UPTIME MAGAZINE

uptime®

aug/sept 17

for reliability leaders and asset managers

AUGUST/SEPTEMBER 2017

REALIZING COMMERCIAL VALUE FROM

ISO55001-ALIGNED ASSET MANAGEMENT

uptimemagazine.com

LUBRICATION ENGINEERS, Inc.

Uptime Hero

30,000 HRS

Meet the Air Compressor That Went **30,000 hours** with the Same Oil

That's right – in 30,000 hours of operation, no oil change and no lubrication-related downtime. In fact, the oil is nearly ageless, providing the same asset protection today as the day it was added. That's nearly four times longer than the OEM-recommended interval for this compressor.

How'd we do it? By Implementing these two simple solutions:

1. **Xamine™ Oil Analysis**
2. **Multilec® Industrial Oil**

What about you?
Apply these solutions to your equipment and start tracking the value to your organization of extreme uptime, extended oil drains, reduced maintenance labor, and reduction of costly unplanned part replacement. Truly heroic stuff.

Read more about our air compressor success story at www.lelubricants.com/air-compressor-lubricants.html and then contact us to get started. All of these solutions – and many more – are available on the LE website or through our local lubrication consultants.

www.LElubricants.com • 800-537-7683
info@LE-inc.com • Fort Worth, TX • Wichita, KS
LE operates under an ISO 9001 Certified Quality System.

LUBRICATION ENGINEERS, Inc.
ASSET RELIABILITY SOLUTIONS™

Produced by the names you trust

IMC2017

The 32nd International Maintenance Conference

Connecting Reliability and Asset Management Through Leadership and Technology

DEC. 11-15, 2017

Hyatt Regency
Coconut Point Resort
Bonita Springs, Florida

LEARN MORE: IMC-2017.COM

SPECIAL PRICING

$300 OFF

See back page for more details.

Featured Uptime® Cartoon

Tom Fishburne, Marketoonist

De
defect elimination

The identification of a defect (or nonconformance) and its removal.

LIFE CYCLE® INSTITUTE

Introducing eMPS Maintenance Planning and Scheduling eLearning

Think of it as a just-in-time planning and scheduling coach with 30 years' experience

- Our most popular Life Cycle Institute course now available anywhere, anytime
- 11 modules that teach the process from work request to work order closeout
- Content from subject matter experts, transformed into eLearning by certified learning professionals
- A toolkit of more than 40 resources. Apply what you've learned and produce lasting results!

Create a set of standard processes and tools
Onboard new planners faster
Reach geographically dispersed teams
Validate competency

◆ Try a sample lesson at www.LCE.com/eLearning ◆

www.LCE.com | education@LCE.com | 800-556-9589

Contents

aug/sept 2017

uptime®
for reliability leaders and asset managers

ON THE COVER
Can you find the hidden Uptime logo on the cover? uptime

8

COVER STORY

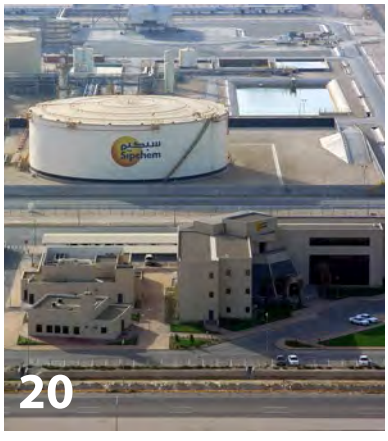
Realizing Commercial Value From ISO55001-Aligned Asset Management

AM Asset Management

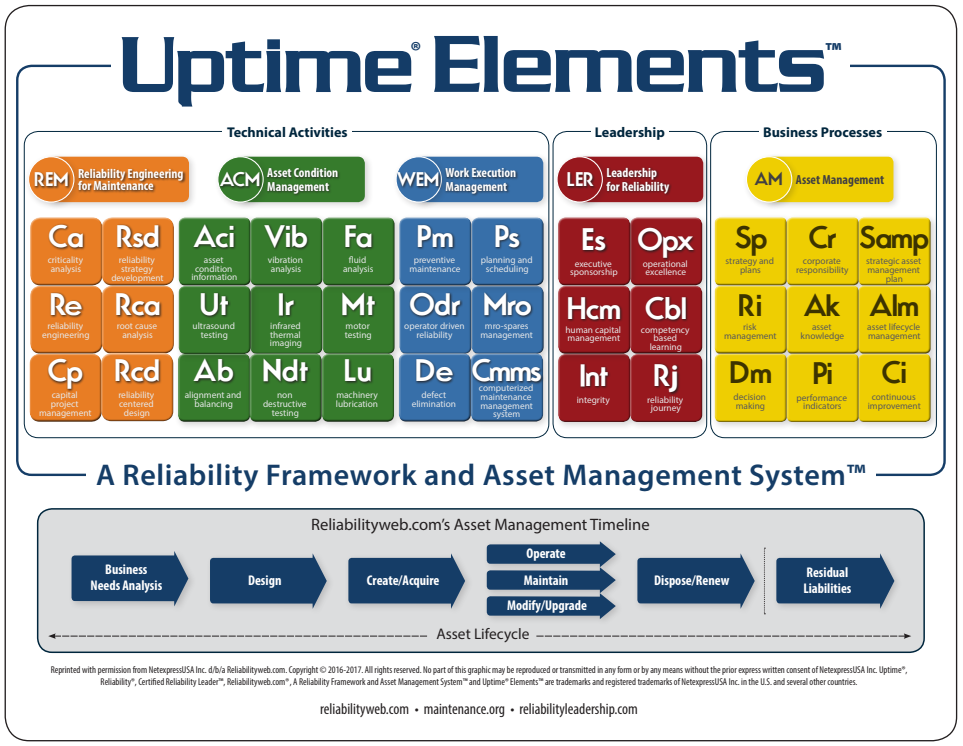
Dr. Bob Platfoot

FEATURES

ARTICLES



Contents [Continued]



uptime®

CEO/PUBLISHER
Terrence O'Hanlon
terrence@reliabilityweb.com

FOUNDER
Kelly Rigg O'Hanlon

EDITOR
Jenny Brunson

CONTRIBUTING EDITORS
Joel Levitt, Dave Reiber

CONTRIBUTING WRITERS
Jason Apps, Paul Craven, Pam Denny, Amin Elsherif, Stuart Gillen, Ramesh Gulati, Doug Hart, John Murphy, Dr. Bob Platfoot, Warren Rodgers, Jean-Paul Sacy, Prakash Shende, Eitan Vesely

ASSOCIATE EDITOR
Sean Flack

DESIGNERS
Jocelyn Brown, Apolonia Lemus

PRODUCTION PLANNER AND SCHEDULER
Andrea Zapata

SALES & ADVERTISING
Crystal Ward
Client Success Manager
crystal@reliabilityweb.com

EDITORIAL INFORMATION
Please address submissions of case studies, procedures, practical tips and other correspondence to Terrence O'Hanlon
terrence@reliabilityweb.com

ARTICLE SUBMISSIONS
publishing@reliabilityweb.com

SUBSCRIPTIONS
To subscribe to *Uptime* magazine, log on to
www.uptimemagazine.com
For subscription updates
subscriptions@uptimemagazine.com

Uptime Magazine
8991 Daniels Center Drive, Fort Myers, FL 33912
1-888-575-1245 • 239-333-2500 • Fax: 309-423-7234
www.uptimemagazine.com

Uptime Magazine is a founding member of
AMP
Association of Asset Management Professionals

Uptime® Magazine (ISSN 1557-0193) is published bimonthly by Netexpress, Inc. d/b/a Reliabilityweb.com, 8991 Daniels Center Drive, Fort Myers, FL 33912, 888-575-1245. Uptime® Magazine is an independently produced publication of Netexpress, Inc. d/b/a Reliabilityweb.com. The opinions expressed herein are not necessarily those of Netexpress, Inc. d/b/a Reliabilityweb.com.

POSTMASTER: Send address changes to:
Uptime® Magazine, 8991 Daniels Center Drive, Fort Myers, FL 33912

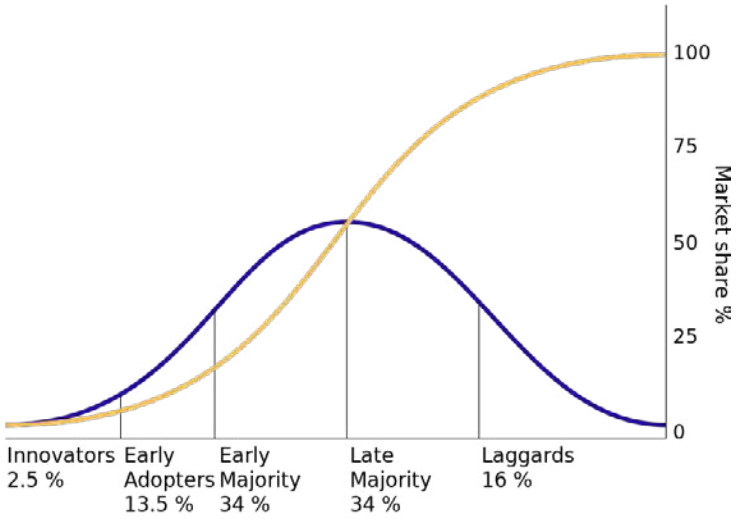
INDUSTRIAL INTERNET OF THINGS:
If you have not started, you are already late.

One of the Reliabilityweb.com activities I enjoy most is facilitating the Reliability Leadership Institute's Community of Practice, which includes dozens of ***high reliability organizations*** that are actively advancing reliability and asset management and share those practices in a safe, secure setting with other members.

In April 2017, we hosted the Internet of Condition Monitoring (IoCM) special interest group meeting in Las Vegas to get a snapshot of the current state of the Industrial Internet of Things (IIoT) technology and its adoption (see page 24). Participation was a mix of asset owners and operators who are innovators or early adopters and solution providers with cutting-edge technology.

The daylong discussion was robust and yielded several insights. It also launched an extended project to discover even more insights and trends within the reliability and asset management community. I invite you to learn more about getting involved.

Immediate data shows that within the Reliabilityweb.com community of practice, 36 percent of our members are already active with IIoT projects and another 23 percent have projects planned for the next 12 months.



Rogers, Everett - Based on Rogers, E. (1962) Diffusion of Innovations. New York: Free Press. The diffusion of innovations according to Rogers: With successive groups of consumers adopting the new technology (shown in blue), its market share (yellow) will eventually reach the saturation level.

https://en.wikipedia.org/wiki/Diffusion_of_innovations#/media/File:Diffusion_of_ideas.svg

Ninety-two percent of these related to asset condition management, with 83 percent focused on fixed plant assets and eight percent focused on mobile assets. Forty-one percent have IIoT project budgets exceeding $100,000.

In other words, your competitors have already filled up the *innovator space*, moved past the *early adopters* segment and are quickly filling the *early majority* space.

Even if you begin now, by the time your project is live, you likely will be in the *late majority* if you accept conventional wisdom related to innovative technology adoption as presented by Everett Rogers' classic work, "Diffusion of Innovations" (**ISBN-13:** 978-0743222099).

If the picture I am painting still does not drive you to immediate action, you are likely to end up in the *laggard* category.

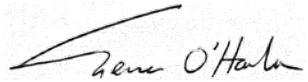
DO NOT HIT THE SNOOZE BUTTON! TIME TO WAKE UP!

The Industrial Internet of Things is happening all around you and it is creating rapid advancement in operational excellence, asset performance, reliability and condition monitoring, and equipment diagnostics.

I urge you to get started today by reading this issue of *Uptime* magazine cover to cover. Make plans to attend the Internet of Condition Monitoring Forum at IMC-2017 (www.IMC-2017.com). If you have a project to share, please submit an abstract for the Internet of Condition Monitoring Symposium co-located with The RELIABILITY Conference™ (www.reliabilityconference.com). Join the Internet of Condition Monitoring LinkedIn group to find a wealth of technology papers related to IoCM. And finally, if you are interested in joining a community of practice to advance reliability and asset management, let me know and we can begin a discussion.

I should go now – I am working on a project to replace myself with deep learning and artificial intelligence.

Warm regards,



Terrence O'Hanlon, CMRP
About.me/reliability
CEO and Publisher
Reliabilityweb.com®
Uptime® Magazine
http://reliability.rocks

LER

RELIABILITY

IN THE NEWS

Curt Burns (LOOP Port Superintendent), Brian Pertuit (LOOP Manager, Reliability & Maintenance Planning), Terrence O'Hanlon (CEO/Publisher, Reliabilityweb.com and Uptime magazine), Tom Shaw (LOOP President/CEO) and Maura Abad (Global Relationship Manager, Reliabilityweb.com)

Leadership, Innovation and Great Business Sense

Sometimes you discover organizations that have the benefit of strong, clear leadership. A team driven to deliver the mission and vision. A willingness to reinvent traditional business and revenue generation approaches. Even with all that, the world is an unforgiving place. But organizations like LOOP, LLC have innovated traditional business. They have embraced industry standards, not simply for compliance, but for business value delivery. Leadership stays focused on making sure the team has what it needs to deliver what is promised.

Uptime recently visited the Uptime Award winners for Best Work Execution (2014) and Best Green Reliability Program (2016) (see June/July 2017 *Uptime* for their story). The highlight of the tour was the opportunity to meet managers, supervisors and frontline team members and learn how they work and what they think. There is no doubt that this team has a lot to teach us and our community about advancing reliability and asset management.

University of Alabama - Automation Conference

Reliabilityweb.com was a proud sponsor and supporter for the 1st Annual Alabama Automotive Manufacturers Association Maintenance Symposium held in collaboration with the University of Alabama. Presentations from Mercedes-Benz US, Reliabilityweb.com, The Automotive Industry Action Group, CARCAM National Science Foundation, Eruditio and Toyota Motor Manufacturing were included in an information-packed agenda.

Reliabilityweb.com Partners with the Vibration Institute's Annual Meeting

The Vibration Institute and Reliabilityweb.com have created a partnership for the 2018 Vibration Institute Annual Meeting. Reliabilityweb.com will host a pavilion exhibition and several educational sessions, including the Certified Reliability Leader Workshop and Asset Condition Management Training Symposium. The event will be held in New Orleans, Louisiana, July 17-19, 2018.

BREAKING NEWS: EuroMaintenance-2018

The Belgian Maintenance Association and Reliabilityweb.com have joined together to produce EuroMaintenance-2018 in Antwerp, Belgium, on September 24-28, 2018.

Mark your calendar and please stay tuned for more details soon.

