Endress+Hauser
People for Process Automation

Is the management of plant assets being done safely and efficiently in your plant?

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Yesterday's greenfield plant is today's brownfield plant. With capital spending dramatically decreasing, today's expenditures need to provide a quick return on investment. When oil prices were high, increased profits were found by going back to construction and adding another well pad or another phase to an existing operation. With today's oil prices, that strategy cannot be sustained. However, there remains an opportunity to improve operations to realize sustainable rewards, year over year.

The upstream oil and gas industry is the only industry segment in Canada where we find brownfield operations that are state-of-the-art, with companies still committed to investing capital, albeit significantly less than in recent years. This paper examines a modern brownfield plant and proposes ways to make it more efficient by leveraging existing plant assets, equipment, tools and personnel.

Working with Endress+Hauser clients, Business Process Consultant, Marco van Veen has found that the most effective maintenance process improvements start with management engagement. "In order to maximize the positive impacts of Plant Asset Management (PAM) on a maintenance process, you need to embed the tools into the process," van Veen says. "Utilizing the modules of a PAM as part of your company's Standard Work Procedures (SWP) results in standardization that is measurable so management can benchmark and build on the improvements as necessary."

A proper PAM plan should govern all aspects of operations and maintenance, following the complete asset lifecycle, from commissioning right through to disposal. Standard Work Procedures define the process step by step, engaging operations staff (plant) and maintenance technicians (instrumentation) need to be equally engaged in the exercise.

Having a PAM plan in place prior to construction is the best practice in order to reduce costs and improve plant safety and efficiency. Many of the brownfield operations today were constructed in the last five years and truly do have state-of-the-art digital instrumentation. Oil and gas operations in Alberta are utilizing HART, Profibus and Foundation Fieldbus instrumentation; these new technologies are already in place. Unfortunately, most operations have not implemented a central PAM system for instrumentation, though instrumentation provides the eyes and ears for operators in the control room. Furthermore, the same running operations have steps in their existing SWP that only apply to 4...20mA conventional maintenance.

There are three basic components required to implement a PAM system:

- Intelligent field devices – sensors and control devices
- An open and standardized communication protocol—the vehicle for delivering device information back and forth to the PAM system
- Lastly, you need the PAM software, typically a suite of PC-based tools allowing:
  - Asset Information Management
  - Calibration Management
  - Asset Health Monitoring
  - Connectivity to Computerized Maintenance Management Systems or Enterprise Asset Management (i.e., SAP or Maximo)
  - Device Configuration Management
  - Historical Reliability Data
  - Obsolescence Monitoring
  - Spare Parts

In most operations today in Alberta, the first two of these three basic components of a PAM system already exist. The bulk of the costs and the thousands of intelligent field devices, equipped with an open and standard

communication protocol, are already in place. Without a PAM system being implemented and enabled to access the information from the intelligent field devices, the ability to reduce costs, improve plant availability and asset reliability is a lost opportunity.

Why include Plant Asset Management of instruments and control valves?

While instruments and control valves tend to account for a small percentage (typically a few percent) of the overall capital costs, the reality is that instruments provide the operator with a vision into the process - allowing the operator to control the process with control valves based on this vision. Today's plants consist of more and more instruments and control valves. It's the quantity of these field devices that can lead to potential operational savings. While plants have many more expensive assets, those larger assets typically represent a ratio of 1:100 or even 1:1000 compared to the vast number of instruments and valves. With a solid handle on instrumentation and valve maintenance - coupled with a predictive maintenance regime - the savings add up. These savings can amount to hundreds of thousands of dollars, in contrast to the costs associated with reactive trouble-shooting for instrumentation issues that can be a significant drain on resources. Instruments and valves amount to about 27% (see figure #1) of the maintenance budget in a typical operation and can be a major contributor to unplanned down time if not maintained properly.

