

Asset Performance Management: Bridging the Gap Between CAPEX and OPEX

A Bentley White Paper

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Executive Summary

Asset performance management has rapidly become a recognized business process and best practice that is helping owner-operators sustain their infrastructure assets and maximize their return on investment. Improving the reliability and performance of an organization's assets has a direct affect on operational efficiency and profitability. Likewise, properly and proactively maintaining assets minimizes costs and reduces spare part inventories, the use of contractors, and overtime. By reducing the variability of capacity and throughput, organizations ensure customer deliveries, achieve revenue targets, and improve customer satisfaction. This paper explains how Bentley helps implement reliability improvement strategies for asset performance management that bridge the gap between CAPEX and OPEX.



An Owner-operator Perspective

The Asset Lifecycle and Whole Life Value

An asset's lifetime is measured in decades, and the majority of its cumulative lifecycle costs – typically ranging from 60 to 80 percent – occur during the operate-and-maintain phase.

Therefore, managing the performance of the asset is crucial. Optimizing processes for the day-to-day running of the asset minimizes operational costs and maximizes production capability, usually through minimizing downtime and running reliably to peak performance as required.

Operational Readiness

Extensive research has shown that operational readiness is the key to achieving the revenue projections that are part of the owner-operator's business case. Ed Merrow, founder and president of Independent Project Analysis, Inc., and author of *Industrial Megaprojects*, says more than 65 percent of megaprojects fail to reach their schedule, budget, and production goals. The cause for this usually is an accelerated schedule demanded by the owner-operator and the accompanying failures in the engineering-procurement-construction (EPC) supply chain to coordinate and collaborate. The consequences are that, on handover, projects fall short of production targets. But, more significant is that in the subsequent years after handover and go-live, it proves impossible to recapture lost performance. If a plant goes live at 40 percent of throughput, it is highly unlikely it will ever reach 100 percent of planned throughput. The lesson here is that handover is all-important, and having accurate, comprehensive information about the asset is absolutely necessary for success.

Bentley has compiled the *Bentley Infrastructure 500 Top Owners*, a ranking of the top owner-operators of infrastructure around the world from both the public and private sectors that is published annually. The ranking compares investment levels across types of infrastructure, regions and types of organizations. It demonstrates the magnitude of the investment in infrastructure, exceeding \$13 trillion in total value in 2012, and highlights the opportunity to improve the return on invested capital and the scope for improving asset performance.

Co-creation of Value

Increasingly, owner-operators look to their EPC partners to warrant the performance of the asset they are handing over. Philosophically, they look to see if the as-built and as-operated models conform to the as-designed model. Furthermore, in order to differentiate their bids, EPCs are providing warranties that the asset will perform as required. Particularly since energy is becoming a larger and larger part of operating costs, the performance characteristics of the asset go a long way to determining the total cost of ownership and, therefore, the return on assets. As a result, owner-operators are looking to EPCs for co-creation of value. More and more frequently, we see owner-operators demanding and receiving a so-called “soft landing” from their supply chains, which means that the financial return to EPCs is determined by the asset performance during the first four or five years of operation.

Bridging the Gap between CAPEX and OPEX

EPCs can and should take into account the reliability and maintainability of assets during the design phase. They can warrant the operational performance of the assets they design and build, and they can provide comprehensive asset information to owner-operators that helps ensure operational readiness upon handover. The supply chain needs to bridge the gap between CAPEX and OPEX. Rather than viewing the phases of the asset lifecycle as distinct and separate, owner-operators and EPCs need to share the holistic view that $TOTEX = CAPEX + OPEX$. Achieving a TOTEX view is only feasible with a strategic approach to asset performance management and, in order to bridge the gap between CAPEX and OPEX, owner-operators should ensure that their software, IT services, and business processes are supporting information mobility.