CRL Workshops

London, UK, June 6-7 & June 8-9

Foothill Ranch, California, June 5

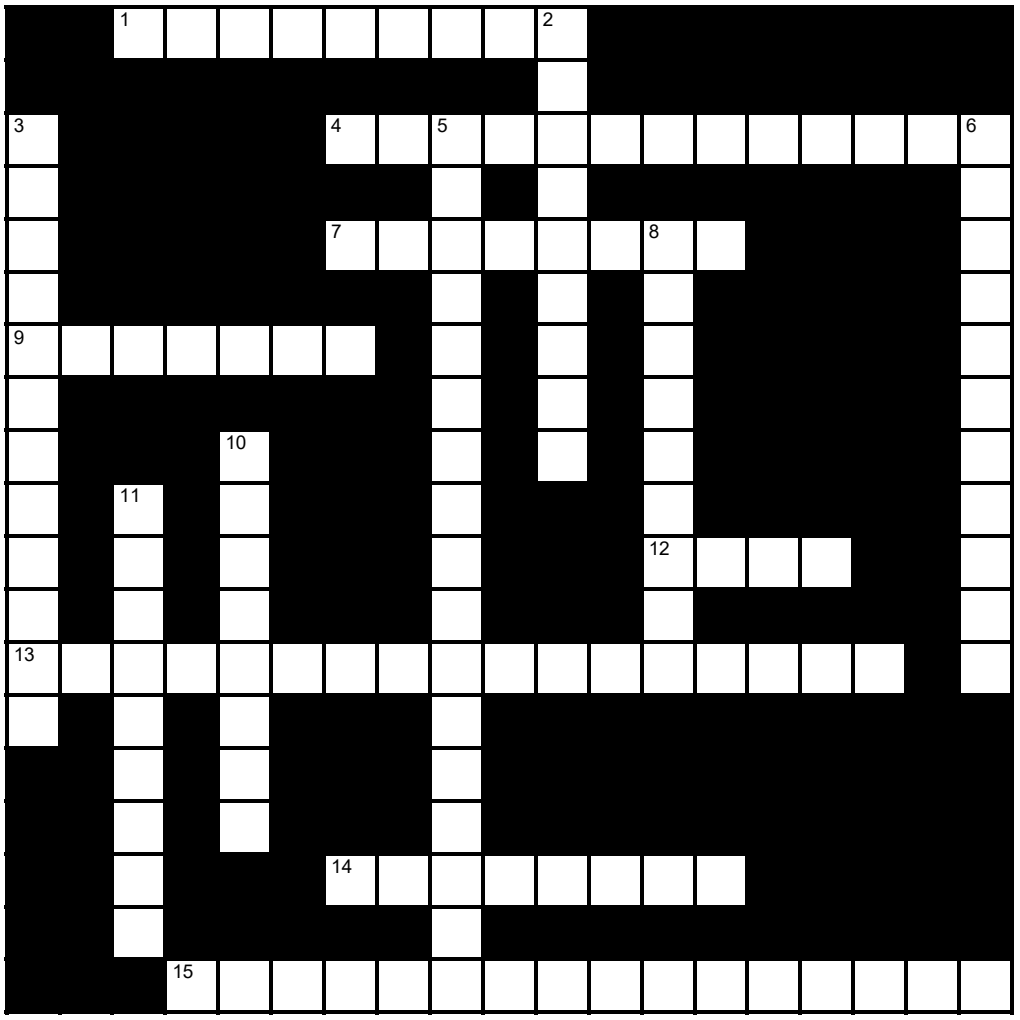
San Juan, Puerto Rico, June 14-15

uptime® Elements™

Uptime Elements Dictionary for Reliability Leaders and Asset Managers

Crossword Puzzle

Created by Ramesh Gulati



ACROSS

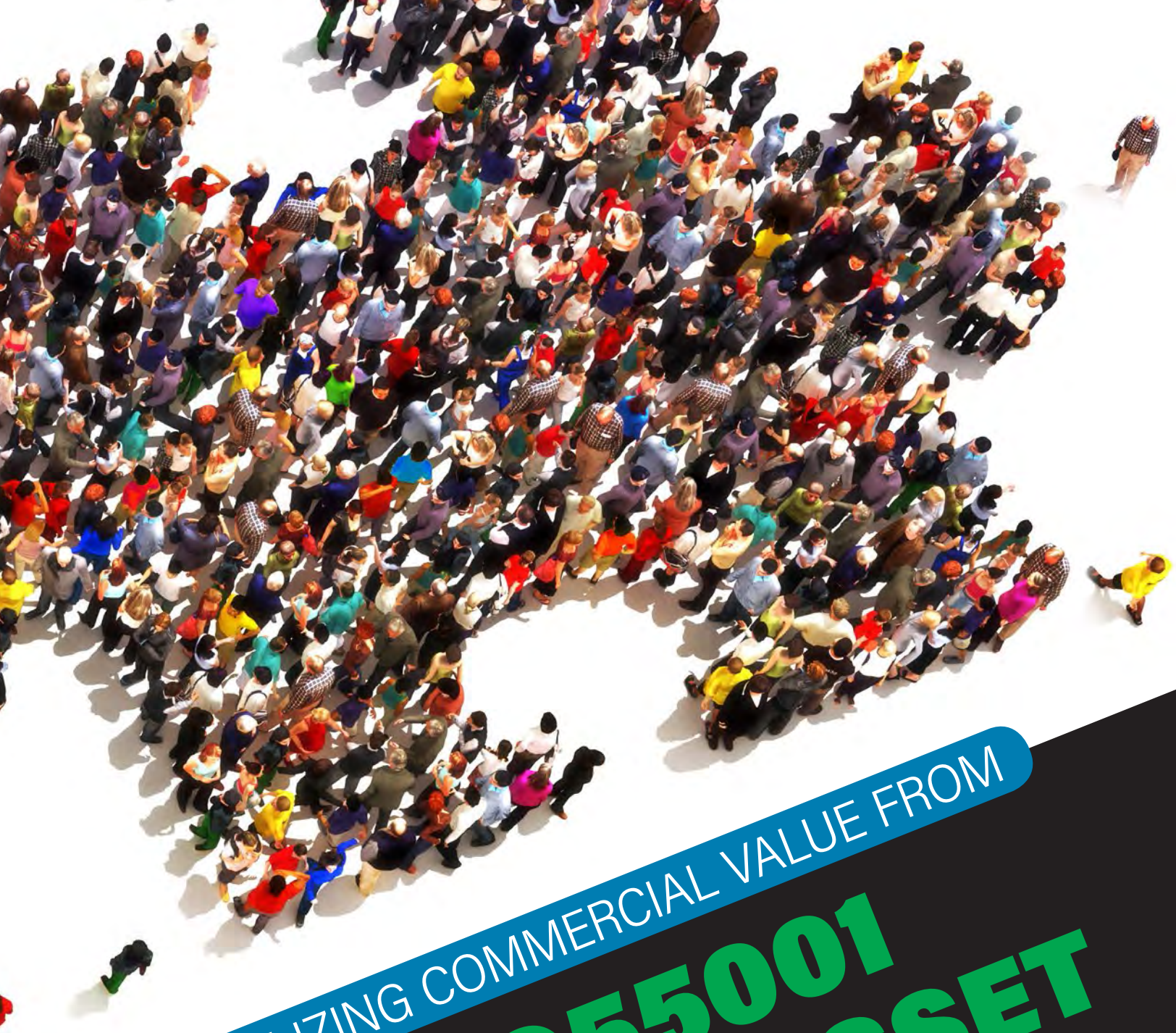
1. A forecast or prediction of outcome, such as how long an asset or component will last or its remaining life left
4. A failure mode that will not become evident to a person or the operating crew under normal circumstances (two words)
7. A condition in which one of the feet on a machine does not sit flat on the base; The foot or base may have been damaged causing misalignment and initiating vibration when tightened (two words)
9. Consequences of failures
12. A future event that has some uncertainty of occurrence and could have negative or positive consequences if it were to occur
13. Anyone who helps another person, a machine, or a gadget to do a better job to improve reliability (two words)
14. The relative importance of a single job in relationship to other jobs based on equipment condition, operational needs, safety, etc.
15. Network of physical objects, such as devices, components, machines, using embedded technology to communicate with each other with minimal human intervention (three words)

DOWN

2. The amount of time an item may be held in inventory (MRO store) before it is no longer fit for use (two words)
3. A person or organization that can affect, be affected by, or believe to be affected by a decision or activity; Also known as interested party
5. The identification of a nonconformance and its removal (two words)
6. Something that is increasing very rapidly
8. An arrangement where an external organization performs part of an organization's function or process
10. A predictive technology that detects thermal energy emitted from an object and displays an image of temperature distribution
11. The elapsed time from the start of an activity/process until it's completed (two words)

Answers for this issue's crossword puzzle will be published in the October/November issue.

AM



REALIZING COMMERCIAL VALUE FROM

ISO55001 ALIGNED ASSET MANAGEMENT

Dr. Bob Platfoot

AM

This article demonstrates the commercial value for an organization improving its entire enterprise asset management approach in line with the ISO55001 standard. An organization implementing ISO55001 must first come to terms with clear asset management objectives, a planning process that optimizes the investment portfolio which, in turn, is delivered by efficient lifecycle processes, and a persistent and comprehensive continual improvement process that is documented and controlled.

Commercial value is realized by the removal of waste in asset management delivery so that the investment is prioritized in accordance with measured business outcomes. An organization must be efficient in determining what it must invest in and then deliver this work in a cost optimal manner that maximizes outcomes for the available resources and budget. The outcomes may be valued in terms of performance and capability or risk mitigation.

"Commercial value is realized by the removal of waste in asset management delivery so that the investment is prioritized in accordance with measured business outcomes."

OVERVIEW OF AN ISO55001-COMPLIANT ASSET MANAGEMENT SYSTEM

Unlike other contemporary frameworks defining an asset management system, ISO55001[1] does not specify leading practice methods and systems. Rather, the standard requires:

- An asset management policy that informs the whole of business what the senior executive considers to be priorities as to how assets are managed to deliver value to the business;
- A strategic asset management plan or asset management strategy that establishes objectives for the whole asset management approach:
  - The objectives accommodate the asset management policy, corporate business objectives, and internal and external stakeholder requirements;
  - The objectives are met by top-level frameworks defined for planning work, contingencies and risk management, key operational processes and continual improvement.
- An end to end planning process leading to a statement of future work to be undertaken on the assets which is also risk prioritized, costed and scheduled;
- A set of operational processes that are documented, supported by training processes, require systems to be used and manage cost, risk and performance in all aspects of delivering asset management work;
- Continual improvement based on performance measurement, internal auditing and learning, and a plan that accommodates both corrective actions and preventive/proactive measures.

A top-level framework, or a definition of all possible processes in an asset management system, is shown in Figure 1. The purpose of such a framework is to explain to all stakeholders the entire asset management system and assist them in understanding how their responsible areas fit in with other parts of the business. This is essential to ensure planning and work processes are not siloed between teams and continual improvement is undertaken across the enterprise, applying a consistent approach.

What ISO55001 does not do is specify required practices and methods within the functional elements shown on the framework diagram. For example, a maintenance approach cannot claim to be in accordance with ISO55001. To meet ISO55001 requirements, the process must be documented, demonstrably able to manage risk, develop people's competencies and improve in a persistent manner.[2]

The most complex process of all is the planning process, where you determine what is the right work to be done at any time on the assets. The subordinate process, which sits underneath the framework diagram, is shown Figure 2a (see page 12). Getting this process right is essential for the resilience of the business against external shocks, such as market demand, aging fleet, extreme weather and so forth.

Two of the most important aspects of this planning framework are the use of data and knowledge of asset health to drive work forward. Asset health and other considerations, such as operational criticality and obsolescence, lead to risk profiling for investment opportunities. Hence, individual work entries in the asset management plan can be risk profiles, as shown in Figure 2b (see page 12), suggesting periods when low risk items may be deferred and high risk work (e.g., risk > 3) needs to be supported. The figure shown is typical of asset management plans, where the expenditure in the first four to five years is relatively firm and longer term forecasts are still immature.

BENEFITS OF THE ISO55001 ASSET MANAGEMENT SYSTEM

The benefits of the ISO55001 asset management system are tabulated in Table 1 (see pages 13-14) as a checklist to which an organization should aspire. Two attributes are cited for each element:

- Value – statement of the value that each element represents;
- Cost Benefit – item in the list of seven known frequently occurring areas of cost benefit are listed below Table 1.

Note that where the same cost benefit occurs across more than one element, both elements must be in place to achieve the full potential saving. All potential savings are a function of the maturity of the organization at the time of commencement of the asset management system implementation.

These improvements can be achieved by individual leading practices that are well understood outside the ISO55001 framework. The ISO55001 framework enables these initiatives and streamlines their introduction as part of the standard way to do business. More importantly, ISO55001 practices and organizational behavior locks in these improvements.

IMPLEMENTATION OF THE ASSET MANAGEMENT SYSTEM

The process to implement an asset management system observes these principles:

- The value to implement an asset management system is recognized and supported by senior executives.
- The value of the implementation must be measured and reported to the sponsoring executives.

