like HART, FOUNDATION fieldbus, and OPC, as well as our **AMS Suite** of predictive maintenance and optimization software, to make this information available wherever it's needed -- in the control room, the maintenance shop, the safety or reliability department office, or even in other plant and business applications.

The equipment information is also integrated into PlantWeb's **DeltaV** and **Ovation** automation systems, which combine it with process data to

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deliver accurate, reliable control and optimization, and to manage alarms and alerts so the **right people** get the **right information** at the **right time**.

The power to predict. We call this new level of insight on what's happening – and *about* to happen – in your process and equipment **predictive intelligence**. With it, your team can accurately anticipate and correct potential problems before they turn into abnormal situations. The result: lower risks to safety, health, and environment, and lower costs.

PlantWeb's predictive intelligence provides early warning of potential problems.

This valve diagnostic, for example, indicates that friction will exceed the recommended limit in one month – enabling you to schedule replacement of the valve packing before deteriorating performance affects safety, health, or environmental protection.
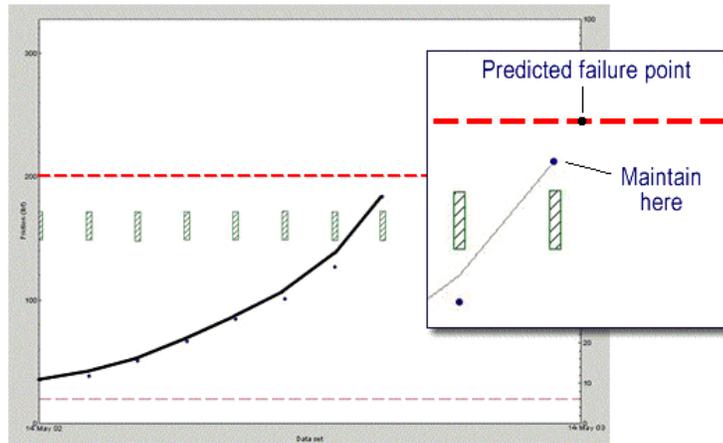
Let's take a closer look at how PlantWeb helps lower costs while improving SH&E performance in each of the three areas discussed earlier: **mechanical integrity**, **operational procedures**, and **regulatory compliance**.

Maintaining mechanical integrity

The best way to maintain the mechanical integrity of your equipment is to **never let it break.** PlantWeb's equipment monitoring and diagnostics help you reach that goal by providing **early warning** of potential problems.

They also tell you which devices and equipment are **working correctly**, so you don't have to perform unnecessary maintenance that can increase costs -- as well as the risk of accidents, spills, or maintenance errors -- or send technicians into hazardous areas for routine checks that often result in "no problem found."

For rotating equipment, **AMS Suite: Machinery Health Manager** software combines online monitoring information with data from a wide range of analytical tools.

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Bearing failure, for example, is a common problem in this type of equipment. But our software can detect and identify the very high-frequency noise associated with the earliest stages of bearing wear. You get maximum warning of future problems, before increasing damage significantly increases the risk of pump or motor failure.

Similarly, **AMS Suite: Equipment Performance Monitor** reports performance deviations in a wide range of process equipment, enabling early detection of potential catastrophic failures in key pieces of equipment such as back pressure steam turbines. PlantWeb diagnostics have also shown their ability to detect conditions leading to a catalyst circulation upset in a fluidized catalytic cracker (FCC) unit…30 minutes in advance.

Maintaining safe and responsible operations also requires that you be aware of any impending problems with the **instruments and valves** that measure and control your process.

Consider the case of a pressure transmitter with a plugged impulse line, perhaps because of freezing. Instead of reading the actual process pressure, the transmitter sees only the pressure in the plugged line – leaving your control system "blind" and you at risk of an incident if the actual pressure changes beyond safe levels. With PlantWeb, however, special diagnostics in the transmitter detect the line plugging and immediately alert you to the problem through **AMS Suite: Intelligent Device Manager**.

The **FIELDVUE digital valve controller** also offers partial-stroke testing to confirm operation of valves in **safety instrumented systems** – without disturbing the process. Test results are automatically time-stamped to aid in meeting regulatory reporting requirements. And because there's no need to shut down the process, testing can be done more frequently for greater assurance that the safety systems will work when needed.

AMS Device Manager capabilities including individual logon security, automatic audit trail, and remote diagnostics also make it an effective tool for safety instrumented system installation and commissioning, maintenance, and modification.