Connecting the Physical and the Virtual World

With the widespread deployment of sensors and monitoring devices, we are now witnessing the emergence of the industrial Internet. Everyday technology from the consumer world such as scanning, global positioning, and high-resolution video and photography is being applied in an industrial context – offering endless possibilities for improving operations and maintenance as diverse as intelligent inspections, augmented reality, and intelligent positioning. This layering of digital information on top of the physical asset produces “big data,” and provides new opportunities for predictive analytics and enhanced asset performance. “Intelligent infrastructure” promises new levels of reliability, uptime, and availability.

Bentley Infrastructure 500

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and highlights the opportunity to improve the return on invested capital and the scope for improving asset performance.

Bentley is the world's leading company dedicated to providing comprehensive software solutions for sustaining infrastructure throughout the design-build-operate lifecycle including software for building performance, structural engineering, water modeling, road and transit design, bridge engineering and plant operations.



Problems and Challenges

Our users typically look to address one or more of the following challenges in the design and engineering of infrastructure.

Unplanned Downtime

Poor equipment reliability leads to outages and unplanned downtime resulting in lost revenue and unsatisfactory customer service. Low asset efficiency leads to low throughput and utilization. Many owner-operators find that reactive maintenance and corrective action are several times more expensive than proactive, planned maintenance. Reactive maintenance and corrective action often lead to poor maintenance productivity and very high maintenance costs. Overall, the total cost of ownership of the asset is higher and often the asset life is not as long as originally expected. The result is the return on assets falls short.

Risk Management

Regulatory compliance is a prerequisite for operations. Failure to comply with regulatory standards or meet environmental targets often carries financial penalties or higher insurance costs. More importantly, incidents can result in loss of life and loss of livelihood, and negatively impact the community and the environment. A failure in risk management usually causes irreparable damage to corporate reputation and enterprise value.

Data Management

Many plants are drowning in data. Data is stacking up in data historians but there is no way to turn that data into actionable intelligence. Massive amounts of data are difficult to process and store and there is a lack of timely data that is trustworthy. Information becomes obsolete and is not reused. Too much time is spent on manual activities to correlate data from different data sources. And in some situations, paper-based processes are slow, labor intensive, and prone to error.

According to Swiss Re, man-made disasters are estimated to have caused almost \$8 billion in damages in 2011. Accidents on drilling platforms, other oil and gas facilities, and to a power station in Cyprus were among the most damaging man-made disasters in 2011.

Aging Workforce

For many reasons, expertise is not shared. Knowledge of an asset, how it can fail, the consequences of failure, and actions to take when it does fail are often in the head of the operator or maintenance engineer and are seldom documented. Organizations don't understand the asset well enough to achieve the required performance. Sometimes operations and maintenance don't communicate well and don't share knowledge. Usually, knowledge is lost when workers retire or leave.

Bentley provides an industrial strength process for achieving world-class asset performance. Enabled by Bentley's AssetWise APM software and Bentley's Asset Performance Management Methodology, it implements reliability-centered maintenance and other approaches to help improve reliability, uptime, and availability.

Why Asset Performance Management?

During the course of undertaking many asset performance management programs, users were asked about their motivation for embarking on a reliability improvement program or asset performance management process. Apart from the obvious safety and environmental factors or chronic equipment performance and reliability problems, their responses demonstrate a drive for improved return on assets. From VPs of operations, plant managers, and asset managers to operations and maintenance engineers, here is what they said.

"Any unplanned plant outages during peak demand periods have a significant impact on plant revenue. Equipment reliability is of vital importance, particularly for those assets that directly impact upon output."

"Benchmarking our maintenance cost against other facilities, we identified that this plant was 25 percent more costly on average. An assessment of current practices and activities revealed that at least 50 percent of maintenance work was performed in a reactive manner. This resulted in increased parts and labor costs due to the inability to properly plan the maintenance work and to the increased degree of damage caused by allowing failing assets to continue operation."