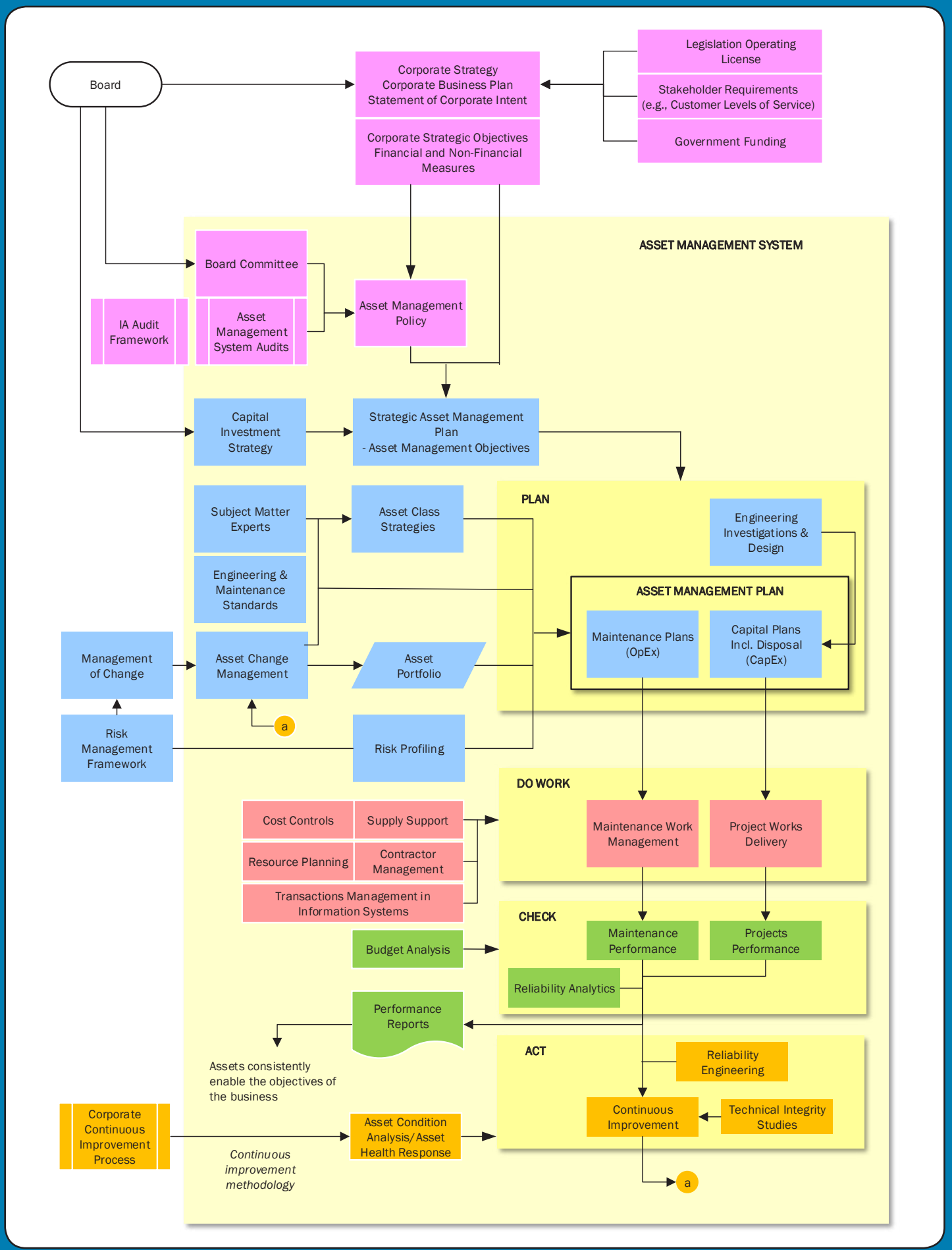


Figure 1: An asset management system

Figure 2: Asset planning

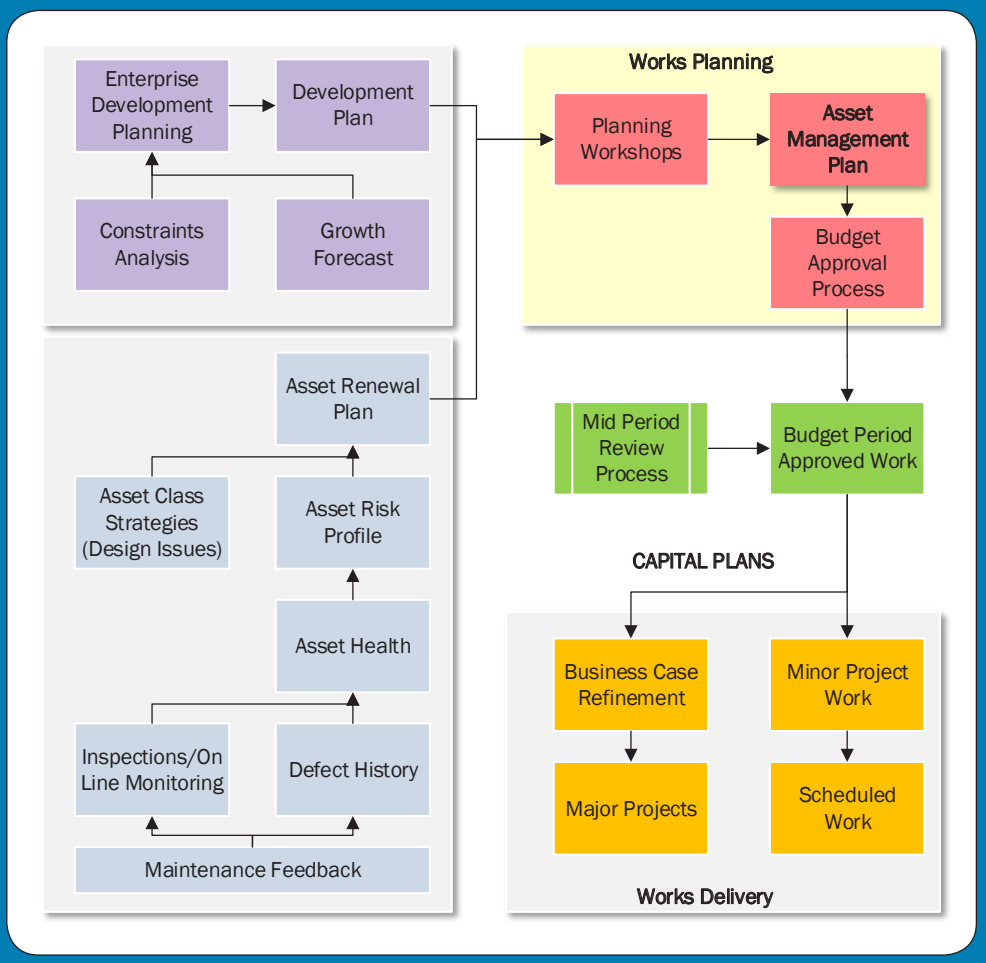


Figure 2a: Framework for an asset planning approach

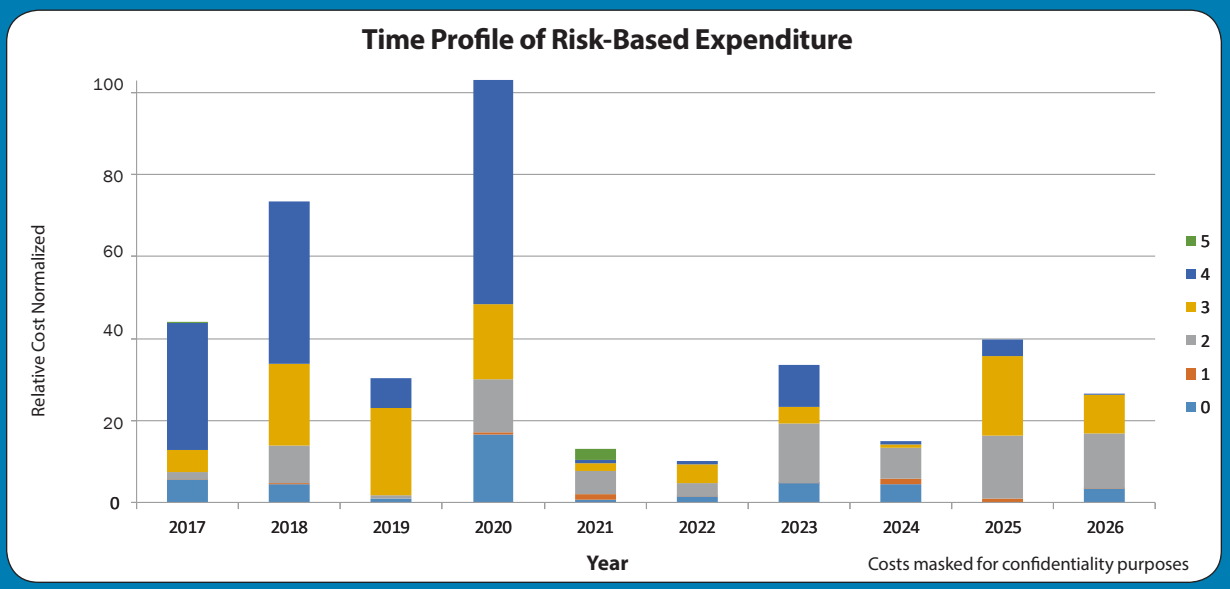


Figure 2b: Asset management plan report: risk profile of proposed expenditure

TABLE 1 – Outcomes of Key Asset Management System Elements

Asset Management Policy	Unarguable statement of what is important for each team member to deliver as part of their work, leading to a desired standard for asset management across the organization Value: Stabilizes the entire organization using some common goals so teams work together and people are confident they can defend their decisions and demonstrate value
Strategic Asset Management Plan (SAMP)	Design of the asset management system brings discipline to the business, aligning existing processes and strengths into the system and identifying gaps that need to be improved: · Stakeholder requirements for capable asset performance · Measurable objectives that define good performance across many functions of asset management · Information systems requirements · Contracting and resource management strategy · Contingency planning processes · Integrated planning processes, balancing business growth with sustaining existing assets · Operational processes that need to be managed and for which competencies of the people can be tracked and supported · Performance measurements and auditing processes to identify opportunities for improvement · Continual improvement planning and delivery Value: An easy to read reference document that specifies what must be implemented across the organization and why; Outcomes include gap identification and initiation of improvement processes that benefit teams and remove waste from the organization
Asset Management Plan	The forecast of work to be undertaken on the assets with the following planning horizons: · 1-2 year schedule that is risk prioritized and defensible on the basis of supporting information · 2-5 year options schedule that allows better grouping of major work into economically optimum packets (i.e., bring some work forward and defer other work) · 5-20+ year strategic view of expected times for major capability renewal and timing for significant investigations and contingencies Such planning is supplemented by appropriate strategies, such as: · Maintenance tactics development · Condition monitoring · Fluids management · Statutory spares management Value: A bottom-up, risk prioritized plan that covers all assets and allows assessment of investments on a common basis and tests decisions of deferrals, as well as expediting work on a risk versus cost basis Cost Benefit: Numbers 1, 2 and 5 on the list following this table
Asset Planning Framework	A top-level framework that allows diverse groups to undertake their work and then bring their funding requirements together in a cohesive plan, which can rank priorities for quite different needs Value: Often the determination of work to be undertaken is a bidding process that may not guarantee that the right work is endorsed and gets done at the right time; This process balances value through assessment of performance, cost and risk Cost Benefit: Numbers 1, 2, 3 and 4 on the list following this table
Risk Management	Implementation of the corporate risk management processes in: · Asset criticality ranking · Prioritization of work · Development of contingency plans · Management of work Value: Most organizations have a top-level risk management framework and some specify down to asset criticality ranking, etc.; This approach ensures all aspects of the asset management system are risk assessed and that risk is used as a decision-making determinant, for example, prioritizing the optimum option Cost Benefit: Numbers 2 and 7 on the list following this table

TABLE 1 – Outcomes of Key Asset Management System Elements [Continued]

Operational Process Design	A common approach to specifying how work is undertaken in elements, such as: · Feasibility, design engagement and construction · Project delivery, including commissioning · Maintenance · Operations support (e.g., switching, isolations, etc.) · Shutdown management · Supply management · Defect elimination Value: Ensures that corporate processes are documented with no gaps in the functionality and their capability to reduce risk is clear and the conduct of the work is measured; The means is established once the competency of the relevant personnel is developed Cost Benefit: Numbers 3, 4, 5 and 6 on the list following this table
Continual Improvement (CI)	An integrated approach to continual improvement that covers: · Performance measurement · Internal auditing · Corrective and preventive action management · Continual improvement plan · Continual improvement processes (e.g., 6σ where the define, measure, analyse, improve and control (DMAIC) approach is well aligned for this work) Value: Ensures CI takes place in a consistent manner across all teams and is measured to track value Cost Benefit: Numbers 6 and 7 on the list following this table
Documentation Specification	The consolidation and management of control documents that govern all aspects of asset management, typically based on existing documents and with enhancements and extensions as defined by the SAMP Value: Many organizations have a proliferation of control documentation, some of which is obsolete; This ensures a precise mix of documents is specified, which need to be maintained and used in competency development

COST BENEFITS OBTAINED FROM THESE INITIATIVES:

1. Reduction in overall capital project portfolio by 10 to 30 percent through removing nugatory work or consolidating work for greater efficiencies
2. Justification to lift per annum capital spending on cash-starved assets by 100 percent, thereby reducing risk
3. Reduction in churn of capital projects per year from 20 percent to 5 percent
4. Improvement in cost estimation from 50 to 80 percent to 15 percent at point of concept
5. Productivity gain leading to a maximum of 10 percent of operating costs
6. Commitment to defect elimination and consistent leading asset strategies can lead to improvement of 30 percent of maintenance outlay
7. Continual improvement generating hundreds of small tasks, etc., has improved overall equipment effectiveness (OEE) of key assets by up to 20 percent over a two to three year period

- It is people who improve and lead improvement, therefore, people must be mentored and supported.[3]
- While a trusted and expert authority may be used to deliver knowledge, teach and assist in addressing bottlenecks, it is the internal teams who deliver actual improvement.

> ISO55001 is about the management of risk, cost and performance in a balanced manner that seeks to unlock business value from the utilization of assets.

- Every organization has its own strengths, which must be respected and retained, and from which it will build sustainable improvement.
- No improvement is valid unless it is sustainable by competency development, measurement and reporting, and locked in as a common sense management process.
- It does not exist unless it is written down. All processes must be documented, communicated and available for future reference.

There are two parts to the implementation:

1. Establishing the governance of the asset management system so that all stakeholders know what is expected of them and there is a resource to both train people and audit performance;
2. Change management, whereby internal, multidisciplinary teams work on capability improvement projects that focus on one or more elements of the asset management system.[4]

Figure 3: Managing the CI plan

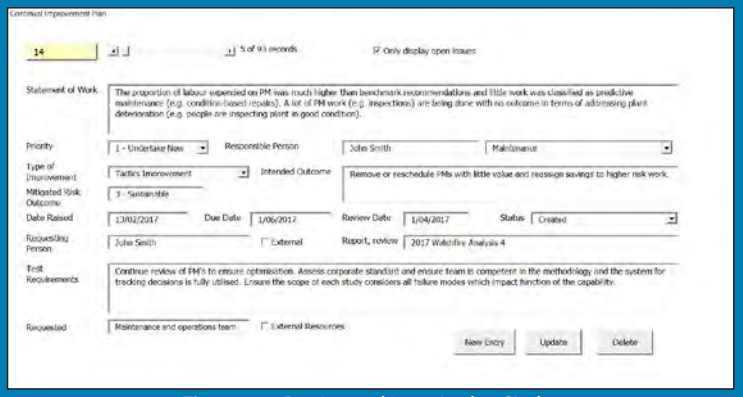


Figure 3a: Registered item in the CI plan

Asset	Description	Count PM Work Orders	Total Hours	MTBW PM (M)	Count CM Work Orders	PM/ CM
12	EMERGENCY MAKE-UP WATER SYSTEM	159	168	.38	1	159
5045	SCS PIPELINES CATHODIC PROTECTION SYSTEM	131	131	.46	1	131
5630	INSTRUMENTATION WORKSHOP EQUIPMENT	361	1274	.17	3	120.33

Figure 3b: Analysis justifying the CI item

Both work streams must be managed as well-defined projects with good project management practices, including schedules, risk management and communication plans. In time, these initiatives will not be unusual additions to normal business, but will represent aspects of the continual improvement process that ISO55001 endorses as a key pillar of asset management.

CONTINUAL IMPROVEMENT IN THE ASSET MANAGEMENT SYSTEM

The continual improvement plan tracks a myriad of small initiatives, who is responsible for each and when each will be completed.[5] It is a control needed to ensure that the performance and resilience of a complex system will continue to lift or be retained at a desired level of capability. This involves many tasks associated with people, plant, processes and systems, each requiring a task owner and scheduled completion data, plus a statement of the risk each task is mitigating.

Good performance tracks the creation per month of new tasks in the CI plan and the close out per month of completed tasks registered in the plan. While a central owner is accountable for the plan and the integrity of its information, the plan must encompass multiple teams who often need to work together. An example of such a plan, shown in Figure 3a, is an extract from a plan for a complex facility.

In Figure 3b, an analytic exercise identifies multiple preventive maintenance (PM) strategies in a complex facility being undertaken with very little repairs needed for these assets. Hence, it was determined there was scope to formally review the risk being managed, as well as regulatory obligations, and, where possible, reduce the effort in these high frequency PMs.

This example highlights the need for measurement and proactive consideration of complex facilities and then an organized, documented approach to manage the resulting hundreds of CI tasks recommended from such analyses. The cost savings potential calculated in this case represented 44 percent of the total PM maintenance budget, which is obviously a prize to be sought.

CONCLUSION

ISO55001 represents an opportunity for an organization to tailor its own approach to asset management within a robust framework. While ISO55001 does not dictate how to undertake specific asset management tasks, it does specify the key elements that should be present. It is not ISO55001 that delivers cost savings to an organization, but teams who believe in and have the discipline to utilize the framework will certainly deliver savings through the removal of wasteful practices.

ISO55001 is about the management of risk, cost and performance in a balanced manner that seeks to unlock business value from the utilization of assets. Measures of these attributes pervades each of the elements that makes up an asset management system.

ISO55001 must be implemented and then sustained by people. The teams need guidance on what the organization expects of them and they need time and opportunity to apply the requirements in a way that makes sense for the local culture, operational demands and level of organizational capability within their own business. As they do so, measures of cost savings, risk mitigation and performance lift are essential and part of the ISO55001 framework, which will persist in the new culture.

ACKNOWLEDGMENT

This article is dedicated to the people of many organizations throughout Australia and New Zealand who have supported its research by injecting their own ideas and implementing the concepts.

REFERENCES

1. ISO55000:2014(E). *Asset management – Overview, principles and technology*, 2014. https://www.iso.org/standard/55088.html
2. Global Forum On Maintenance & Asset Management. *The Asset Management Landscape*, Second Edition, 2014. http://www.gfmam.org/files/isbn978_0_9871799_2_0_gfmamlandscape_secondedition_english.pdf
3. Berling, Clas. "The human side of continuous improvement." *International Journal of Human Resources Development and Management*, 2001, Vol. 1, No. 2/3/4: pp183-191.
4. Salah, S.; Rahim, A.; and Carretero, J. "Total Company-Wide Management System (TCWMS): culture change management considerations." *International Journal of Strategic Change Management*, 2011, Vol. 3, Issue 4: pp260-280.
5. Nordin, N.; Deros, B.; Wahab, D.; and Rahman, M. "A framework for organisational change management in lean manufacturing implementation." *International Journal of Services and Operations Management*, 2012, Vol. 12, Issue 1: pp101-117.

Prior to this issue going to press, Dr. Platfoot was honored with the recognition of a Fellowship of the International Society of Engineering Asset Management. Congratulations!

Dr. Bob Platfoot *is the Founder of Covaris, a company that assists both individuals and companies in unlocking productivity and managing out waste associated with underperforming equipment and systems. Dr. Platfoot has developed unique capabilities which identify with precision where an organization should invest and improve their overall business. www.covaris.com.au*

Rsd
reliability strategy development

ASSET STRATEGY MANAGEMENT

THE MISSING LINK IN RELIABILITY PROGRAMS

Jason Apps

While the process of reliability-centered maintenance has not changed much over the past 20 years, technology has certainly changed. You are now able to be more efficient in the way you go about reviewing maintenance tasks and you can improve how you use the increasing data available to you. However, even with new technologies, more data and a strong approach to maintenance strategy development, many asset managers are still leaving millions of dollars of their organization's money on the table. It's money that can be easily saved if you know why it's disappearing and how to save it.

To illustrate, let's look at a real-life example. Asset managers are regularly asked to lead projects to review maintenance strategies for sites and assets that are not meeting their availability targets or are suffering frequent unplanned failures or high costs. They typically set to work collecting the asset hierarchy, work order history and current maintenance plans. Using all this data, they apply sophisticated methodologies to build an optimized maintenance strategy. In one particular project, the resulting revised strategies were forecasted to reduce maintenance costs by -18 percent per annum and improve availability by +3 percent.

It was a great outcome. But – and herein lies the problem – the site ***failed to effectively implement and execute the strategy***, and so it continued to suffer from unplanned failures and poor availability. There's the money down the drain.

To truly realize the value, a good strategy needs to be implemented and then updated over time. In essence, the strategy needs to be managed. This includes workflows, review and approval by appropriate subject matter experts, use of generic content wherever possible and data driven decision-making.

Learning From Past Failures

Ten years ago, when reliability-centered maintenance (RCM) was really hitting its stride, more and more organizations started investing in the task of developing maintenance strategies. But according to research, a ***massive 60 percent of these strategies were never implemented***. Think of the money wasted.

Or, if a strategy was implemented, it likely would get changed over time with little or no oversight. Typically, the good strategy work is undone and things go back to how they were.

Realistically, any change to a strategy, such as the interval, durations, specific tasks and instruction content, should be managed with a dedicated workflow that includes justification and the opportunity to utilize any great improvements across your entire asset base.

The Power of Combining Work Management With Strategy Management

To fix these endemic problems, the focus of an organization needs to evolve to ***strategy management, as well as work management***.

Think about it. Work management is all about executing tasks. Strategy management is all about deciding what tasks should be executed. You can have the best work execution process, but if you're not working on the right strategies, then it won't deliver results. Asset managers need to make sure that teams are effectively executing the right strategy.

Furthermore, reliability and maintenance teams need the agility to adapt when a positive change is made to a strategy at one site in a multi-site organization, or a common asset is used multiple times on a single site. How do you quickly deploy this cost-saving change across other sites in the organization?

For example, think of a water utility that operates 400 pump stations across the country, with each one operating the same equipment. Say there's a pump failure at one site and a technician does some good root cause analysis work that leads to a recommended strategy around a task that needs to be done. If the technician's decision goes to a central area for review and approval, and then gets deployed efficiently and electronically to all the other pump stations, the utility could potentially save thousands on future fixes, reduce risk and improve performance.