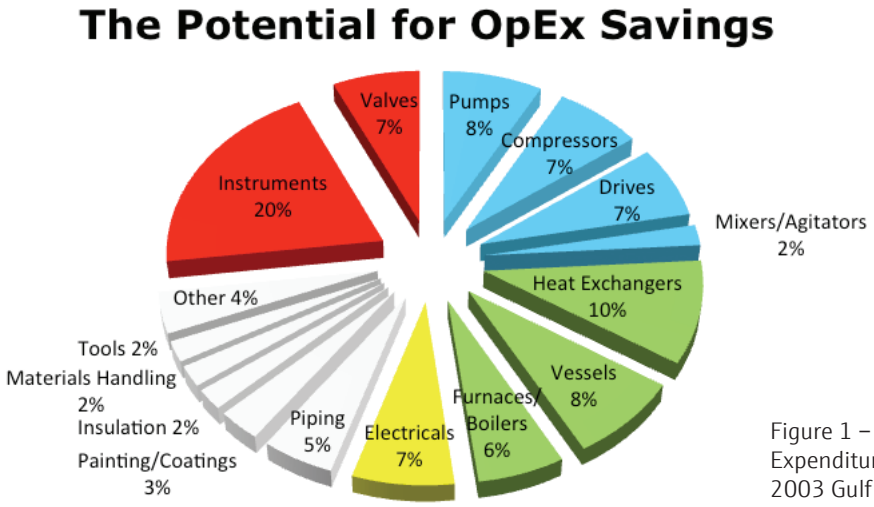
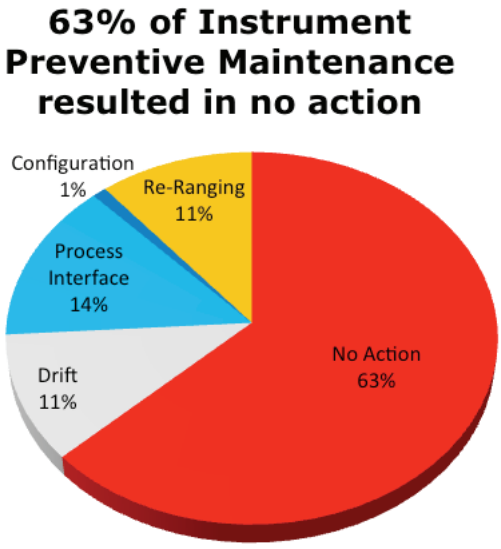


Figure 1 – The Potential for Operational Expenditure Savings Source: HPI Market Data 2003 Gulf Publishing Company



To further emphasize these opportunities, Figure 2 (from Shell Global Solutions) illustrates that 63% of instrumentation preventive maintenance typically resulted in no action—no net benefit.

Figure 2–63% of Instrument PMs resulted in no action taken Source: Shell Global Solutions

Recent surveys of maintenance management effectiveness indicate that one-third or 33 cents out of every dollar)of all maintenance costs is wasted as the result of unnecessary or improperly carried out maintenance. When you consider that U.S. industry spends more than $200 billion each year on maintenance of plant equipment and facilities, the impact on productivity and profit that is represented by the maintenance operation becomes clear.[2]

In fact, reliability engineering data (see figure 3) indicates that more than 80% of failures are random — leaving less than 20% of failures being time-based — reinforcing the argument that preventive maintenance strategies (time-based) for instrumentation are less than optimal. Without predictive or condition-based maintenance and new Standard Work Procedures, the numbers suggest that time-based maintenance alone would result in a significant missed opportunity.