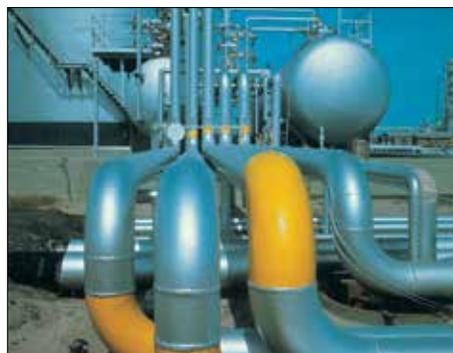
"Though the plant has achieved performance improvement targets in previous years, a more aggressive and consistent focus on reliability improvement was required. We set new objectives including the optimization of scheduled maintenance outages to maximize output and a reduction in overall cost."

"The company has reduced costs over several years, becoming a very lean organization. However, it was apparent that additional measures were required. The only solution was to find a way to accomplish more with the same manpower and the same or less equipment."

“The company’s assets are worth close to a billion dollars and require high-cost raw material inputs to operate. While we had no dramatic recurring asset failures, we knew that any incremental improvement in asset performance would result in a substantial increase to our bottom line.”

“Like many other plants within and outside our sector, we will see a significant level of retirement of our experienced maintenance and operations personnel within a five-to-10-year period.”

How does an organization with millions of assets get a handle on the overall health of its physical plant? How much should it be spending on capital renewal, and where should those investments be made for maximum impact? How much routine maintenance should be done on assets that are soon to be replaced?



A Catalog of Disasters

According to Swiss Re, man-made disasters are estimated to have caused almost \$8 billion in damages in 2011. Accidents on drilling platforms, other oil and gas facilities, and to a power station in Cyprus were among the most damaging man-made disasters in 2011.

Among these disasters were a January fire at an oil sand plant in Alberta, Canada, which houses the largest sand oil reserve in the world; damage to a floating vessel in the North Sea in February; and a July explosion of the Vasilikos Power Station in Cyprus, which caused a massive power shortage on the island.

In 2010, there were 6,446 victims of man-made disasters including a lead poisoning outbreak at an illegal gold mine in Nigeria in March (400 victims, mostly children) and the collapse of a gold mine in Sierra Leone, also in March, that killed 200 people. Economic loss estimates from man-made disasters in 2010 were more than \$24 billion, most of which were attributed to the explosion of the Deepwater Horizon oil rig in the Gulf of Mexico.

Other recent man-made disasters include:

- A chemical plant destroyed by fire
- A fire at a petrochemical plant
- An explosion at a gas plant
- An explosion and fire at a power station during turbine test
- A fire in a fertilizer plant
- A fire at an iron and steel plant
- A leaky pipeline explosion
- An explosion at an oil refinery

- An explosion at a manufacturing plant
- A gas pipeline explosion
- A gas leak at an exploration rig
- A high-speed train that crashed into a stalled train
- A gas explosion at a coal mine

The Solution: Redefining Asset Performance Management

Asset Performance Management = Operate & Maintain

Asset performance management is defined as optimizing processes for the day-to-day operation of assets, to minimize costs and maximize production capacity, usually through minimizing downtime and running to peak performance as much as possible. One example of this is reliability-centered maintenance, which is focused on the procedures and practices of maintenance through monitoring asset performance.

What if...?

What if it were possible to align maintenance strategies to business goals, improve maintenance productivity, detect the onset of failures, and extend asset life? What if it were possible to consolidate and analyze data from disparate databases and other sources, trigger the right work at the right time, share information between functions and sites, and share information across phases of the asset lifecycle? What if it were possible to ensure that knowledge of experts is incorporated into decision-making, ensure decisions are consistent, and reduce time to train and become efficient?

Asset Health Visibility

Bentley's AssetWise APM provides one consolidated view of asset health to identify which assets to maintain and when as well as when to eventually replace them. It builds confidence that maintenance decisions are based on what is really happening (i.e., they are data driven). It integrates the 'as-designed,' 'as-built,' and 'as-operated' information models and helps engineers take reliability and reliability-centered maintenance data into account during the design phase. It helps drive operational changes such as renovations, expansion, or repurposing to best consider implications across the asset lifecycle. It supports a continuous, proactive engineering lifecycle recognizing that improvements can always be made.