Wherever you find pockets of excellence, you need to deploy them everywhere, effectively.

> To truly realize the value, a good strategy needs to be implemented and then updated over time.

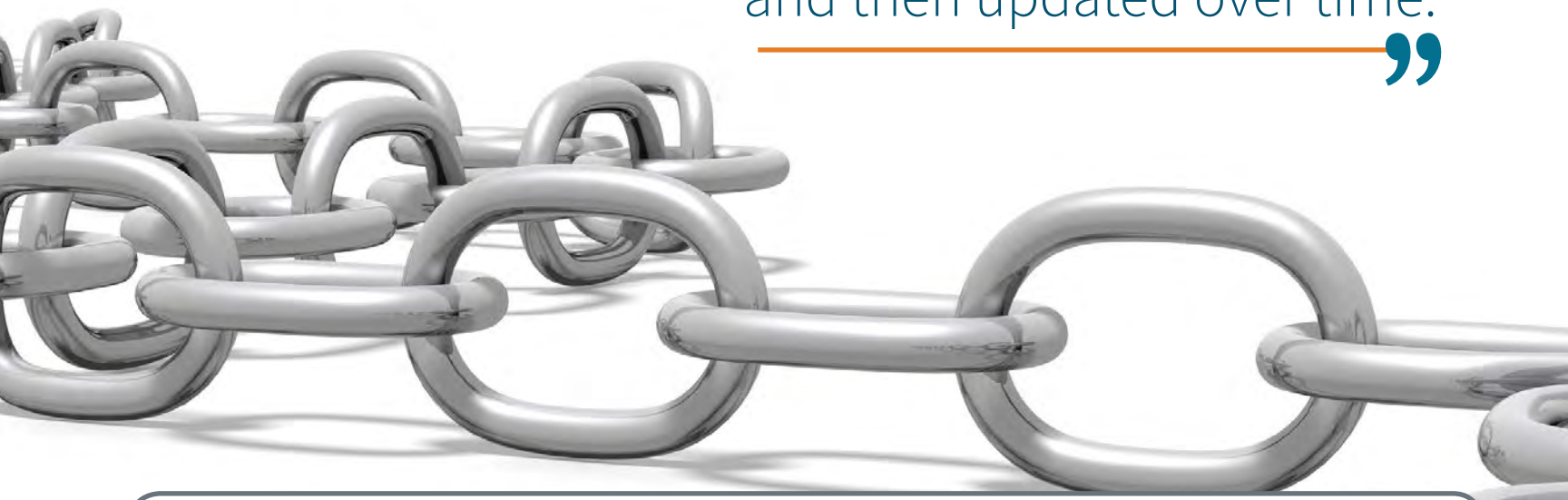
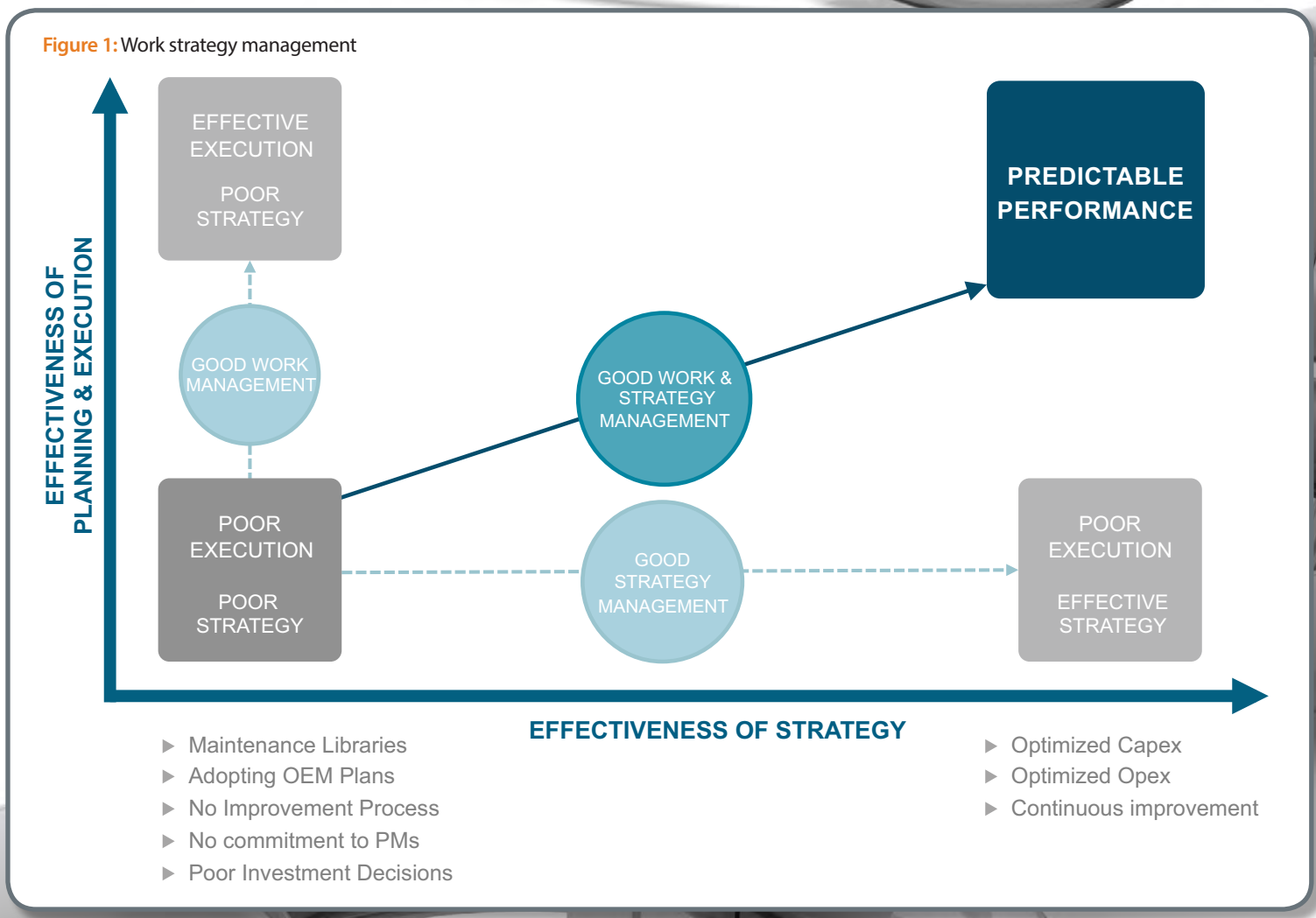


Figure 1: Work strategy management



WHAT DOES ASSET STRATEGY MANAGEMENT MEAN?

Asset strategy management is a defined process to capture and review data from all sources and leverage those learnings to enhance strategic decisions across the enterprise. Identifying pockets of strategy excellence, deploying those strategies across the organization wherever they are relevant, and managing compliance performance will take a step change.

- Deploy your best strategies to every asset, every time, rapidly
- Drive continuous improvement through establishing benchmarks, monitoring key performance indicators (KPIs), refining strategies and redeploying
- Report and manage compliance to approved strategies
- Gain control over execution and manage deviations through a formal approval process
- Obtain a living strategy that responds to changing conditions and continually deploy the best strategies applicable

Adopt a Best Practice Approach and Create a Culture of Excellence

The secret of successful strategy management lies in looking beyond the SAPs and Maximos of the world. You can try to standardize these systems for a "generate once, use many times" approach, but it won't work. A computerized maintenance management system (CMMS) is designed to manage work tasks, not manage strategy.

Instead, you need a separate approach and solution for strategy management that directly integrates with your work management system. This way, if your reliability team and subject matter experts devise a new asset strategy that is going to save your organization millions of dollars, then you can be assured it will be successfully applied to all relevant assets across all sites. Likewise, you will gain visibility into single site strategy excellence and be able to quickly and easily deploy it enterprise-wide. With an asset strategy management program, your asset strategies will be dynamic, constantly evolving and instill a culture toward achieving excellence in reliability.

THIS MAKES RELIABILITY A REALITY.

Jason Apps *is CEO of ARMS Reliability global operations focused on providing asset reliability improvement solutions to a wide range of industries. He has over 20 years of experience in asset management, plant maintenance, reliability engineering, master data analysis and root cause analysis.* *www.armsreliability.com*

PRÜFTECHNIK

AN EXTRA INCH PER SECOND CAN ACCELERATE YOUR PROFIT.

PRUFTECHNIK is a leading single-source solution provider for machine laser alignment, condition monitoring and nondestructive testing. PRUFTECHNIK's technical innovations optimize the availability of your production assets—and stop small amounts weighing heavily on your bottom line.

THE MAKERS OF OPTALIGN® AND ROTALIGN®

www.pruftechnik.us

Opx
operational excellence

UPS MAINTENANCE

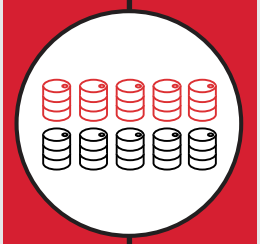
RELIABILITY PERFORMANCE

Jean-Paul Sacy

EARLY TRANSFORMATION ACHIEVEMENTS

Maintenance spend reduced by an average of 20% year on year without compromising output

Schedule compliance improved from 48% to 100% within two months



Backlog slashed by 50% in two months

Elimination of some significant, repetitive reliability issues

Improved efficiency

Reduced contract costs

In consultation with DuPont, the Saudi International Petrochemical Company (Sipchem) establishes a transformation program to deliver significant and sustainable improvements in business performance.

Starting from humble roots in 1999, Sipchem is now a globally recognized chemical manufacturer and a Saudi stock company, employing more than 1,100 people from all around the world. Today, it produces around 2.6 million MT of basic, intermediate and polymer products every year at 10 integrated plants in Jubail. With a host of complex production processes, maintenance reliability is key to ensuring safe and efficient operations. One of the plants had to undergo a major unplanned outage in 2014, which required extensive maintenance and repairs and resulted in significant production losses.

Sipchem had already spent a lot of time working with a number of different consultants over the years to improve plant reliability. "We had seen some good results, but never sustainably," says Ibrahim A. Al-Rushoud, Vice President - Operations, Manufacturing Services. "We really wanted to improve efficiency and quality to achieve excellence throughout the organization. That meant establishing a defect elimination culture to allow us to realize asset optimization."

Determined to avoid a recurrence of unplanned outages and improve maintenance reliability in general, Sipchem decided in late 2014 to call in DuPont Sustainable Solutions (DSS), the safety and asset management consulting arm of DuPont, to conduct a focused, four-week assessment of Sipchem's M&R function.

Focusing on Proactive Prevention

The assessment shined a light on all aspects of the M&R function, analyzing performance data, carrying out benchmarking and observation studies, conducting focused interviews with the managerial team and mapping processes.

The existing M&R culture at Sipchem was mainly reactive, with the emphasis on completing urgent actions. That generated constant stress and tension and hindered the organization from focusing on prevention and developing a system based on proactive intervention. The result was a high level of fixed costs, which negatively impacted the company's competitive position, particularly in view of the recent shift in oil and gas market conditions.

The proposed solution was to design a transformation program that would prevent reliability

problems, solve existing reliability issues, improve planning and scheduling, and boost uptime. The consultants identified a range of significant and sustainable improvement opportunities that would be achievable within a three year time span of implementing the transformation program by reducing the frequency and severity of reliability incidents and their impact on productivity.

Mr. Al-Rushoud explains: "We selected two pilot sites with different plant processes to trial the transformation project, allocated two dedicated, full-time resources, and put together an experienced project team." Sipchem named the program SMARTO (Sipchem Maintenance and Reliability Transformation for Operations).

Project Objectives

One of the first things the SMARTO project team did was to have all members play the Manufacturing Game®. Far from being a children's board game, this game, developed by a small team of ex-industry inventors, helps players understand the role of other manufacturing functions by having them take on different positions within the fictional organization.

When it came to clarifying roles and responsibilities for core processes and interfaces between reliability, maintenance and operations – one of the project's objectives – the game experience helped people gain a better understanding of others' functions.

As part of the new safety program, management systems were established to enable Sipchem to make more fact-based decisions. Performance dashboards were displayed throughout the sites so everybody could see the benefits of SMARTO and, in this way, drive continuous improvements.

Proactive communication and behavioral change were also vital. A two-day leadership workshop was held for 25 senior managers who signed up to eight key commitments, ranging

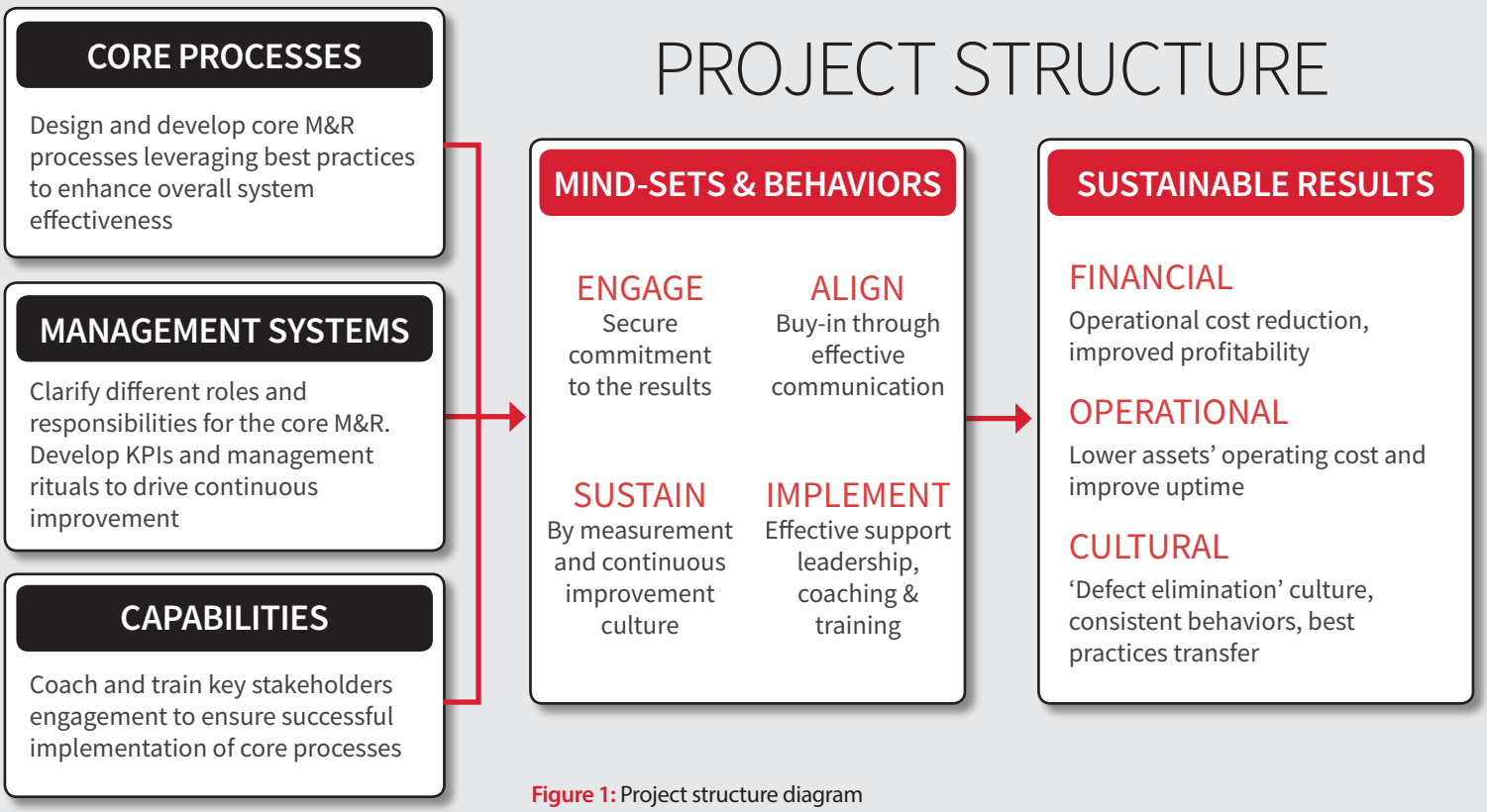


Figure 1: Project structure diagram

from doing a minimum of two line walks per week to increasing the number of times they give and receive feedback. Afterward, they each had one-on-one coaching sessions to take them through the whole M&R methodology.

The aim was to set up a management system that would ensure sustainable results through daily, weekly and monthly review meetings. Tracking and reporting daily metrics put Sipchem in a better position to monitor overall performance. To this end, Sipchem also agreed to measure new key performance indicators (KPIs):

- Percentage of high priority notifications;
- Number of overdue work orders;
- Number of open work orders;
- Manpower utilization;
- Planning efficiency;
- Schedule compliance;
- Planning accuracy;
- Maintenance cost as a percentage of the plant's estimated replacement value (ERV);
- Maintenance inventory value as a percentage of the ERV.