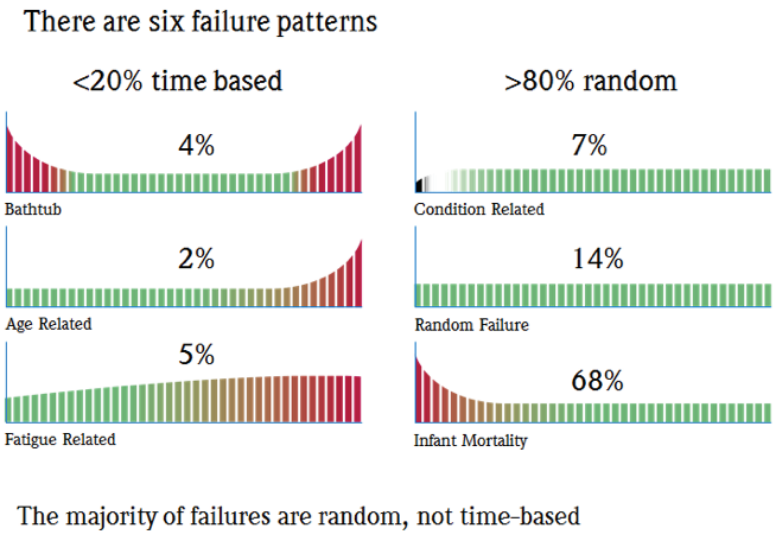
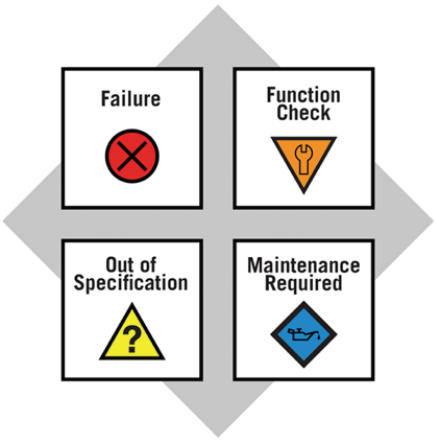


Figure 3 - There are Six Failure Patterns
>80% are random.
Source: Ivara Corporation

End-users have requested clearer diagnostics and the market has responded. Namur, a European group of endusers, has delivered a recommendation, NE107: "Self-Monitoring and Diagnosis of Field Devices," asking vendors to categorize field device diagnostic messages as (see figure 4):

- **Failure** – The device provides a non-valid output signal due to some malfunction at the device level.
- **Function Check** – The device is temporarily non-valid due to some activities, such as maintenance activities on the device.
- **Out of Specification** – The device is operating outside of the specified limits
- **Maintenance Required** – Although the device is still able to provide a valid output signal, the device is about to lose some of its functionality or capability due to some external operating conditions. The maintenance may be required short-term or mid-term.



The Fieldbus Foundation has adopted this recommendation with FF912 and Profibus has adopted the recommendation in Profile 3.02. HART 7 is being adapted accordingly.

Figure 4 - Namur NE107: "Self-Monitoring and Diagnosis of Field Devices"

Endress+Hauser's Plant Asset Management Suite consists of Asset Health Monitoring (based on NE107) dashboards and alerts that can be linked to Maintenance Management Systems—to generate work orders, enabling users to take advantage of predictive and condition-based maintenance—for all of their instrumentation, regardless of the manufacturer.

The real benefits of Endress+Hauser's PAM Suite are observed when instruments and smart positioners have built-in early warning systems. At Endress+Hauser, we call this "asset health monitoring," which leverages our design-based functional wear reserve. Oneexample could be "build-up detection" in a flowmeter flow tube. If a flowmeter can alert maintenance teams that it has detected a significant build-up on its measuring sensor, maintenance teams can plan to take this meter out of service and clean it, based on actual conditions rather than implementing a time-based preventive maintenance routine that is applied to all flowmeters. If only this one flowmeter is scheduled for maintenance, overall plant availability is optimized. Endress+Hauser can design the flowmeter to be able to alert maintenance teams and still wear-on for some time before the problem progresses to the point of failure. This functional wear reserve provides up time to plan the required maintenance task (see figure 5).

Analysis of maintenance costs indicates that a repair performed in the reactive or run-to-failure mode will average about three times higher than the same repair made within a scheduled or preventive mode. Scheduling the repair minimizes the repair time and associated labor costs. It also reduces the negative impact of expedited shipments and lost production."[2]

Given the status of instrumentation in plants today, we estimate that 5–10% of instrumentation is in need of maintenance, yet nothing is being done because:

- there is no Plant Asset Management system in place/ diagnostic information is stranded;
- the device display is not readily visible even though the device is screaming out for help; and
- current maintenance culture does not promote advocacy for distressed equipment found during operational rounds.