For commissioning or testing safety shut-down systems, **QuickCheck** capability in AMS Device Manager simplifies interlock validation by enabling you to put several instruments in fixed checkout mode at the same time. This ability to simulate process states without actually operating the plant not only improves safety, but saves time. Its use at one customer's site reduced interlock commissioning effort from two

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people working an average of 4-6 hours per interlock to one person working half an hour per interlock.

For a broader view of what's happening across the operation, DeltaV **Inspect** software provides advanced process monitoring to instantly identify under-performing loops. This includes "advisory alerts" for equipment that is still currently **healthy but may need attention** soon, before it affects safety or performance – such as a valve that has traveled beyond its recommended cumulative stroke distance, or a transmitter that is deployed outside its recommended operating range.

Improving operational procedures

By providing reliable process and equipment information when and where it's needed, PlantWeb helps you reduce the risk of problems introduced by human error. Operators and other personnel gain the data, the tools, and the confidence to **respond quickly and correctly** – and to adopt new procedures that take full advantage of PlantWeb's capabilities for reducing costs, increasing efficiency, and enhancing SH&E.

PlantWeb's powerful but easy-to-use **DeltaV** and **Ovation** automation systems help operators keep the process running smoothly, especially in non-steady-state situations like startups where manual control can increase the risk of errors and upsets.

Even during normal, ongoing operations PlantWeb's predictive intelligence can help minimize process variability, reducing the need for operator intervention. For example, DeltaV Inspect also monitors overall loop performance and variability, and automatically flags any degradation or abnormal condition so it can be remedied -- before it ever hits the operator's "dashboard."

DeltaV and Ovation also **monitor the signal status** from intelligent FOUNDATION fieldbus instruments (something not every system can do) to verify that the data is valid for use in control algorithms. If it's not, the systems can be configured to **automatically modify key control actions** to maintain smooth, safe operations – more quickly and accurately than if operators had to make all the changes themselves.

Operators, maintenance technicians, and others can also easily check equipment condition to anticipate and investigate potential problems. The **AMS Suite: Asset Portal** provides an integrated, high-level view of information from valves and instruments, rotating equipment, and process equipment in a **single browser-based interface**.

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These capabilities also increase operators' confidence that systems and equipment are performing as they should – encouraging them to leave **more loops under automatic control** and focus their attention on those that truly need it.

When process or equipment problems do occur, targeted **PlantWeb Alerts** help ensure that the right people get the right information right away.

Instead of simply flooding operators with alarms, as many control systems do, PlantWeb software analyzes the incoming information, categorizes it by **who should be told**, prioritizes it by **severity** and **time-criticality**, and then not only tells the recipients what's wrong but also guides them through an **appropriate response**.

The information provided with these alerts, coupled with PlantWeb's **remote diagnostics**, often eliminates the need to send technicians into the field to locate and troubleshoot the problem. Besides saving time, this also enhances personnel safety when the problem is in a remote or hazardous area.

Together, these capabilities mean your team will be facing abnormal situations far less often. To help them gain hands-on experience carrying out appropriate procedures, DeltaV and Ovation **simulation packages** provide an exact copy of the production control system where operators and others can **safely practice** dealing with both normal and abnormal process events.

Emerson also offers carefully designed **training** – at our location or yours, or in video-, web-, or PC-based courses – to meet certification requirements and help your team learn both the "why" and "how" of new procedures and work practices. Course offerings include our **Plant Safety** series designed to give managers, engineers, and others a working knowledge of OSHA standards, process hazard analysis, and the fundamentals of process safety management.

Streamlining regulatory compliance

PlantWeb makes responsible operations easier and less costly by
* providing **tight, reliable control** to help you stay out of situations that can increase emissions, and
* reducing time and effort to **document compliance** with environmental, safety, quality, or validation requirements.

We offer an unmatched range of measurement and analytical instruments you can depend on, from **stack-gas** and **dissolved oxygen** analyzers to **safety-approved** transmitters and valves. **Enviro-Seal** valve packing

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systems also help avoid fugitive emissions. And PlantWeb's predictive intelligence enables you to keep these devices performing at their best.

The DeltaV and Ovation systems add **supervisory and advanced control** to keep the process running smoothly and on target – including, as mentioned earlier, the ability to recognize and adjust for potential equipment problems.

PlantWeb's **advanced control and optimization** capabilities can also help adjust to frequent feedstock or operating changes, or even increase production by shifting the process closer to optimum **without exceeding constraints**.