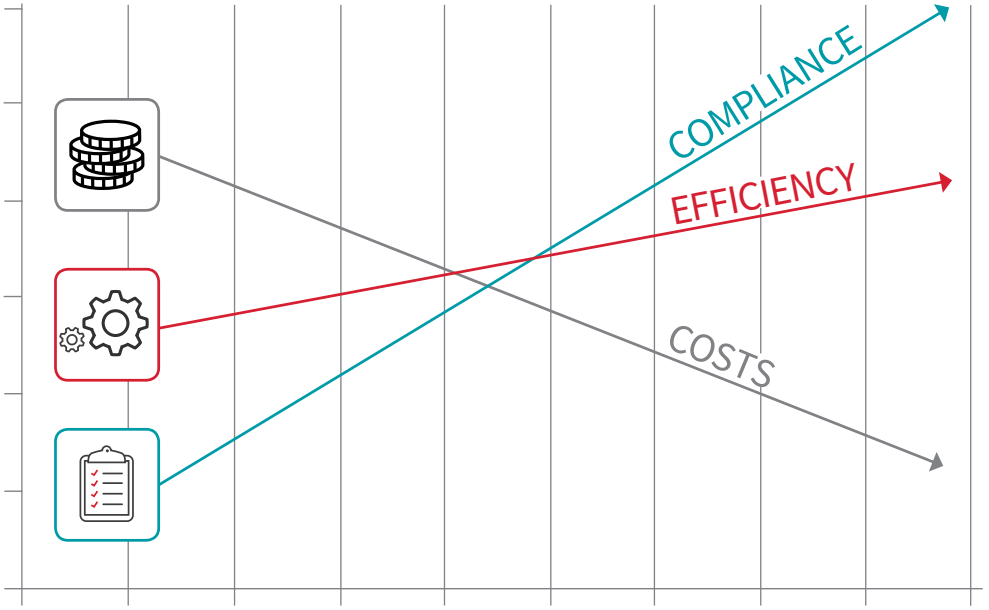


Figure 2: The effect of the SMARTO program over time

As it progressed, the SMARTO project progressively put in place corrective actions to deliver major improvements in the KPIs. The main project objective, however, was to design, develop and implement the four core processes of M&R: planning and scheduling, solving reliability issues, preventing reliability issues and improving uptime.

Project Design and Development

During the design phase of the transformation project, a series of workshops were held that focused on the four core M&R processes and capturing best practices in associated process manuals. A software program for tracking production efficiency was used in the two selected pilot plants to achieve effective and consistent measurement of plant uptime and correctly allocate production losses and causes.

At the end of the first year of the transformation, the program is already showing tangible results. Sipchem has changed the way it measures performance and, instead of only focusing on lagging indicators, is now taking a much more proactive approach.

Another change is that recommendations are now acted upon, whereas previously they often stayed on paper. Implementing recommendations from a root cause failure analysis (RCFA) led by the SMARTO project team has made it possible to eliminate a recurring overheating problem at one of the plants, allowing full production capacity to be maintained during the summer months.

"Our aim is to be one of the top petrochemical companies in the region in terms of safety, reliability, efficiency and quality," Mr. Al-Rushoud concludes. "People are now more engaged because they see results. There has been a positive change in culture, commitment, accountability and compliance. We have seen a 20 percent cut in maintenance costs without compromising output. Our efficiency has improved and that has also started to reduce our contract costs."

The next step for Sipchem is to ensure full sustainability of some of the early impacts of the SMARTO program, build on the lessons learned and achieve further continuous improvements by rolling out SMARTO to its remaining plants.

Figure 3: The extended SMARTO project team and all involved stakeholders

Jean-Paul Sacy *is a Senior Manager at DuPont Sustainable Solutions. He leads the delivery of multi-year operations excellence transformation programs for clients in the Middle East and Africa. Jean-Paul has 15 years of experience in operations consultancy for companies in the utilities, petrochemicals, upstream oil and gas, manufacturing, construction and healthcare industries. www.sustainablesolutions.dupont.ae*

Internet of Condition Monitoring Community

Special Interest Group Founders Meeting

John Murphy

Publisher's Note:

The Internet of Things, the Industrial Internet of Things and Industry 4.0 are getting a lot of attention and for good reason. These approaches are developing rapidly and showing huge results. They will be disruptive to many who are not prepared.

Reliabilityweb.com's Community of Practice (CoP) started the **Internet of Condition Monitoring (IoCM) Special Interest Group** to focus attention on the technologies that will have the most immediate impact to advance reliability and asset management. The following IoCM report is the first of a series and introduces the need for this group and the work it will produce. The best way to predict the future is to invent it. Get involved today to create a future that was not going to happen anyway.

- Terrence O'Hanlon, Publisher

Background

Companies' explosive focus on improving financial performance through leveraged (i.e., fixed) asset optimization has become even more fiery with the rapid adoption of the Industrial Internet, which enables multitudes of devices and equipment to be connected. The result of this combination is accelerating levels of asset management innovations and creativity not seen in the industrial asset space from both a products and services perspective.

Within the asset optimization market, no segment has grown faster than the condition monitoring space. **Condition monitoring (CM)** is the process of observing parameter(s) of condition in an asset (e.g., machinery) in order to identify a significant change that is indicative of a developing fault. Conversely, **condition-based maintenance (CBM)** is the maintenance strategy that monitors the actual condition of the asset to decide what maintenance needs to be done. Both CM and CBM are now key segments of the Industrial Internet of Things (IIoT), which is estimated to have a market value of $124 billion to as much as $14 trillion over the next 15 years.

Asset intensive industries are facing a number of challenges on their road to improved asset management that include:

- High cost of implementation, both internal and supplier driven;
- Data privacy and security concerns regarding use of connected strategies;
- Inadequate infrastructure, whether it is aged IT systems, analog assets, or lack of information and reporting systems;
- Unclear path(s) to return on investment (ROI) of asset optimization and asset condition monitoring investments;
- Lack of standards and unclear terminology;
- Technology overreach or unclear objectives.

Additionally, asset owners' levels of maturity in managing their assets tend to dictate the level of investment and speed of adoption. Generally, with many companies still operating with traditional maintenance organizational structures or some continuing to operate with run to failure mentalities, while others face strong competitive market challenges, their willingness to invest in these new technologies is perceived as high risk alternatives.

Creation

It was this backdrop of deterrents, M&A activity implications and customer adoption challenges that led Reliabilityweb.com founder Terrence O'Hanlon to the realization that a forum was needed to promote the business of condition monitoring. In his remarks at the founders meeting held April 24, 2017, in Las Vegas, Terrence shared his mission vision.

Mission

The Internet of Condition Monitoring Special Interest Group is created to organize the early adopters, the technology pioneers, the start-ups, the underdogs and the individual innovators. By collaborating and cooperating, we can create a clear path to innovation, rapid adoption and application within our community of practice.

Vision

Over three dozen organizations attending from both the asset owner and supplier sides represented these industries.

Suppliers

- Wireless sensors
- Services vendors
- Mobility and communications solutions
- AI and algorithm based analytics
- Asset management platform
- Big data/data historians
- Condition monitoring and machine learning

Asset Owners

- Utilities
- Chemicals
- Automotive
- Medical
- Paper
- Consumer Products
- Aerospace

Terrence recognized the existence of other forums, such as the Industrial Internet Consortium, but differentiated the goals of the IoT Condition Monitoring Special Interest Group (IoCM SIG).

> “There are a lot of BIG companies laying claim to the Internet of Things, and when it comes to washing machines and refrigerators, we have no issues with them. Many of these large conglomerates fail to recognize and respect the past 40 years of contribution and innovation that enterprising entrepreneurs have brought to the art and science of condition monitoring.”

He proposed a multifunctional working environment for all, where the supply chain could work together to:

- Create and lead new test beds or join in IoCM members’ test beds;
- Access IIoT condition monitoring research reports, white papers, industry guidance and other materials produced by the IoCM SIG;
- Gain industry recognition through involvement in IoCM Working Groups;
- Influence technology adoption and future direction by joining with innovators in technology, manufacturing, academia and government agencies in IoCM Working Groups;
- Network with other members and industry experts to create and develop critical collaborations.

Highlights

Meeting participants shared their business asset strategies, or in the case of suppliers, their products and services business strategies, to establish a foundational shared understanding across participants. Next, participants created the following wish list of items for inclusion in the IoCM SIG work plan.

Wish List

- ✓ Develop a common language: words, phrases and definitions (i.e., a glossary)
- ✓ Common standards: measurement, analytics and interoperability
- ✓ Promotion of open architecture among the membership and generally
- ✓ Develop a format for partnership: inclusion of financial business/use cases, change and project management, and leadership education
- ✓ Best practices assessment and identification for optimizing current asset performance
- ✓ Skill development programs to address serious supplier and asset owner resourcing gaps
- ✓ Development of a public relations/communication program to educate, engage and broaden participation in the IoCM SIG

Reliability Leadership Institute (RLI) Community of Practice (CoP) members are automatically included in the Internet of Condition Monitoring Special Interest Group. The member list includes:

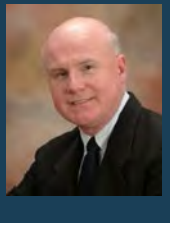
- Honda North America
- Boeing
- Medtronic
- Bristol-Myers Squibb
- B. Braun
- CBRE
- Central Arizona Project
- Metropolitan Council
- DC Water
- Jacobs
- JLL
- Siemens
- Bentley Systems
- Gwinnett County Water
- Arizona Public Service

Conclusion

Well received by participants, the IoCM SIG concluded with a directive by the participants to create an IoCM SIG three-year go forward plan. Terrence summarized the meeting, recognizing the great discussions and sharing, but noted that the outcomes created at the IoCM SIG will be achieved only through future participation. He added,

> “It’s up to us to create a better future for ourselves and for our businesses. We are stronger, more agile, and get better results when we can work together through the IoCM SIG.”

The team at Reliabilityweb.com has proven itself to be a trusted steward of community interest. They have a history of facilitating work that has advanced reliability and asset management. Furthermore, they have their own history of major contributions over the past 18 years.



John R. Murphy *founded Gallatin Management Services in 2016 and recently joined Reliabilityweb.com as Senior IoT Leader. For 34 years prior to starting Gallatin, Mr. Murphy was Chief Mechanical Officer – Engineering and Strategy at CSX, a leading freight transportation company.*
www.reliabilityweb.com

Thank you

to those who attended the
IoCM Founders Meeting
in Las Vegas, Nevada.

UPCOMING INTERNET OF CONDITION MONITORING MEETINGS

August 1, 2017
MaximoWorld 2017
Orlando, Florida
8:00am – 11:45am

October 20, 2017
AMP Chapter Meeting
Martinez, California
11:00am- 3:30pm

December 11, 2017
IMC-2017
Bonita Springs, Florida
9:00am – 4:00pm

Email iocm@reliabilityweb.com for more details or request an invitation.

Congratulations to the newest Certified Reliability Leaders

Julie E. Albion
Amec Foster Wheeler

Oscar Antunez
Abbvie

Preetesh Bansal
Bristol-Myers Squibb

John Barneson
Kaiser Aluminum

Rodney Bartell
GAF

Jared Bears
First Quality

Brendan Bishop
Bristol-Myers Squibb

Wendy Borsini
Bristol-Myers Squibb

David Bowers
DP World Southampton

Kyle Brumfield
CBRE

Jon Butterfield
Bristol-Myers Squibb

Emmet Byrne
Abbott Labs

Ozan Cakitli
Pruftechnik

Scott Campbell
KraftHeinz

Scott Capsello
Bristol-Myers Squibb

Justin Carpenter
Bristol-Myers Squibb

Deven Chauhan
Bristol-Myers Squibb

Ong Peck Cheng Randall
PRÜFTECHNIK

Albert Christian
Bristol-Myers Squibb

Tan Kian Chuan
Abbott Labs

Scott Comstock
Weyerhaeuser

Dan Conlon
Bristol-Myers Squibb

Ciaran Connolly
Abbott Labs

Thomas Costello
Bristol-Myers Squibb

Tony Crincoli
Bristol-Myers Squibb

Douglas Crosswhite
American Sugar Refining

Kristen Deardorff
Jacobs

Larry Dearman
Kaiser Aluminum

Johanna DeFrancisco
Bristol-Myers Squibb

Paul Deighton
SKF

Mike DeStefano
Jacobs

Samuel Dias
ASR Sidul

Barry Dyer
DP World Southampton

Oahimire Ejakhegbe
DP World

Scott M. Endres
Kaiser Aluminum

Richard Er Seng Koon
Abbott Labs

Fred Espinoza
Kaiser Aluminum

Tracey Fitzpatrick
Bristol-Myers Squibb

Sven Fleischer
Pruftechnik

Demetrius Frazier
Kaiser Aluminum

Douglas Gannon
RINA Consulting

Juan Jose Garcia Mesa
Abbott Labs

Sean Garry
American Sugar Refining

Adam Gary
Bristol-Myers Squibb

John Gibson
CBRE

Laurence Hendrickson
DC Water

Paul C. Hilford
Estep Ltd

Dave Holloway
ADM

Vincent Hudner
Analog Devices Intl.

John Hurlburt
Kaiser Aluminum

Richard Isabelle
Bristol-Myers Squibb

Jeff Jenkins
Kaiser Aluminum

Kevin Josh
ADM Pura Foods

Tommy Kennedy
Abbott Labs

Robert Laquerre
Honda of Canada

Adam Lea-Bischinger
AR Consulting

Graham Leadbetter
KraftHeinz

Anthony Lim C. C.
Abbott Labs

Thanaraj Loganathan
Abbott Labs

Darren Maloney
KraftHeinz

Cindy Marks
Kaiser Aluminum

Richard Martel
Bristol-Myers Squibb

Trevor Martin
Tate & Lyle Sugar

Andrew May
CBRE

Padraig McCarthy
Bristol-Myers Squibb

Joshua Moriarty
ADM

Dennis Morris
DC Water

Mike Oakes
Kaiser Aluminum

John O'Kelly
Abbott Labs

George A. Orrison IV
Jacobs

Ray Parkinson
Kaiser Aluminum

John Petty
CH2M

Bryan Pingitor
Bristol-Myers Squibb

Nancy Poirier
Bristol-Myers Squibb

Dan Post
Bristol-Myers Squibb

Kendra L. Price
CBRE

David Rickman
Kaiser Aluminum

Matt Rivard
Bristol-Myers Squibb

Pedro Juan Rivera Torres
Bristol-Myers Squibb

Henrique Rodrigues
Bristol-Myers Squibb

Antonio Martin Rodriguez
Abbott Labs

Victor I. Rodriguez Ramos
N/A

Scott Rogers
Bristol-Myers Squibb

Scott Rojas
eMaint

Jon Roland
Bristol-Myers Squibb

Jose Romero
American Sugar Refining

Carmen Romero
Bristol-Myers Squibb

Edward Rosario
Bristol-Myers Squibb

Bob Salsbury
SSE

Boun Sananikone
Kaiser Aluminum

Graham Sanders
ASR Group

Janette Santana
Bristol-Myers Squibb

Raul Santiago
Bristol-Myers Squibb

Elsie L. Santiago Rivera
Patheon Puerto Rico, Inc.

Anna Sayani
Bristol-Myers Squibb

Michael Sayre
Medtronic

Conor Scanlon
Abbott Labs

Lim Ser Lan
Abbott Labs

Amit Shah
Bristol-Myers Squibb

Mark Shelley
Kaiser Aluminum

Randy Soudah
CBRE

Bob Stabler
Kaiser Aluminum

Steve Stum
Kaiser Aluminum

Rajat Subhra Basu
Abbott Labs

Luis Tirado-Maldonado
Bristol-Myers Squibb

Randy Tison
Kaiser Aluminum

David Turner
American Sugar Refining

Dominick Tursi
American Sugar Refining

Piotr Ucher
Bristol-Myers Squibb

Jorge Uriona
DC Water

Harold Van Der Vinne
Abbott Labs

Sonja van der Voort
Abbott Labs

Daniel Vogt
CBRE

Ron Walls
Kaiser Aluminum

Jason Walsh
Kaiser Aluminum

Brant Weaver
Kaiser Aluminum

Stanley Webb
Hollingsworth and Vose

James Wiley
Honda of Canada

Lawrence Wong
Bristol-Myers Squibb

Allen M. Woods
Medtronic

Zejiang Wu
Abbott Labs

Edwin Yaniga
DC Water

www.maintenance.org

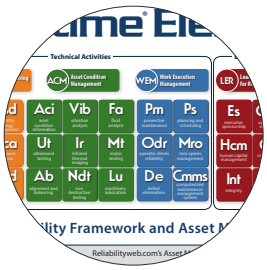
WHEN YOU MAKE YOUR RELIABILITY JOURNEY,

WOULD YOU PREFER TO PARTNER WITH SOMEONE WHO:

SHARES THE SAME
VALUES

SPEAKS THE SAME
LANGUAGE

USES THE SAME
FRAMEWORK



Uptime Elements Mapped Services and Training™ (MSAT) Solution Providers Program:

Solution providers who have earned the **Certified Reliability Leader™** designation and who support Reliabilityweb.com's work to expand its use and follow the **4 Fundamentals of Reliability Leadership.**

Look for the CRL value seal when seeking your solution provider.