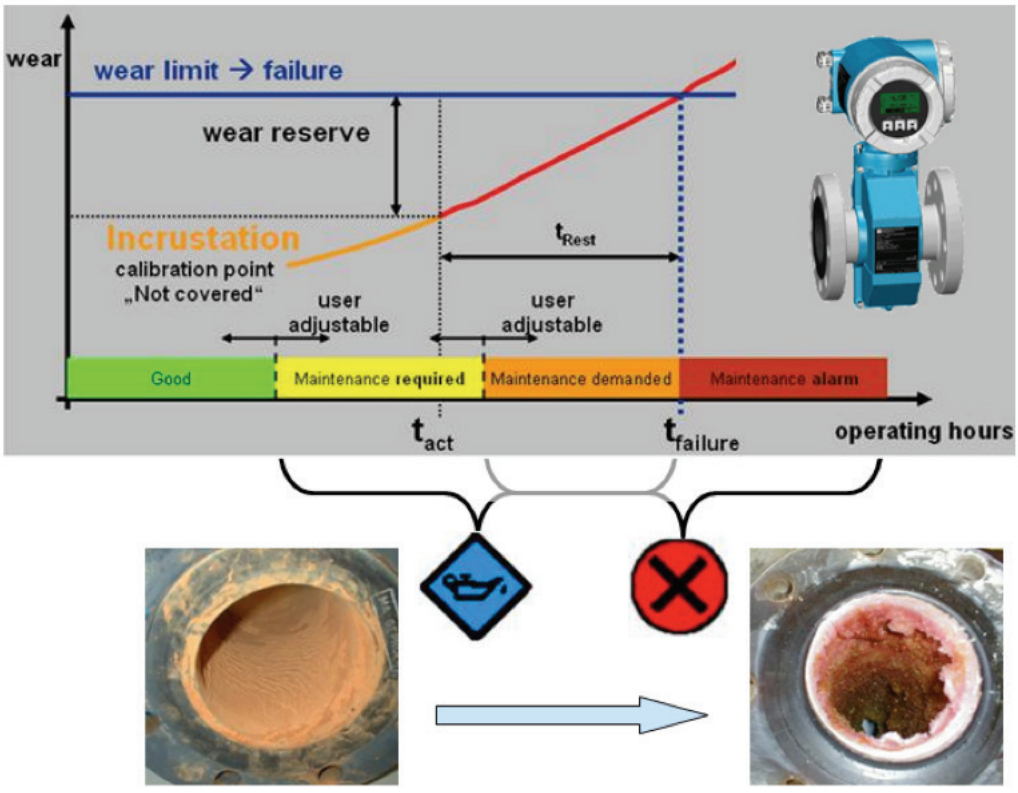


Figure 5 - Maintenance urgency based on functional wear reserve

What are the challenges facing oil and gas companies today?

Speaking before the Chamber of Commerce in Fort McMurray, Steve Laut, president of Canadian Natural Resources Ltd (CNRL), said "the drop in oil prices is an 'opportunity' for every part of the industry to cut costs and eliminate inefficiencies that were allowed to creep in when business was booming." He added, "that by seizing the moment and lowering costs, it [oilsands companies] could get back to a healthy return on investment.[1]"

Once again, while oilsands companies today have state-of-the-art digital instruments and valve positioners they continue to maintain them the same way they did when their plants were merely analogue.

What would be the impact on operating costs if a producer saved 1–2 hours per instrument work order?

We estimate that a producer of 30 000 bbl/d could save $100,000 per annum, year over year, just by implementing Standard Work Procedures and using a centrally positioned PAM system.

Corrective Maintenance

Corrective Maintenance is a huge cost for producers; production quality may slip leading up to the eventual equipment failure. The equipment failure may go unnoticed for some time, until the Operator Console detects an input failure. Where production quality has not been sacrificed, the potential remains for over production; extra costs incurred through excessive use of expensive chemicals and utilities. These extra costs accumulate, leading up to the failure. Once the failure has actually occurred, manual testing and manual operations are required, resulting in even more waste or quality losses. This will continue until the failure has been corrected or an unplanned shutdown occurs.