Toward a Culture of Reliability

AssetWise APM provides an integrated approach to developing, implementing, and managing a living reliability improvement program. It strengthens the asset care operation by instilling reliability and asset performance management as a daily process within the organization. AssetWise APM was created to solve the challenge of implementing and sustaining maintenance processes and practices, providing a way

There are many strategies for improving reliability and optimizing maintenance.

Kristian Steenstrup, an analyst with Gartner, defines seven levels of a reliability strategic road map in a recent report.*

"The higher levels are progressively more strategic, more integrated, more costly, more complex, but more beneficial if well-implemented."

to collect, consolidate, and act on all of the condition data to optimize asset performance and reliability. It provides a holistic view of asset health to anticipate the onset of failure and make timely and informed proactive maintenance decisions. This helps mitigate risk and the consequences of failure while at the same time lower maintenance costs.



A Strategic Roadmap for Asset Performance Management

There are many strategies for improving reliability and optimizing maintenance. Kristian Steenstrup, an analyst with Gartner, defines seven levels of a reliability strategic road map. The higher levels are progressively more strategic, integrated, and complex, but more beneficial if well implemented.

Level 1: Run to Failure

This involves run-to-failure or “breakdown repair.” Software to support these activities should detect failures remotely and instantly, should allow for easy job entry and scheduling, and should be able to assign resources readily to prioritize work. It will also be beneficial to link to a data repository of failures for future pattern detection, and to use “tree maps” for failure review.

When to use: when equipment is redundant, quickly replaced, and costs the same in failure as it does in controlled replacement.

Level 2: Preventive — Planned on Time

Typically, this involves maintenance based on manufacturers’ schedules. As most maintenance organizations evolve, they start to carry out preventive maintenance based on time (that is, days, hours, or months, regardless of usage).

When to use: when an asset has progressive wear based on time rather than on usage, or when usage is constant.

Level 3: Preventive — Planned on Usage

Preventive maintenance based on operational measures is the next step. It adds sophistication because, for many items, equipment use will be a more reliable predictor of failure than time. Equipment with steady or constant use does not benefit as much from this form of maintenance.

When to use: when equipment has variable usage that is not predictable.

Level 4: Condition-based Maintenance

Monitoring-based maintenance can assess the condition of assets. As utilities generate more data on their assets, and have a more complete picture of failure contributors, there is a need to measure the condition of assets as a way of intervening before failure.

When to use: when equipment has tell-tale signs and measures of extreme usage or parametric limits.

Level 5: Predictive Maintenance

This involves maintenance-based projections of wear characteristics. Although one form of predictive maintenance is based on usage statistics, in a more advanced form, the wear characteristics and wear rate or degradation are used to predict the point of failure or sub-optimal performance. This can be highly valuable information for assets that progressively wear or degrade over time and use.

When to use: when equipment has a progressive degradation and an eventual extreme limit.

Level 6: Reliability-centered Maintenance

This includes improvements based on failure mode analysis. For some enterprises and some high-value assets within those enterprises, reliability-centered maintenance strategies can assist in improving reliability by engineering out failure.

When to use: when planning the optimal maintenance regime for the most critical and expensive assets.



Level 7: Financial Optimization of Replacement and Repair

Although rarely seen and difficult to support in software, it is possible to build models and algorithms to advise on the optimal time for replacement or intervention based on cost.

When to use: for forward budgeting and capital planning processes.

An Industrial Strength Process for Achieving World-class Asset Performance

Asset performance management puts in place a business process for managing the performance and reliability of infrastructure assets throughout their operating life. The asset performance management process is supported by reliability-centered maintenance practices and enabled by AssetWise APM software to drive the process and to sustain it. The Bentley APM methodology is an industrial-strength approach aligned with asset management standard PAS 55, which instills a proactive process

for managing change, ensuring that people develop competency, understand their roles and responsibilities, and are accountable as measured through leading and lagging key performance indicators.