4 FUNDAMENTALS OF RELIABILITY LEADERSHIP

1. **INTEGRITY**
   Do what you say you will do
2. **AUTHENTICITY**
   Be who you say you are
3. **RESPONSIBILITY**
   Be accountable/ take a stand
4. **AIM**
   Work for something bigger than one's self

WORK WITH SOMEONE YOU TRUST

LUDECA Keep it running. · LCE LIFE CYCLE ENGINEERING · db PRÜFTECHNIK · SDT HEAR MORE · Bentley Advancing Infrastructure · ARMS RELIABILITY EMPOWER | EDUCATE | EQUIP · JACOBS · THE ULTRASOUND institute

Find a current list of MSAT Providers: www.reliabilityweb.com/directory

RELIABILITY WEB.COM

888.575.1245
239.333.2500
crm@reliabilityweb.com

De
defect elimination

How Nova Scotia Power Implemented Its AM Program:

Equipment Integrity Through PdM and RBI

Warren Rodgers

Aging assets, changing utilization, demographics and regulatory changes precipitated the need for an innovative and comprehensive asset management (AM) program at Nova Scotia Power Inc. (NSPI). Building on the elements of PAS55 and ISO55000, NSPI constructed a program for its power production business. The universal challenges of an aging infrastructure and workforce, along with industry specific and regulatory changes, demanded a shift in the company's organizational philosophy toward asset management. Many of the company's generating equipment assets are 30 to 40 years of age and had reached a point where new strategies were required. Among those strategies is the implementation of condition-based monitoring (CBM) techniques.

Predictive maintenance (PdM) and risk-based inspections (RBI) are an integral part of Nova Scotia Power's asset management approach. These two elements are part of asset CBM strategies through, for the most part, noninvasive means. They provide information on deficiencies that feed the probability portions of risk assessments. Knowledge of a deficiency allows for an estimation

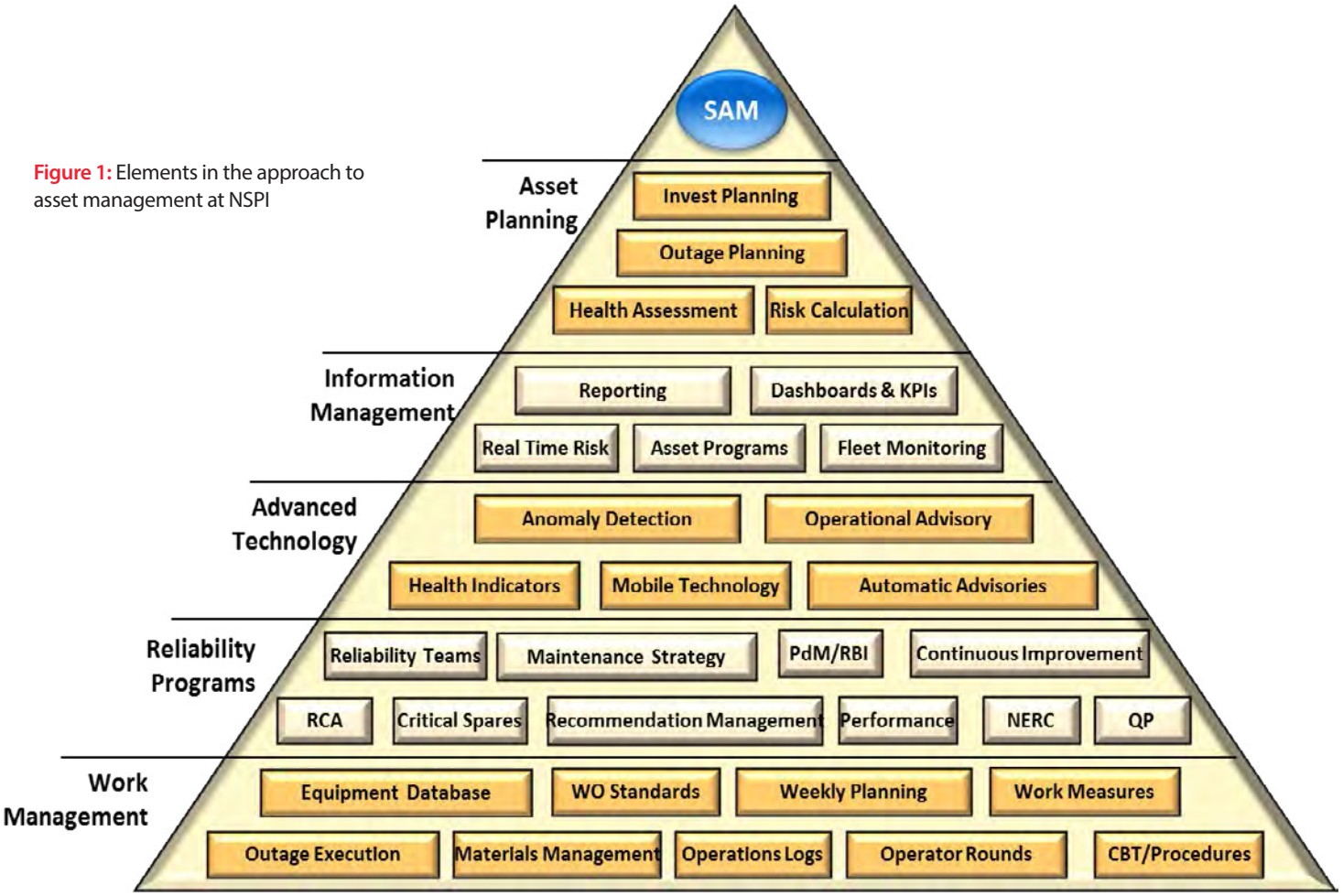


Figure 1: Elements in the approach to asset management at NSPI

of probability to timely mitigate prior to a failure, ultimately reducing impact and improving reliability.

PdM and RBI programs fall into the category of asset condition management and form elements within the overall strategic asset management program shown in Figure 1. It was important to NSPI to utilize common reliability tools and systems in such a way as to fit its organization's capacity and need. For example, the augmentation of maintenance strategies using PdM and RBI facilitates reliability programs, but fits within functional maintenance strategies for rotating and static equipment. The key elements contained within each layer make up NSPI's strategic asset management portfolio.

In concert with the strategic asset management approach in Figure 1 is the mechanism by which system condition information feeds risk profiling for decision makers in Figure 2. Note the application of PdM/NDT on the lower right of Figure 2. As demonstrated in the figure, they form part of the overall maintenance strategy for any asset. An increase in deficiencies noted in the PdM or nondestructive testing (NDT) environment indicates an increase in risk influence based on worsening condition and the risk level, hence the decisions around mitigating that risk.

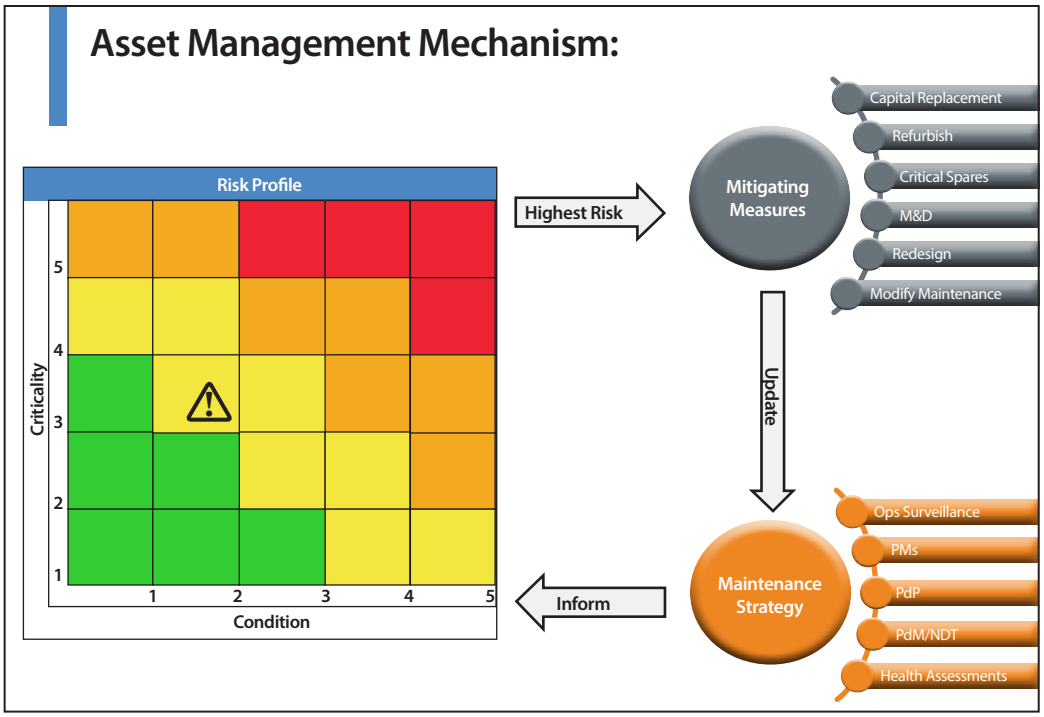


Figure 2: The mechanism for delivery of equipment risk assessment to identify high risk assets

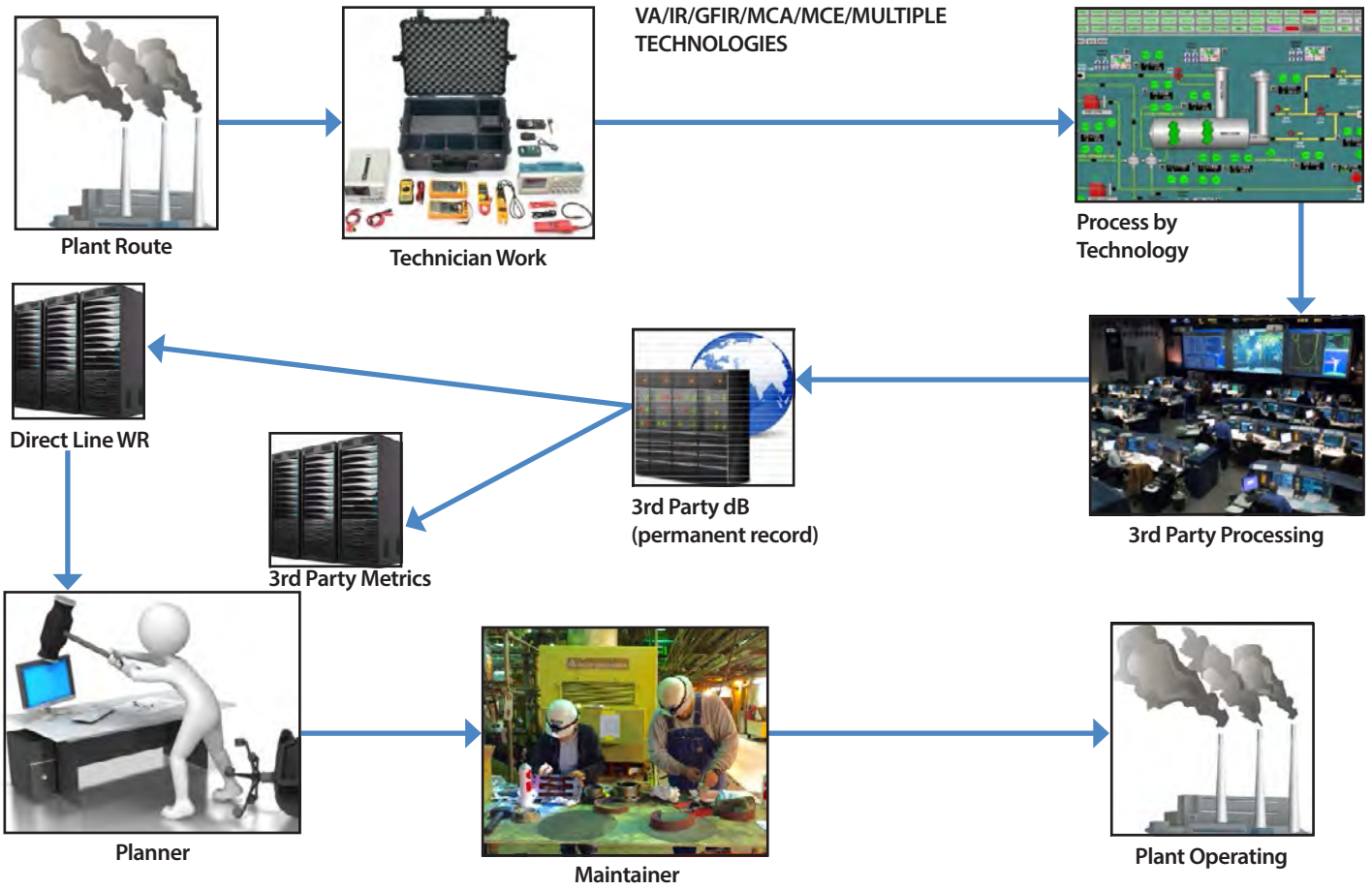


Figure 3: The process for delivering a found deficiency to the CMMS/business unit

CBM is defined by the more general analysis of equipment condition from many sources. NSPI equally takes on a number of forms for CBM, including automated monitoring, manual testing, predictive pattern recognition and the human senses. CBM for NSPI is also augmented by:

PdM: A third-party vendor with full-time equivalent (FTE) stations at NSPI plants supplies all vibration analysis, oil analysis, infrared (IR), ultrasound, electric motor testing and gas finder IR. Weekly deficiencies and recommendations are uploaded to the computerized maintenance management system (CMMS) program. By contracting out the service, NSPI aligns itself to best practices, imparts high quality assurance/quality control (QA/QC) and repeatable, consistent testing and data interpretation. Another important part of the relationship is access to specialized engineering resources required for special analyses.

Risk-Based Inspection: Starting with flow assisted corrosion (FAC) and high energy piping failure detection (HEP), separate programs are underway, partnering with third-party services to support program design, develop risk registers and inspection protocols. The deployment of FAC and HEP inspections resulted in NSPI adding over 10,000 measurement locations on piping in its stations alone. Future programs will include oil piping, tanks and vessels, and other static equipment that utilize NDT in a more classic sense.

Defining a purpose, protocols, methods and objectives for a fleet-wide program is the starting point to the delivery of these programs. By conducting gap analysis against those elements, NSPI created justification for a formal program that incorporates the needs of its regulators, insurers, plant staff, executives and leadership. Managing the development of a company-wide program is handled best as a project.

Starting with equipment and plant surveys allows for the design of practical routes and provides the service provider an opportunity to build its equipment databases matching NSPI's. Technical applications followed with the appropriate alarms, trend requirements, measurement points and documentation of the process.

> "Many of the company's generating equipment assets are 30 to 40 years of age and had reached a point where new strategies were required."

> Understanding the health of equipment is a growing challenge as assets age and utilization changes.

NSPI designed the RBI approach very similarly, but due to the nature of the nondestructive examination (NDE) environment versus the PdM one, it becomes necessary to treat the deployment a little differently. The primary challenge comes from the increased amount of measurement points required to track on any one system or component. For example, to check pipe thickness on an elbow, one may have to record up to 20 grid assigned points. To track each of those and repeat them in the future, they must exist as separated objects within a database. An example is the development of NSPI's critical piping program. After the database was created, no less than 13,000 measurement points were generated for tracking.

Another primary difference between PdM and NDT is the nature of the frequency of most testing. For many assets, there is only a need to conduct NDE over many years or, in some cases like oil tanks, over decades. This means creating systems that are not reliant on people dependent procedures is necessary. Development of such processes requires more time and resources to design.

Once successful in addressing the plant and business unit differences, creating a business accepted strategy and objectives puts you most of the way there. The technical details in the program must be documented and become standards for the organization. This way, as people change roles, the processes will be consistently applied. The system, program and the processes must be measured with well-planned key performance indicators (KPIs) and open for continuous improvement.

Continuous improvement is a hallmark of any successful business model. Allowing room for growth and meeting the ever changing expectations of business is built into the program at NSPI. The primary method is through formal, regularly planned meetings between the contract administrators on both sides to cover such topics as safety, operations, budgeting, technical issues and staff.

These mechanical integrity programs have gained acceptance by demonstrating the successes of preventing equipment failures, making informed decisions and work management excellence. NSPI deploys a common monitoring strategy across a fleet, providing staff and management with measures of success over time and ultimately, informed decision-making.

If a business is not prepared to open up the program occasionally to look beyond its own boundaries, it will become stagnant and ineffective. Understanding the health of equipment is a growing challenge as assets age and utilization changes. Since the 2012 deployment, NSPI has generated, on average, over 850 deficiencies per year in the fleet and direct many resources and funding in the form of maintenance dollars or capital projects where they are needed most. By deploying rigorous and comprehensive PdM and RBI based programs, NSPI ensures that the overall asset management program will meet these challenges and others in the future. Success hinges on a good foundation, understanding the needs and differences between RBI (NDT) and PdM tools and techniques, advancing technology, inspiring change and striving for continuous improvement.