In this plant, state-of-the-art digital instruments and control valves already exist. However, throughout the boom, there was no urgency or time commitment to setup and optimally utilize the PAM software. As a result, several wasteful steps are still being taken to correct the fault. These steps may include (see figure 6):

- travel first to the device to see what type of instrument it is and if the issue is obvious, as the Operator Console only indicated an input failure;
- travel back to the maintenance shop to search for manuals;
- travel once again to the device, this time with the correct manual, only to find out the failure is not correctable in the field;
- now, the technician travels to the warehouse to get a spare device;
- once more the technician travels back to the device to finally correct the failure through replacement with a spare; and
- one last trip back to the Control Room to close out his permit and work order.

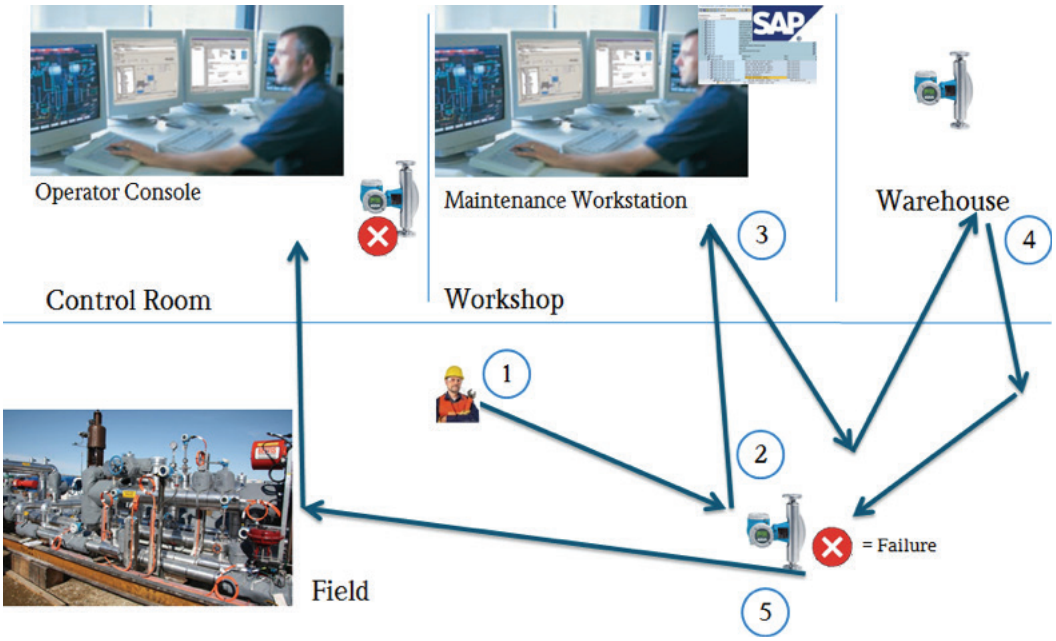


Figure 6 - The typical process for corrective maintenance is inefficient and requires an actual failure first

If you feel this example is exaggerated, review this process with your most experienced technician. Then, review this process with your least experienced technician. The conversations may surprise you.

Predictive Maintenance

How could this picture be different if the Plant Asset Management system was implemented and used to the ultimate level of predictive maintenance? Through the utilization of Asset Health Monitoring, a module of the PAM, operations are alerted that maintenance is required for the device in question. Early detection can avoid chemical and utility wastes or even worse – poor product quality. The "maintenance required" alert informs the operations team that the intelligent field device has just detected an undesirable condition. However, correct measurement is still possible for the time being. From the maintenance shop on a maintenance workstation, the technician can now remotely access the device with the Device Configuration Module to identify the model number, instrument brand and serial number, as well as the manuals. All this information has been proactively stored in the Asset Information Module. The technician can then make a call to the warehouse to confirm that the required spare device is correctly stocked. The operations team can meet and determine the urgency required to replace the still-functioning meter. The device doesn't need to be replaced immediately as it has not failed yet. Now, with the correct tools and manuals in hand, the technician picks up the spare device from the warehouse and then travels just once to the device to replace it even though the device has not failed yet (see figure 7).