Bentley's APM process is organized into five phases.



Strategy Development

The process starts with strategy development. First, the goals of operations and maintenance are aligned with the business goals of the company. Next, the physical assets are identified that have the highest risk relative to the business, typically in terms of safety and environmental risk as well as throughput, costs, and customer satisfaction, and perfor-

mance targets for each asset are set to meet the business goals. Then a technically based reliability program is defined that contains the minimum amount of maintenance work to ensure the asset meets performance targets. The most rigorous methodology to define reliability programs is reliability-centered maintenance (RCM2). Bentley has world-renowned expertise in RCM2 with its Aladon Network of independent reliability practitioners that dates back to the origins of the methodology, which was founded by John Moubray. Other methodologies include maintenance task analysis (MTA) and current practice review (CPR), which are frequently used to quickly capture knowledge of an aging workforce and document or automate existing manual programs.

Implementation

Once the program is defined, it needs to operate as part of the organization's day-to-day process. Adopting RCM and executing RCM analyses can sometimes be challenging because the program results in a data-intensive day-to-day process. But with AssetWise APM software, the data is collected, consolidated, and analyzed in a central database. With handheld data collectors to consistently record indicator readings, and tablet devices for use in remote locations to access asset information, users can conduct proactive inspection routes that immediately analyze the data and recommend corrective actions. Online data collection (ODC) can be used to capture useful data from online sources like SCADA systems and data historians as well as predictive technologies like infrared thermography and oil and vibration analyses.

Performance Management

The program is fully visible and actionable on AssetWise's Asset Health Dashboard – the heart of the asset performance management process – from which all decisions on asset performance are made to ensure the right work is done at the right time (that is, the minimum maintenance work to meet performance requirements of the asset).

Trending and comparative analyses provide visibility of the overall picture of asset health to make fast and accurate decisions. Resulting work orders (or work requests or notifications) are triggered in the enterprise asset management (EAM) system or computerized maintenance management system (CMMS).

Work Management

CMMS or EAM systems play an important part in managing assets and the work to be completed by maintenance. Planning, scheduling, execution, and follow-up of the work orders are managed by AssetWise based on work strategy and program.

Analysis and Optimization

Lastly, to continuously improve, it is essential to analyze performance gaps. When failures happen, their root cause must be determined, as well as whether or not a management program is in place, and then the current strategy must be updated. In situations where there are a lot of like assets, failure data should be analyzed for any existing patterns to provide feedback into the current reliability program, forecast lifecycle costs, and to determine replacement dates.

An Operational Information Platform

AssetWise APM is an operational information platform that integrates field and plant processes and other day-to-day operational systems with work management and computerized maintenance management systems, enterprise asset management systems, and enterprise resource planning systems. It collects and consolidates performance and condition data from interactive inspections, sensors and real-time monitoring devices, calculates numeric and rule-based performance indicators, and produces alarms and triggers for non-normal states that can be displayed in an asset health dashboard. This is used by operators and maintenance engineers to optimize asset reliability and utilization. It generates work orders and work requests that are transmitted to work management systems.

Remote and Mobile Applications

For situations in which assets are spread across a wide geographic area or working conditions are hazardous, Bentley's AssetWise APM Mobile can support remote and asynchronous operation for devices that are disconnected from the network. With this technology, field workers have access to asset information when they need it. They can update asset information immediately on the remote device and sync it up with the network. Bentley's APM Handheld can support mobile and handheld devices that are commonly used in interactive inspections. Windows Mobile, Android, and iOS devices help field workers directly collect condition data and enter it into the system without rekeying or interpreting the reading. Bentley's AssetWise APM Remote and AssetWise APM Mobile applications help ensure data quality, save time, and assure integrity, in contrast to manual, paper-based processes that are error prone.

Condition checks are inconsistent and depend on the expertise of the technician in checking for the right things and requesting the appropriate follow-up work based on the condition found. Since all the data is on paper, it is impossible to mine it for trends, and very difficult to use it to demonstrate regulatory compliance during equipment audits.