Warren Rodgers, *P.Eng, CMRP, is Senior Engineer at Nova Scotia Power. Warren has helped build the current asset management program and lead the predictive maintenance program involving rotating and static equipment. He has a passion for reliability and asset management, and has over 15 years of experience.* www.nspower.ca

RELIABILITY WEB.COM

2018

CONFERENCES

From the full conference experience to focused, two-day events, Reliabilityweb.com offers options that are designed to meet objectives based on your time, budget and needs. The full conference experience is five days and includes workshops, short courses, learning sessions, expo and ample opportunities to network. Training symposiums provide all the same great options but condenses it all into two days!

March 7-8
Lima, Peru

April 23-27
Las Vegas, NV

June 6-7
London, UK

July 17-19
New Orleans, LA

August 7-9
Orlando, FL

September 6-7
Honolulu, HI

September 24-28
Antwerp, Belgium EU

October 9-10
Queretaro, Mexico

December 10-14
Bonita Springs, FL

CERTIFIED RELIABILITY LEADER (CRL) WORKSHOPS

The CRL workshop is designed to teach the language of reliability, so students can discover what it is to "BE" a Reliability Leader and to exercise reliability leadership as natural self-expression. Perfect for those pursuing the CRL certification or for those seeking a reliable operation.

January 22-26
Fort Myers, FL

March 19-23
Fort Myers, FL

April 24-27
Las Vegas, NV

May 14-18
Fort Myers, FL

September 17-21
Fort Myers, FL

September 25-28
Antwerp, Belgium

December 11-14
Bonita Springs, FL

RELIABILITY LEADERSHIP INSTITUTE COMMUNITY OF PRACTICE (COP) MEMBERSHIP Face-to-Face Meetings

Organizations from all industries join to enhance the business effectiveness and sustainability of reliability and asset management through peer-to-peer collaboration, active project management, research, related initiatives and industry alliances. Four face-to-face meetings are held annually. Membership required.

Febuary 28-March 1
U.S.A.

April 22
Las Vegas, NV

August 28-29
U.S.A.

December 9
Bonita Springs, FL

EVENTS

IOCM MEETINGS

The Internet of Condition Monitoring (IoCM) is happening. Join the early adopters, the technology pioneers, the start-ups, the underdogs and the individual innovators in regular meetings for discussions and demonstrations.
Special Invitation - Request Your Seat

April 23
Las Vegas, NV

July 16
New Orleans, LA

September 5
Honolulu, HI

September 24
Antwerp, Belgium

December 10
Bonita Springs, FL

ASSET MANAGEMENT BENCHMARKING ROUNDTABLES

Leaders in rail, water and life sciences come together for two-day discussions and industry benchmarking.
Special Invitation - Request Your Seat

April 4-5
Rail Asset Management Roundtable

May 2-3
Life Sciences Asset Management Roundtable

July 11-12
Water Asset Management Roundtable

RELIABILITY LEADERSHIP ROAD MAP

Leadership on the road! These introductory, one-day events allow attendees to learn and engage with those carving the path to true reliability leadership. Limited seats available so register early to guarantee your place.

January 16
Denver, CO

January 18
San Jose, CA

February 6
Atlanta, GA

February 8
Detroit, MI

March 27
Boston, MA

March 29
Baltimore, MD

April 10
Jersey City, NJ

April 12
Chicago, IL

May 8
Houston, TX

May 10
Nashville, TN

July 24
Minneapolis, MN

July 26
Indianapolis, IN

August 14
Phoenix, AZ

August 16
Seattle, WA

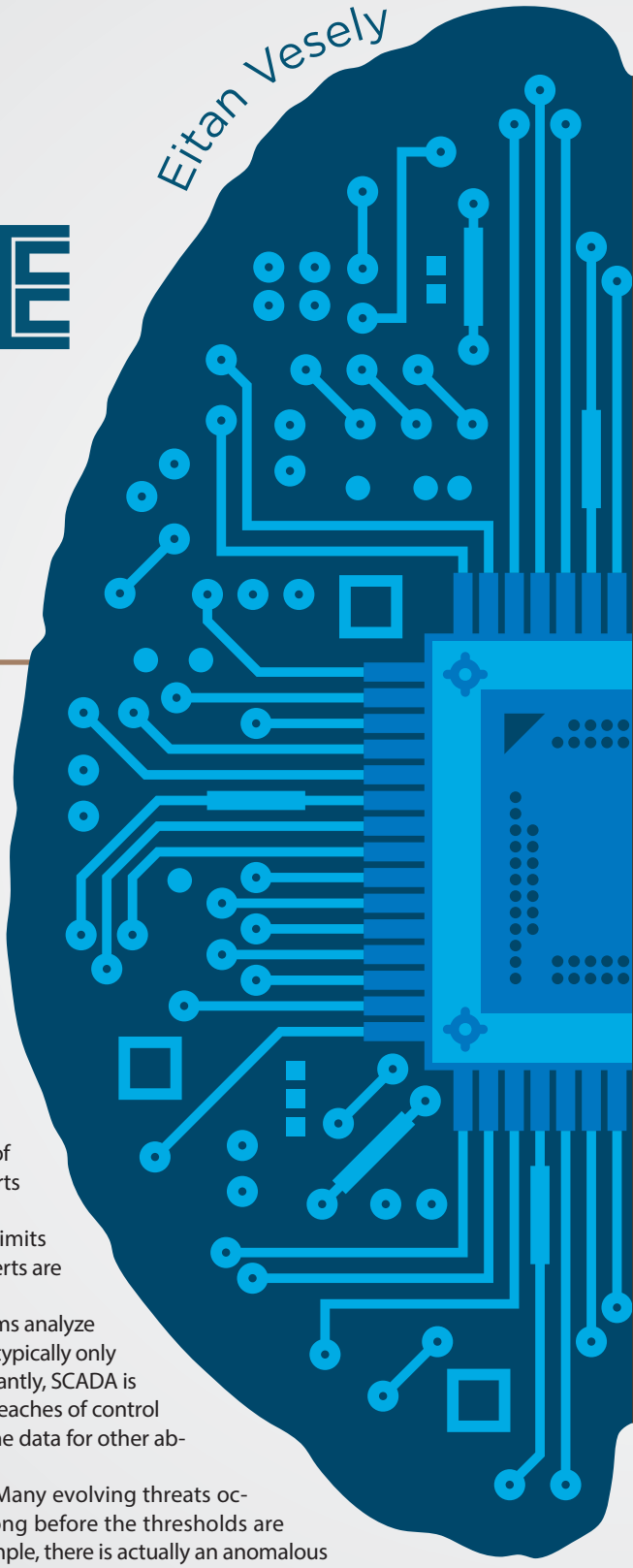





AM

WILL DIGITAL TWIN REPLACE SCADA?

Eitan Vesely



For decades, supervisory control and data acquisition (SCADA) has been the industry standard for asset management. But, the sizable investments in digital twin concept offerings on the part of two leading digital industrial companies have generated much discussion about the long-term viability of SCADA. Gartner's recent forecast that digital twin will be one of the top 10 strategic technology trends for 2017 is one of several reports that point to momentum in this category.

This article evaluates the likelihood that digital twin will replace SCADA by providing a realistic assessment of each solution. In addition, a third alternative, unsupervised machine learning, is presented.

The Traditional SCADA Approach to Asset Maintenance

Currently, a significant number of industrial plants rely on SCADA rule-based monitoring systems for predictive asset maintenance. Conceptually, SCADA is simple. It monitors sensor data from machinery parts (e.g., pressure, flow, vibration, temperature, etc.) and attempts to identify early warning signals of machine failure. Engineers provide a set of predefined rules or control limits and SCADA generates alerts if these control limits are breached.

Figure 1 shows data from a sensor that measures temperature. The engineers set the control limits between 20 and 40 degrees. As long as the temperature does not exceed 400 or fall below 200, no alerts are generated.

The challenge for industrial plants that rely on SCADA is twofold. First, most SCADA control systems analyze a small number of sensor data. As a result, most factory sensor data is not monitored in real time and is typically only accessed and used for postmortem root cause analysis after a fault has already occurred. More significantly, SCADA is only capable of identifying breaches of control limits, but does not analyze the data for other abnormalities.

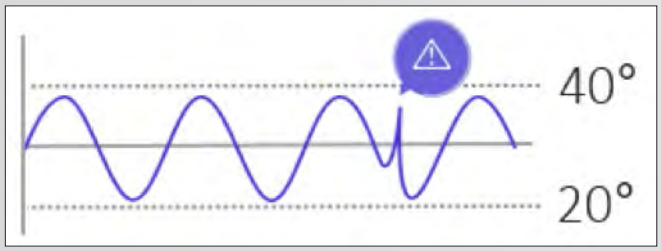
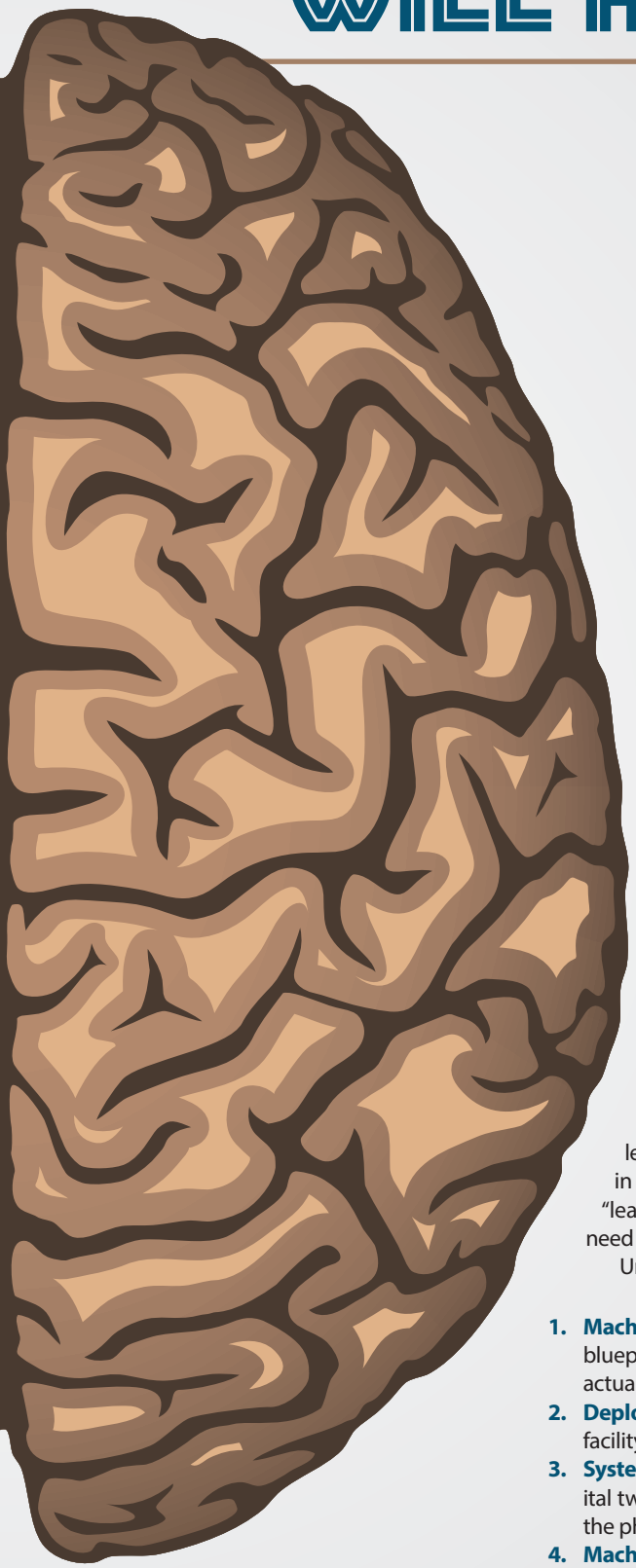


Figure 1: Manually configured rule-based alerts

Why is this significant? Many evolving threats occur within the sensor data long before the thresholds are breached. In the Figure 1 example, there is actually an anomalous data pattern that is not captured by SCADA control limits. The problem is, by the time the control threshold has been exceeded, the problem has already occurred and it is too late to prevent machine or factory downtime.

WILL ANYTHING ELSE?



The Digital Twin Alternative

Digital twin technology is arguably the most comprehensive solution for predictive asset maintenance. An exact virtual replica of the machine or factory is generated using 3-D modeling, physical rules and mathematical equations. In real time, sensor data from the actual machine is streamed to the digital twin so it is "live." Using big data machine learning, the digital twin is able to recognize anomalous sensor data and generate alerts of potential failure.

So, it is not surprising that the ability to create an exact virtual copy of a physical machine or plant has generated so much industry and analyst interest. This is further validated by the willingness on the part of industry heavyweights to make long-term financial commitments to their platforms.

Putting the hype aside, there are legitimate concerns about whether digital twin is practical and scalable for most industrial plants. In order to deploy a digital twin, physical blueprints need to be available so that virtual models can be created. Factories source their equipment from multiple original equipment manufacturer (OEM) suppliers and changes are made to the physical plant over time. Unfortunately, factory blueprints are not always updated, thereby adding an additional and onerous complexity to the deployment of a digital twin.

Furthermore, the creation of a digital twin requires a significant investment of time and resources. The digital twin requires inputs from facility managers, process engineers and electrical and mechanical design modeling experts. No matter whether cost is borne by an outside vendor or from internal facility resources, the investment to deploy a digital twin is not economically viable for many industrial plants.

The Third Alternative: Unsupervised Machine Learning

For those facilities moving away from SCADA-based, fixed rule systems, an unsupervised machine learning platform is a viable alternative to consider. Unsupervised machine learning analyzes sensor data in real time using advanced artificial intelligence algorithms. Instead of creating a digital twin and then "learning" the factory machinery, the unsupervised approach uses innovations in big data to bypass the need to create the virtual clone of the physical machinery.

Unsupervised machine learning differs from the digital twin approach in five major areas:

1. **Machine Model Development:** The digital twin simulates the machine model based on learning the factory blueprints. In the unsupervised approach, algorithm-driven, deep learning of sensor data does not require actual human or blueprint input and automatically develops machine models.
2. **Deployment and On-Site Resources:** Deploying the digital twin is intensive and time consuming for on-site facility staff. The unsupervised model does not require any input from factory personnel.
3. **System Knowledge and Requirements:** Detailed knowledge of the physical plants is required for the digital twin. In the case of the unsupervised model, there is no requirement for the algorithm to "understand" the physical plant.
4. **Machine Model Updates:** Any change to the physical plant requires a parallel update to the virtual model. This is both time consuming and adds additional complexity. There is no requirement for updates with unsupervised machine learning. The platform will adjust its models by itself over time.
5. **Onboarding Costs:** Vendors deploying digital twins provide a human capital intensive service with hourly billable rates. Unsupervised machine learning does not require costly onboarding.

AM

What Is AI Predictive Machine Maintenance?

Unscheduled machine breakdowns are never planned and can be extremely expensive. The average factory downtime is 17 days per year. That's 17 days of lost production. The number one goal of artificial intelligence (AI) predictive machine maintenance is to prevent machine failure in order to maximize plant availability.

Let's start with the existing solution: condition monitoring systems. These are rules-based systems to monitor sensor-generated data (e.g., temperature, vibration, pressure). Upper and lower control boundaries are predefined. Take, for example, machine temperature, which is monitored by sensors. If the lower control is set at X and the upper control is set as Y, there are no alerts generated. As long as the machine temperature stays within this range, there is no mechanism to identify an early warning for machine fault. But what often happens is that by the time the temperature exceeds the control limits, it is too late to prevent a machine breakdown.

AI predictive machine maintenance can predict machine failure hours before the rules-based monitoring system has identified a control breach. This is done by accessing the historian databases that record data generated by machine sensors in the factory plant. Systems capture masses of sensory and log file data, but factories simply lack the tool to access and analyze big data in real time. Many of the monitoring systems are old and not built to cope with immense data in real time. Typically, the historian database is used for troubleshooting or root case analysis. In other words, after the breakdown has already occurred. But, AI predictive machine maintenance uses advanced algorithms to learn how a machine behaves.

How Does AI Predictive Machine Maintenance Work? In order to predict a breakdown before it occurs, the following steps are completed.

Manufacturing Business Intelligence: Machine data is centralized in the Cloud and made accessible at any location. By visualizing the data in an easy to use format, machine maintenance employees can use the information in a meaningful way.

Fully Automated and Unsupervised Anomaly Detection: By accessing the machine's historian database, the algorithm allows the computer to build a statistical model for how the machine is expected to behave. Instead of looking for breaches in sensor control, a baseline is set for the number of anomalies that are expected for a given period. Each deviation from the expected behavior is detected and an alert is generated and monitored as the early warning trigger of a potential machine breakdown.