This predictive maintenance example is just one of the possible improvement outcomes that can be expected when PAM is implemented. In some cases, the actual corrective action can be delayed for months perhaps until a planned shutdown.

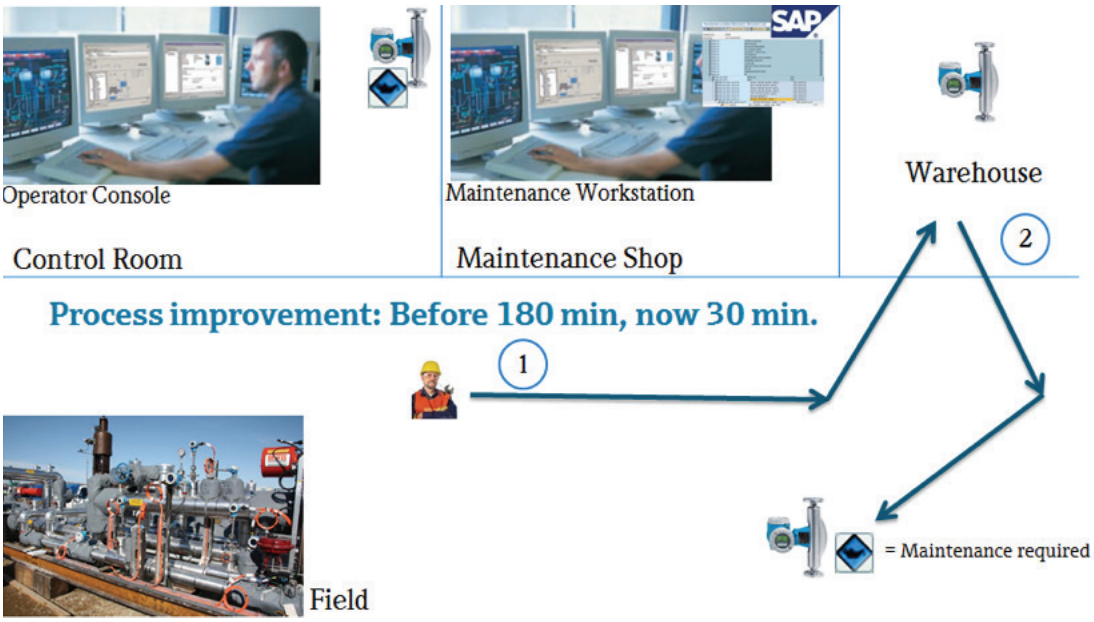


Figure 7 - Maintenance process improvements can allow for much more efficiency, even proactive maintenance

Until recently, middle-and corporate-level management has ignored the impact of the maintenance operation on product quality, production costs and, more importantly, on bottom-line profits. The general opinion has been, "Maintenance is a necessary evil," or "Nothing can be done to improve maintenance costs." Perhaps these statements were true 10 or 20 years ago, but the development of microprocessor- or computer-based instrumentation that can monitor the operating condition of plant equipment, machinery and systems can manage the maintenance operation. This instrumentation can reduce or eliminate unnecessary repairs, prevent catastrophic machine failures and reduce the negative impact of the maintenance operation on the profitability of manufacturing and production plants. [2]

Increased safety is a good by-product of being more efficient. In the Corrective Maintenance example (figure 6), consider the number of trips back and forth from the device that were required and think about the location of a typical well pad. Enform, the safety association for Canada's upstream oil and gas industry, suggests driving causes 50% of the work-related deaths in the Canadian oil and gas industry.

Figure 8 - Half of oil workers' deaths due to driving, says safety council Enform

Your team members need information to safely sustain high levels of plant availability and through-put, day in and day out.

Ever wonder how much information your equipment vendor may have on your plant assets? How can you gain access to that information?