Benefits

There are many benefits to be gained by implementing a specialized operational information platform for asset performance management. This platform eliminates silos of data and helps assure consistency and integrity of data, which is essential to addressing regulatory and compliance needs. It also helps build confidence that maintenance decisions are based on what is really happening (i.e., the right work is triggered at the right time). In addition, it helps remove bottlenecks and inefficiencies in data collection and analysis and allows that information to be shared across phases of the asset lifecycle and between different plants, sites, and functions.

Bentley's AssetWise APM provides one consolidated view of asset health. It helps ensure that ongoing and planned activities continually facilitate best asset performance, extend asset life, and ensure safety for the users of the asset and the public. With AssetWise APM, asset information is always up to date, continuously renewed through active use, accurate, reliable, and trusted.



The Cost of Poor Information Quality

Studies show that poor information management is a critical problem for stakeholders across the lifecycle of infrastructure assets.

A 2004 National Institute of Standards and Technology (NIST) report that examined the cost of inadequate interoperability in the U.S. Capital Facilities Industry estimates that the increased CAPEX and OPEX costs for poor information quality and availability across the complete design, build, and operate supply chain are nearly \$16 billion per year. The report suggested that two thirds of these costs are borne by owner-operators.

How Are You Managing Your Performance and Condition Data?

When plant managers, maintenance engineers, reliability engineers, and vice presidents of operations are asked how they manage their performance and condition data, this is what they typically say.

“Condition checks are inconsistent and depend on the expertise of the technician in checking for the right things and requesting the appropriate follow-up work based on the condition found. Since all the data is on paper, it is impossible to mine it for trends, and very difficult to use it to demonstrate regulatory compliance during equipment audits.”

“While we collect vast amounts of asset data from visual inspections and predictive technologies, the information resides in separate systems. A basic evaluation of an asset's performance is complex and time-intensive, typically requiring many hours to extract and analyze the information.”

PAS 55 is the British Standards Institute publicly available standard for the optimized management of physical assets, which was developed in conjunction with the United Kingdom's Institute of Asset Management. It has been successfully adopted in several industries including utilities, transportation, and process manufacturing.

"It is difficult to identify which engineer owns which asset. With hundreds of thousands of maintainable assets (plant systems, structures, and components), we require a solution that will allow us to easily monitor equipment performance and condition, and to quickly access equipment performance data."

"Critical equipment data collected by engineers during their inspection routes is not captured in an effective way. Paper records are not well organized, and it is difficult to retrieve information. Computerized records are stored as personal data by each engineer, making the data completely inaccessible to others."

"We have many maintenance procedures in place, yet there is no integrated business process to ensure a productive, sustainable approach to asset care. Maintenance and production workers either use paper-based check sheets to conduct inspections or maintenance is conducted simply as a result of the maintainers' and operators' personal knowledge and experience of what the equipment needs. The company also leverages several predictive technologies, yet the resulting data is not consolidated into one centralized system. Between our predictive technology data and our inspection check sheets, we have lots of information, but not everyone can readily see it. The raw data is not shared and check sheets are not easily retrieved."

How to Get Started

The successful implementation of an asset performance management process within any organization is highly dependent on following the foundational elements of the Bentley APM methodology – namely, business, organization, and technology alignment.

Business Alignment

This focuses on ensuring that the overall objectives of the business drive all asset performance decisions. The current state of the organization is reviewed in terms of asset management policy, strategy, objectives, and practices, and a business case for improvement is developed. Gaining the endorsement of senior executives to support reliability improvement is critical at this stage in order to position the organization for sustainable change. High-level objectives to determine ultimate success are established, agreed upon, and communicated throughout the organization, and key milestones are identified for regular assessment of improvement results.