Automatic documentation and reporting tools dramatically reduce time and effort (and risk of errors) for compliance-related paperwork like that required for FDA 21 CFR Part 11.

AMS Device Manager software automatically documents all changes made through its workstation – including date, time, user, and as-found/as-left information. Available **Audit Trail** capabilities provide a valuable tool for meeting documentation and reporting requirements.

The DeltaV and Ovation systems' **self-documenting engineering environment** also helps eliminate the need for separate offline or manual recordkeeping. Reporting tools let you easily generate reports to meet regulatory requirements. Where needed, we can also draw on our extensive experience in **system validation** to provide documentation required by the FDA or other regulatory agency.

Maximizing the advantage

In plants where staffs are already stretched thin by layoffs and retirements, finding the resources to make improvements can be a challenge. Emerson can help.

Besides training to help your team learn new technologies and work practices, we offer a broad range of **consulting, engineering, and maintenance services** to supplement your in-house capabilities and deliver PlantWeb's **full capabilities** for improving SH&E.

With decades of experience managing automation projects, we have the expertise to help with planning, analysis, implementation, and support of your risk-reduction program. We can even provide a dedicated Asset Optimization program manager who will work full-time in your plant to **monitor, evaluate, and advise** on mechanical reliability, electrical safety, process equipment performance, and valve and instrument health.

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Real projects, real results

Safety, health, and environmental benefits at lower costs are among the reasons that users have chosen PlantWeb architecture for thousands of automation projects in plants, mills, and refineries all over the world. Here's what just a few of them have said:

- "More efficient control not only saves money, but improves safety. Since we installed PlantWeb, we have greatly reduced the swings in our boilers that result from process upsets. This provides a much higher operating efficiency, and prevents borderline dangerous situations."

    - Commercial power producer, USA

- "Having an integrated operation environment, with robust control like that offered by fieldbus integrated with PlantWeb, allows you to attain a stable operation, minimizing deviations in the process and therefore minimizing the venting of contaminants into the atmosphere."

    - Petroleum refiner, Venezuela

- "Accurate documentation of process instrument calibration and maintenance is a key element of our compliance program. Because we are able to automatically record these activities through PlantWeb, time-consuming report writing by hand is eliminated, along with unavoidable human errors."

    - Pharmaceutical manufacturer, UK

- "Two valves handling hydrofluoric acid in an alkalization unit have a history of sticking. Because of the acid, it's necessary for personnel to don heavy rubber suits when entering the unit. AMS [Device Manager] enables us to frequently check the packing friction and other operating parameters, remotely obtaining important information about their condition, without sending personnel into that potentially hazardous atmosphere. The result is a saving of maintenance dollars by avoiding time-consuming trips into the acid unit by technicians."

    - Refiner, Canada

- "PlantWeb delivers the highest degree of automation plus remotely accessible performance and predictive information. This enables the plant to establish best practices to ensure safety and control of deviation across the plant, with maximum traceability to document cause and effect of any disturbance."

    - Engineering contractor, Finland

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For additional case histories and proofs of PlantWeb architecture's capabilities, visit **www.PlantWeb.com** and click on "Customer experience."

Taking the next steps

You wouldn't still be reading this if you hadn't already realized the advantages that PlantWeb offers for your SH&E program. But with so many potential ways to improve – and plenty of work already on your plate -- how do you get started?

First, assess where you are. What are the primary risks or regulatory requirements you face? What is your current SH&E program? Who manages it? With what resources? How are results measured? How did last year's results compare to goals, and to similar operations?

Next, identify areas that offer the largest (or most immediate) opportunities for improvement. Which equipment has the highest risk of failure – and the greatest impact on process stability and safety? How often do your personnel have to do troubleshooting or repairs in hazardous environments? How quickly can your operators return the process to normal after an upset? How much of their time do your engineers and maintenance technicians spend on paperwork?

Finally, work with your local Emerson team to define PlantWeb solutions for these "high opportunity" challenges. If you'd like, we can even help with the assessment and goal-setting portions of this process, from performing a site audit to developing the business case for your next project.

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Other resources

SH&E is just one of the areas where PlantWeb helps improve process and plant performance. This innovative architecture has also proven its ability to help increase throughput, availability, and quality, as well as reduce cost for operations and maintenance; energy and other utilities; and waste and rework. To learn about these other opportunities, visit **http://PlantWeb.EmersonProcess.com/Operational_Benefits**

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