For nearly 12 years, Endress+Hauser has collected asset information on behalf of clients, just in case they need the information at some point in the future.

Today, every single device Endress+Hauser touches is catalogued in a cloud database, no matter the manufacturer of the device. Whether the instrument is an Endress+Hauser device or from another company – whether it be for commissioning, calibration, verification, repairs or optimization – we catalogue it and document our activities.

Endress+Hauser utilizes enterprise-wide systems, leveraging state-of-the-art technologies for our own service process. Endress+Hauser's clients may decide to retain our services for an Installed-Based Audit, in which every single instrument and valve is audited, classified for process criticality and risk of maintainability. The driving force is to have Endress+Hauser catalogue every asset, collect all manuals, document baseline settings, valve signatures and level device echo curves. We store this information in a secure cloud repository, where the client knows the information is safe and ready and always available.

The technology utilized is collaborative, such that any Enterprise Asset Management or Computerized Maintenance Management System can be linked or connected to, instantly turning these traditionally empty asset management shells into fountains of knowledge and information.

Figure 9 illustrates an example in which SAP (market-leading Enterprise Asset Management software provider) demonstrates ERP 6.0 linked to the data collected by Endress+Hauser. This utilizes either our cloud-based solution or a server-based solution (a local copy of the data inside the plant, rather than Internet-based, for security) which gives our clients freedom of choice. The benefits are clear: maintenance personnel are more likely to embrace systems when they can get timely, accurate and relevant information from the system.