Organizational Alignment

This focuses on institutionalizing the APM process to drive continuous improvement of asset performance within the organization. All of the activities involved in an effective APM process are clearly defined and assigned to specific roles within the organization. Competent individuals are assigned to all of the roles and any existing skill gaps are identified and addressed with appropriate training and mentoring. Roles and responsibilities for APM are clearly understood and individuals learn how to use process measures to manage their own performance as well as the performance of their direct reports.



Technology Alignment

This involves establishing the technology infrastructure, systems, and interfaces to support improved asset performance. AssetWise APM software is designed and configured, as are the interfaces to other systems, to support implementation of the APM process (e.g., EAM, CMMS, ERP, and production systems). Handheld units, tablet devices, and ODC data sources are

configured to support efficient collection of equipment condition and performance data. Customization of AssetWise APM software is performed as needed to support the APM process. The objective of technology alignment is to ensure that all data collected is consolidated and transformed into asset health indicators to support effective and informed decision making.

Bentley's APM methodology is consistent with asset management standard PAS 55.

What Makes the Difference Between Success and Failure?

The first 100 days of the program are critical. Accountability is key. Based on the experience of implementing asset performance management programs in several industries throughout the world, here are the factors that make the difference between success and failure.

- Keep safety and quality top of mind
- Be consistent, repeatable, and auditable
- Be system focused rather than asset focused
- Find the right balance among performance, cost, and risk
- Consider the long-term effects of decisions

PAS 55 and ISO 55000 Industry Standards

PAS 55 is the British Standards Institute publicly available standard for the optimized management of physical assets, which was developed in conjunction with the United Kingdom's Institute of Asset Management. It has been successfully adopted in several industries including utilities, transportation, and process manufacturing.

PAS 55 will likely be superseded by ISO 55000 in 2014. ISO 55000 is an International Standards Organization specification for an integrated, effective management system for assets. ISO 55001 defines requirements for an asset management system in the same way that ISO 9001 specifies a quality management system and ISO 14001 specifies an environmental management system. The scope of ISO 55000 will encompass the management system for assets, but it will not specify the information management system, such as an EAM system or CMMS, nor will it specify how maintenance is to be performed or how assets should be disposed or retired.

You should not wait for the publication of the ISO 55000 specification to implement an asset performance management process. It is smarter to make progress with asset information management and asset health visibility, which will contribute toward the goal of asset management rather than waiting for the perfect standard.

Customer Success: Asset Performance Management in Practice

Here are some examples of asset performance management programs in the real world.



Scottish Power

Challenges:

A series of industrial incidents highlighted the vulnerability of Scottish Power to a major incident and the need to make asset management and process safety a priority. Scottish Power needed to change a very reactive culture in an older coal-fired plant to a proactive culture, while

at the same time address the lost knowledge due to employee attrition and the lack of technology to support its approved business model.

Strategy:

Plant Performance to improve reliability and process safety, PAS 55 accreditation Risk Management to move toward a real-time view of operational, technical and process risks. Focus on health and safety.

Results:

- 20 percent reduction in O&M costs
- 22 percent increase in plant availability
- 25 percent reduction in forced outages
- 10 percent reduction in insurance premiums

How they did it:

Automatic Detection of Deteriorating Performance

- CPR – used as default to quickly put in place a maintenance program
- MTA – where CPR failed to bring the asset under control
- RCM2 – where MTA failed to bring the asset under control
- AssetWise APM – to identify which information was important, to improve data quality

Management of Change

- Business leads assigned, governance ensured coherent program
- Built on existing core processes and underlying integrated IT platforms
- Continuous cycle of challenge and review

PAS 55 Principles

- Aligned (business plans ->asset plans ->actions -> learning top-down and bottom-up)
- Managed (whole life planned, costed, optimized)
- Optimized (inputs/outputs, short/long term, CAPEX/OPEX, costs/risks/performance)



ArcelorMittal USA

Challenges:

In 2009, the Burns Harbor Hot Strip Mill operation was experiencing an average delay rate of greater than 22 percent, almost 4 percent over the business plan of 17.58 percent average delay rate.