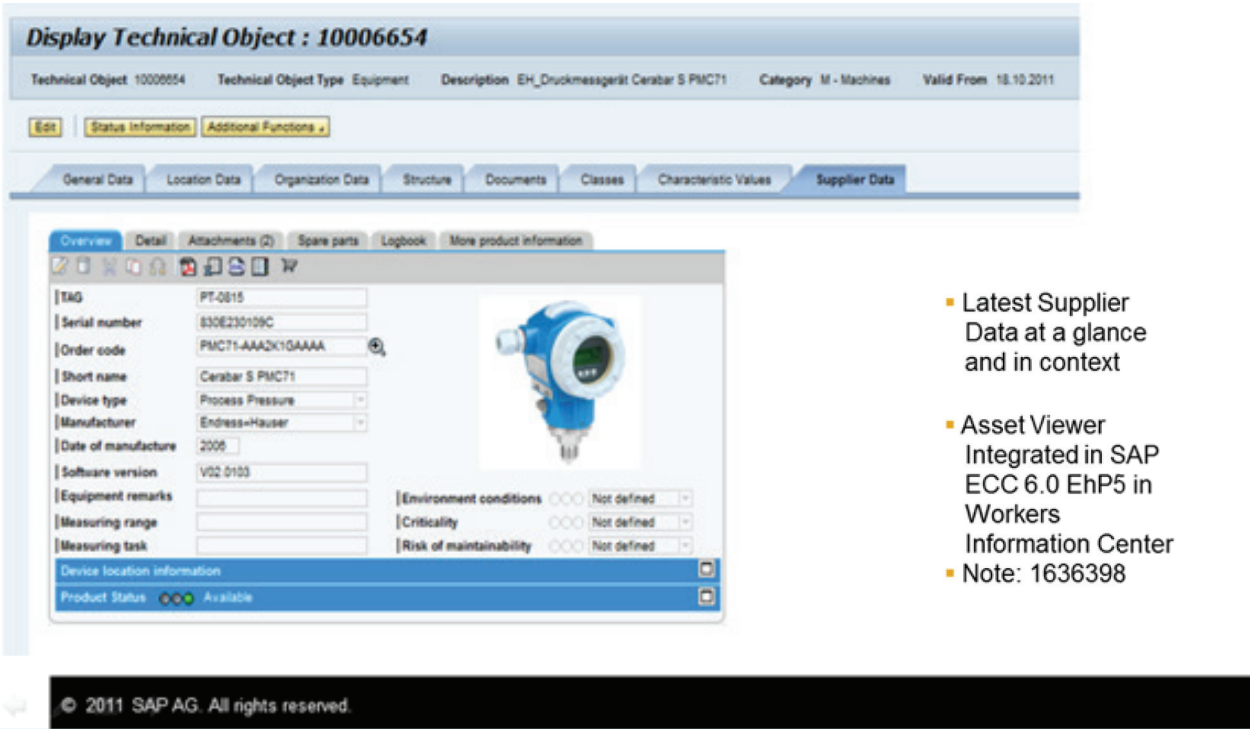


Figure 9: Integrated Asset view in SAP ERP 6.0. Contact SAP and refer to technical note 1636398 for more info.

As “People for Process Automation,” we automate the workflow process to eliminate nearly all manual tasks related to data entry, data collection and archiving – resulting in an optimized benefit. As a vendor and industry partner, Endress+Hauser makes real-time information available to clients:

- exploded view spare parts diagrams and lists;
- maintenance instructions;
- obsolescence monitoring/reports and notification of successor equipment; and
- all new assets procured (regardless of manufacturer) are automatically registered into the system.

Plant Asset Management should normally start with your design phase. However, the design phase is a re-occurring theme for any plant that is not obsolete. Over the life-cycle of your plant, information is aggregated throughout the various phases (engineering, procurement, installation, commissioning, maintenance, repair and operations) to take advantage of information collected by your vendors and service providers. This is a key opportunity that should not be missed. Utilizing Predictive Diagnostics, as previously mentioned, will positively impact plant availability and process performance. Exploit the information flow to start-up projects earlier, deliver shareholder value, finalize capital expenses and be on the road to operational excellence sooner (see figure 10).

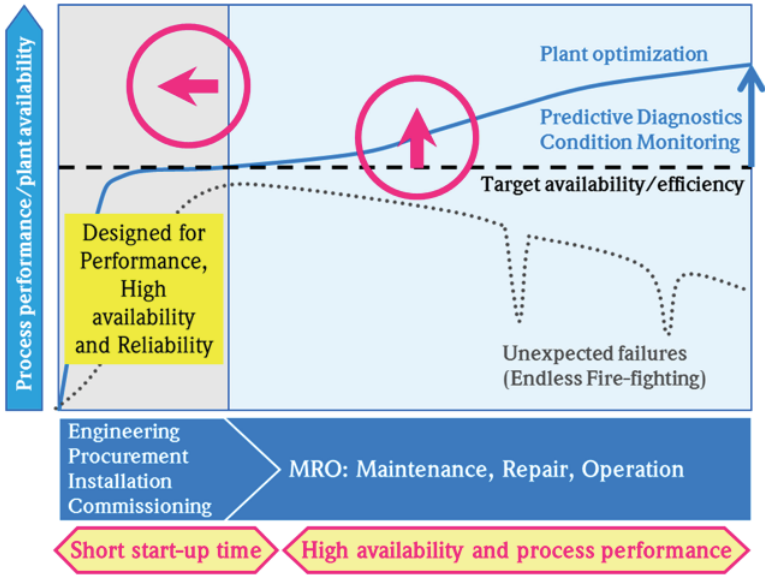


Figure 10 - The Opportunity for Sustainability

Today’s plants need to leverage intelligent assets to achieve sustainable operating costs, higher levels of plant safety and operational efficiencies. Access to these assets unlocks the intelligence within the asset, leading to improved plant performance.

A Plant Asset Management system represents the collective knowledge used to manage your plant throughout its lifecycle and feeds back best practices uncovered along the path to operational excellence. Plant Asset Management in today’s plants will offer a competitive advantage for your future operations.

Isn’t it the right time to reduce costs by becoming better, safer and more efficient?

SOURCES/REFERENCES:

[1] From *The Globe and Mail* – Cut costs or face ‘death spiral,’ CNRL warns oil sands (Peter Scowen), published Thursday, February 19, 2015.
[2] AN INTRODUCTION TO PREDICTIVE MAINTENANCE Second Edition by R. Keith Mobley

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