In addition, as economic conditions improved in 2010, the production require-

ments for the facility increased significantly, therefore, improvements in production equipment reliability were necessary.

Strategy:

Implementation of a proactive asset management business process supported by Bentley's AssetWise APM software. Risk prioritization analysis conducted by AssetWise APM software to determine the production equipment on which to focus.

Mobile devices used throughout the operation to collect data.

Four methodologies used for formal work identification, including Aladon Reliability-centered Maintenance (RCM2), Aladon Maintenance Task Analysis (MTA), Current Inspection Implementation (CII), and RCFA. All maintenance and operations personnel were training on the principles of reliability-centered maintenance as a foundation for reliability thinking going forward.

To fast track the analyses and implementation, ArcelorMittal USA used AssetWise APM templates and smart copy capability. Also, APM Cloud was used for shared content library.

Results:

Save over \$2.1 million annually including:

- Avoidance of unplanned downtime addressing non-normal conditions before failure occurred (\$1.2 million).
- Improved efficiency of corrective work performed during scheduled shutdowns due to information provided.
- Schedule compliance for shutdowns increased from 65 to 80 percent, for an increase in manpower savings of \$394,400 yearly.
- Energy (gas/electric) consumption of \$400,000 annually.



Shell

Challenges:

Shell needed to consolidate risk-based inspection (RBI) strategy development and corrosion inspection management software (CIMS) applications.

IT Portfolio Management required reduction of duplicate systems deployed in individual regions.

Be able to deploy solution across 92 countries where Shell does business.

Strategy:

Implement AssetWise APM software to address these functional and technical requirements:

- Corrosion management framework (CMF) – threats, degradation mechanisms, barriers, barrier management.
- RBI – semi- and full-qualitative risk assessment, reliability strategy development (RCM, MTA, etc.) interval determination, remaining life, next inspection date.
- CIMS – tag/subtag measurement locations/points, corrosion rates, alarms, isometric viewing.
- Online Data Collection (ODC) – integrity operating window excursions.
- SAP PM Integration – maintenance plan item interval updates, new notifications and work orders from CIMS alarms.

Results:

Phased rollout to greenfield and brownfield operations

Implementation

- Shell selected AssetWise APM software due to its functional coverage and flexible/extensible framework.
- AssetWise APM enables Shell to replace various applications with off-the-shelf enterprise software.

Next Steps

We know from undertaking many asset performance management programs that every organization is unique and has its own priorities and challenges. Asset performance management is a never-ending quest and it can be difficult to know where to start and how much to bite off at first. What is certain is that small, marginal improvements in asset reliability and maintenance will lead to significant payoffs in terms of productivity, cycle times, and profitability. Bentley has world-renowned expertise in asset performance management and access to independent consultants worldwide from the Aladon Network to assess where you are, perform a current practices review, identify gaps, and help form a solid business case to justify the investment of time and resources. In addition, reliability-centered maintenance practitioners from Bentley and the Aladon Network offer training and consulting services to help jumpstart an industrial-strength reliability or asset performance improvement program.

For more information, please visit www.bentley.com.

About Bentley Systems, Incorporated

Bentley Systems is the global leader dedicated to providing architects, engineers, geospatial professionals, constructors, and owner-operators with comprehensive software solutions for advancing the design, construction, and operations of infrastructure. Bentley users leverage information mobility across disciplines and throughout the infrastructure lifecycle to deliver better-performing projects and assets. Bentley solutions encompass MicroStation applications for information modeling, ProjectWise collaboration services to deliver integrated projects, and AssetWise operations services to achieve intelligent infrastructure – complemented by worldwide professional services and comprehensive managed services.

Founded in 1984, Bentley has more than 3,000 colleagues in over 50 countries, more than \$600 million in annual revenues, and since 2006 has invested more than \$1 billion in research, development, and acquisitions. Additional information about Bentley is available at www.bentley.com.

*Gartner, Inc., Asset Management and Reliability: A Strategic Road Map, Kristian Steenstrup, November 15, 2010.

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