Abnormal Events Correlation: Finding anomalies is the starting point, but understanding the relationship between abnormal events provides a much deeper level of analysis and detection. Finding patterns in anomalies allows failure causation to be identified and early warning signs are detected.

Failure Prediction: Alerts are based on a holistic view of all machines in a facility. Aberrations are identified and cause and effect relationships are understood. This provides context as to why the machine is likely to fail. The sequence of events is captured, leading to the failure prediction and isolation of the root causes. This allows the factory to prioritize troubleshooting.

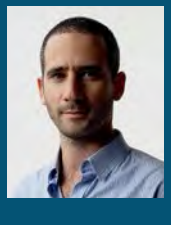
Prescriptive Maintenance: This is generated by the system to provide guidance to the technicians responsible for asset maintenance.

		Supervised Predictive Maintenance	Unsupervised Predictive Maintenance
Anomaly Detection Model		Simulated machine model based on machine blueprints or experts knowledge	Algorithm-driven deep learning of sensor data; No expert knowledge needed
Deployment and On-site Support Requirements		Intense and time consuming engagement with facility engineers	Almost no involvement with on-site engineering staff
System Knowledge Requirements		Detailed knowledge of machine blueprints	Sensor type and machine behavior agnostic
Machine Model Updates		Requires manual remodeling with any change in machine behavior	Automatic adaption to new machine configurations
Onboarding Costs		Additional costs for learning machine blueprints and assessing facility staff	No additional onboarding costs

Figure 2: Benefits of an unsupervised machine learning solution

Conclusion

SCADA rule-based systems, digital twin and unsupervised machine learning each use different technologies to address the same need: early identification of machine and plant failure before downtime occurs. Every industrial plant has its unique requirements and for some, SCADA rule-based systems may suffice for the near to medium term. For those industrial plants seeking to tap into big data machine learning, both digital twin and unsupervised big data machine learning are valid options to consider.



Eitan Vesely *is the CEO of Presenso, a pioneer in the field of big data predictive maintenance and part of the ongoing industry 4.0 transition. The solution uses advanced artificial intelligence to provide real-time asset failure predictions based on monitoring sensors' signal data in the Cloud.* *www.presenso.com*

ARMS RELIABILITY

OPTIMAL STRATEGIES ON EVERY ASSET ALL THE TIME

Asset Strategy Management

OnePM® is an innovative Asset Strategy Management solution that acts as the thread across all systems. It allows organizations to capture and review data from all sources and leverage learnings to enhance asset strategies, by identifying pockets of strategy excellence and deploying those strategies across the organization, wherever they are relevant.

Learn more at www.armsreliabilitysoftware.com

NORTH / LATIN AMERICA
P: +1 512 795 5291

AUSTRALIA / ASIA / NEW ZEALAND
P: +61 3 5255 5357

EUROPE / MIDDLE EAST / AFRICA
P: +44 1484 505 776

North America | Latin America | Europe | Asia | Africa | Australia

Leverage a leader in Reliability

OnePM® was created by ARMS Reliability. Since 1995, ARMS Reliability has helped companies around the world - and across a broad range of industries - to get more from their assets, avoid unplanned downtime and reduce operating costs.

Hcm
human capital management

THE CHALLENGE :
Developing a Reliability Culture

Prakash Shende

In some organizations, reliability is not just a word, but a culture that has been built over a period of time. Developing a reliability culture is not solely a top-down approach or dependent on the company's vision. Sometimes, it is taken as a normal, routine job, while other times, it may get a fast-track status.

In fact, all the giant organizations in the oil, gas and hydrocarbon industries are aware of what reliability of their assets is. Their management information system (MIS) will have some numbers that keep top management happy that reliability is maintained and assets are not deteriorating. That is, of course, until some failure takes place and then everyone becomes busy finding out the "why" of the failure. Most times, the answer is: "Except for this **particular instance**, the systems are maintained."

So, what happened in this "particular instance?" To illustrate, let's look into a classic corrosion under insulation (CUI) failure case that occurred in a refinery in 2013. It involved a pipe section with a nominal 210 mm internal diameter and consisted of a straight section, some 1,430 mm in length (see Figure 1). Its failure led to an explosion and fire at the refinery site, leading to the evacuation of the site and resulting in millions of dollars worth of damage to the facility.

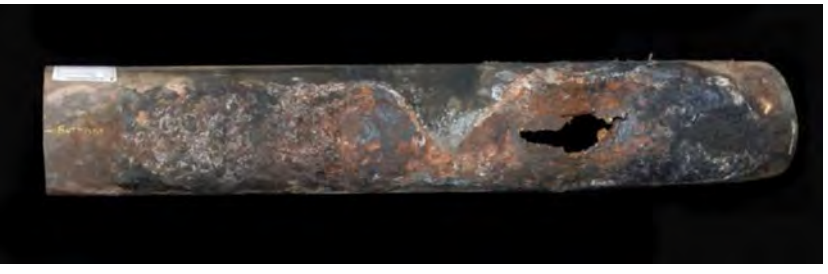


Figure 1: The corroded pipe section that contributed to a refinery explosion and fire in 2013

The root cause of the incident was threefold. First, management failed to adequately assess the suitability of the installation design with respect to the proximity of the walkway bracket to the pipe work (see Figure 2).

Figure 2: The proximity of the corroded pipe to the walkway bracket

Second, there was a failure to ensure that the implemented installation was adequately weatherproofed and third, there was a lack of an adequate in-service inspection regime that might have identified degradation of the pipe prior to failure.

Some of the salient points from the conclusion of the failure report are:

1. The pipe coating system appeared to be compliant with specifications; there was no evidence to suggest that an inadequacy of the coating contributed to failure.
2. The lagging system appeared to be fit for purpose; there was no evidence that inadequacy of the intended system contributed to failure.
3. Failure of the pipe had occurred as a result of corrosion under insulation (CUI), the rate of corrosion was entirely consistent with published data.

The wall thickness of the pipe had been reduced to a level that would not support the internal pressure; the remaining ligament had then failed as a result of a ductile overload.

4. The proximity of the pipe to the walkway bracket was not in compliance with published guidance.
5. Water had entered the lagging system through a breach in the jacketing/lagging made to accommodate a walkway support bracket. It is probable that no adequate precautions were taken to weatherproof the penetration into the lagging system.

In this **particular instance**, the organization's system data did not correlate with the culture of the organization. Why? Because, unfortunately, the dashboard of top management's MIS system **does not capture culture**.

How to Solve the Culture Problem

First, it starts with defining culture. There are many definitions for the word culture, but for purposes of this article, the following definition is proposed:

A culture is a way of life for a group of people---the behaviors, beliefs, values and symbols that they accept, generally without thinking about them, and that are passed along by communication and imitation from one generation to the next.

So, let's say people are trained or ordained to follow certain rules, but somewhere a breach occurs. Since the issue where the breach occurred is so minor, people do not take notice of it and over time, it becomes the culture and then disaster occurs.

So, how do you overcome the problem? You have to build, or perhaps rebuild, a culture where people **resist** rather than **accept** these apparently minor deviations. Are today's megacorporations equipped to do it? Yes, since they can do anything on the earth. But, are they willing? Here one finds the problem everyone is looking for: Fast, faster, fastest progress does not distinguish a small variation or aberration until many years later – and after everyone has forgotten about it – causes a disaster.

The solution to the problem lies not in getting past such deviations, but in encouraging frank discussions at all levels and listening carefully. This is not something that is available from the dashboard, so those who are immediately next to top management have to take it upon themselves to find such incidences or deviations. Then, the chain of command continues until reverse communication (i.e., bottom to top) gets completed to give the light of day to such a critical issue.

Developing a reliability culture requires extremely high courage and determination from the organization to discuss such issues. Often times, the trivial issues are discussed at the lowest levels, where workers are bound by their own culture and would never want to break it. Those who do are considered traitors, even if they are working in the best interest of the organization. This is the dilemma organizations have to solve. They will only find the right solution if the issue is treated as a breach and tackled without hurting anyone. Only then can the organization get back on the right track, ensuring that the path to a reliability culture will not lead to a disastrous end.

There is no doubt that organizations will have enough mature people to tackle such deviations and uphold the culture leading to reliability.

Reference

Geary, W. *Case Study: Analysis of a corrosion under insulation failure in a carbon steel refinery hydrocarbon line.* London: Elsevier Ltd., October 2013. https://www.scribd.com/document/311121227/Analysis-of-a-Corrosion-Under-Insulation-Failure-in-a-Carbon

Prakash D. Shende *has over 44 years of work experience in the hydrocarbon industry. Prakash has worked in renowned and reputed companies in both India and Venezuela. He currently is a private consultant.*

...the dashboard of top management's MIS system does not capture culture.

Rsd
reliability
strategy
development

HYDRAULIC SYSTEM FMEA MADE EASY

Paul Craven

Figure 1: Truck dumper in operation (Courtesy of: Phelps Industry)

In the not too distant past, most senior level managers would cringe when someone said a failure mode and effects analysis (FMEA) needed to be performed on the hydraulic system. What immediately came to mind is a bunch of highly paid people sitting around a table dreaming up ways to eliminate things that may or may not happen to their hydraulically operated equipment.

What they finally realized is that the majority of their day-to-day work orders were being generated to repair things that were happening at the *failure mode* level, which was determined to be reactive maintenance. How times have changed! These days, the majority of those senior level managers have been promoted into positions within the reliability group and their technicians are now using improvement-based maintenance techniques. They have never looked back since!

One easy, yet effective way, to perform a FMEA on a typical hydraulic system is through gathering, analyzing and trending relevant data from a few properly placed inexpensive devices.

Failure Mode and Effects Analysis Defined

FMEA is a proven process, created within a spreadsheet, to help facility managers anticipate what might go wrong with a machine set or process and how that asset would fail to perform its intended function. FMEA also helps find the possible causes of functional failures and failure modes, and the likelihood of those being detected before occurrence. It requires a well-defined function statement that clearly describes the machine function or what it should do and performance or how it should do it, and must be quantitative or measurable.

Fundamentals of Hydraulics

In any hydraulic system, whether it's a truck dumper in a paper mill or a farm tractor, there are only three things you need to know when determining how to identify functional failures and failure modes for a FMEA. They are the rate of flow vs. the required rate of flow, the direction of the flow vs. the required direction of flow and the operating pressure vs. the required operating pressure. Properly placing simple, inexpensive detection devices, such as flow meters and pressure gauges, in the design phase of your hydraulic system allows you to *design in* reliability and longevity of service. Breaking into a hydraulic system to add these devices after the fact is very costly and will introduce other unforeseen problems.

Getting Started

The following is an acceptable function statement developed by Drew Certain, P.E. Sales Engineer at Phelps Industries. They are the original equipment manufacturer (OEM) of the hydraulic truck dumper used to describe the FMEA process in the rest of this article.

Figure 1 shows a truck dumper in operation. The truck drives onto a deck and the entire truck is lifted into the air until it reaches the proper angle and the trailer has been emptied of its contents.

Truck Dumper Function Statement

The 70-foot-long truck dumper's decks are designed to go up and down in a continuous, uninterrupted motion and handle six trucks per hour. The hydraulic system is designed to extend the deck into the air at a 58 to 61 degree angle, the maximum angle being 63 degrees, with two telescopic cylinders that extend 500 inches in 150 seconds at between 800 and 1,500 pounds per square inch of pressure based on a standard loaded trailer, and two fixed displacement vane type hydraulic pumps with a combined discharge flow of 180 gallons per minute. It is designed to retract by gravity with no discharge flow or pressure from the pump 500 inches in 90 seconds for a total cycle time of 240 seconds or four minutes. The dumper may be stopped at any point, typical is 56 to 61 degrees, as set by the end user.

(Author's Note: There also could be a dwell time at any point during the lift based on the operator, but for the purpose of this article, 240 seconds is being used.)

System	Number 3 hydraulic chip dumper	
Subsystem	Hydraulic operating system	
Function Statement	Functional Failure (Loss of Function)	
The 70-foot-long truck dumper's decks are designed to go up and down in a continuous, uninterrupted motion and handle six trucks per hour. The hydraulic system is designed to extend the deck into the air at a 58 to 61 degree angle, the maximum angle being 63 degrees, with two telescopic cylinders that extend 500 inches in 150 seconds at between 800 and 1,500 pounds per square inch of pressure based on a standard loaded trailer, and two fixed displacement vane type hydraulic pumps with a combined discharge flow of 180 gallons per minute. It is designed to retract by gravity with no discharge flow or pressure from the pump 500 inches in 90 seconds for a total cycle time of 240 seconds or four minutes. The dumper may be stopped at any point, typical is 56 to 61 degrees, as set by the end user.	**A**	The deck raises too slowly, 300 seconds instead of 150 seconds

Figure 2: Function statement and functional failure

		System	487-126	Facilitation	Paul C	Date
		Subsystem	487-126-12	Auditor	Kevin C	Date
Failure Mode (Cause of Failure)				Level 1 (Due To)		
1	One pump is not discharging flow			**1.1**	Inlet strainer clogged	
				1.2	Coupling key sheared	
				1.3	Electric motor tripped	
2	The relief valve has cracked open			**2.1**	Pressure setting not correct	
				2.2	Contamination locked spool	
				2.3	Thermal locked spool	

Figure 3: Possible failure modes and Level 1 due tos.

2/18/2017	Sheet	1		
2/18/2017	Of	1		
Failure Effect			**Failure Consequences**	**Appropriate Task to Mitigate**
(What happens when it fails)			**(In what way does it matter)**	**(Task and detection device)**
Since the pump is the heart of the system, when it fails the entire system is down and there is always the possibility of contaminating other components if you do not have proper filter placement.			The consequences of this will be slower cycle times and lost production.	This task falls under all of the three things that you must know in any hydraulic system. So you would install a flow meter at the discharge of the pump and a vacuum gauge at the pump inlet between the pump and the reservoir and assign a task to monitor them for any variations.
When the relief valve nears its pressure setting, the spool begins to lift off its seat and cracks open, allowing a portion of the pump's discharge flow to be directed back to the reservoir. This would result in a dramatic increase in oil temperature and a slowdown of cycle times.			If this were allowed to persist, the consequences could result in a fire, equipment damage and/or loss of life.	This task falls under all of the three things that you must know in any hydraulic system. So you would install a flow meter at the pump discharge and a flow meter in the return line of the relief valve and assign a task to monitor them for variations.

Figure 4: Failure effect, failure consequences and an appropriate task and measurement device

Now *that* is a function statement! It clearly describes what the truck dumper is supposed to do and how it should do it. The statement presents many things that can be measured.

Here is an example of a very poor function statement:
To unload as many trucks as we can.

What It Looks Like on Paper

The truck dumper function statement states that the 70-foot-long deck is designed to extend 500 inches in 150 seconds, with two fixed displacement vane type hydraulic pumps with a combined discharge flow of 180 gallons per minute.

A functional failure would be the deck extending too slow at 300 seconds, which is double the amount of time it is supposed to extend. This indicates that half the flow has been lost because in hydraulics, the rate flow is equivalent to the rate of speed. More flow equals more speed and less flow equals less speed for a given actuator's size.

So, now it's necessary to populate the document with the appropriate information:

- Function statement;
- Functional failure;
- Failure modes;
- Level 1 or the due to;
- Failure effects;
- Failure consequences;
- Appropriate task and detection device to mitigate the occurrence.

Your system is now identified: the Number 3 hydraulic chip dumper, your subsystem, the hydraulic operating system, your function statement and your first functional failure, which is "the deck raises too slowly."

Figure 2 (see page 43) shows a clear function statement and describes in detail the scenario when the deck raises too slowly at 300 seconds instead of the required 150 seconds as a functional failure.

Next, determine the possible causes or failure modes that would allow this to happen.

One major failure mode: Ninety gallons or the full volume of one pump is lost, proving that amount of flow. This shows flow does equal speed.

What are at least three items that could have contributed to the failure?

a) The inlet strainer could be clogged, effectively choking off the inlet flow from the reservoir to the pump inlet.
b) The key in the pump shaft coupling could be sheared, allowing the coupling to spin and the pump shaft not to rotate.
c) The electric motor could have tripped, not allowing the electric motor shaft or the pump shaft to turn.

Here is the really great thing about a flow meter located in both the pump discharge line and the return line of the relief valve: you are able to immediately identify where the oil is going and where it is not going. Simply meaning, if the pump discharge flow meter shows zero flow, then the problem is the pump and does not go beyond that point.

Figure 3 (see page 43) shows two possible failure modes and three Level 1 due to reasons.

What are the failure effects, the failure consequences and the appropriate tasks to control these failures?

Figure 4 shows the failure effects, the failure consequences and the appropriate task to control them, as well as the devices to measure and trend the data to look for even the slightest variations in operating parameters.

Some people will keep drilling down and add problems with contamination or temperature. You can add devices to monitor these problems just

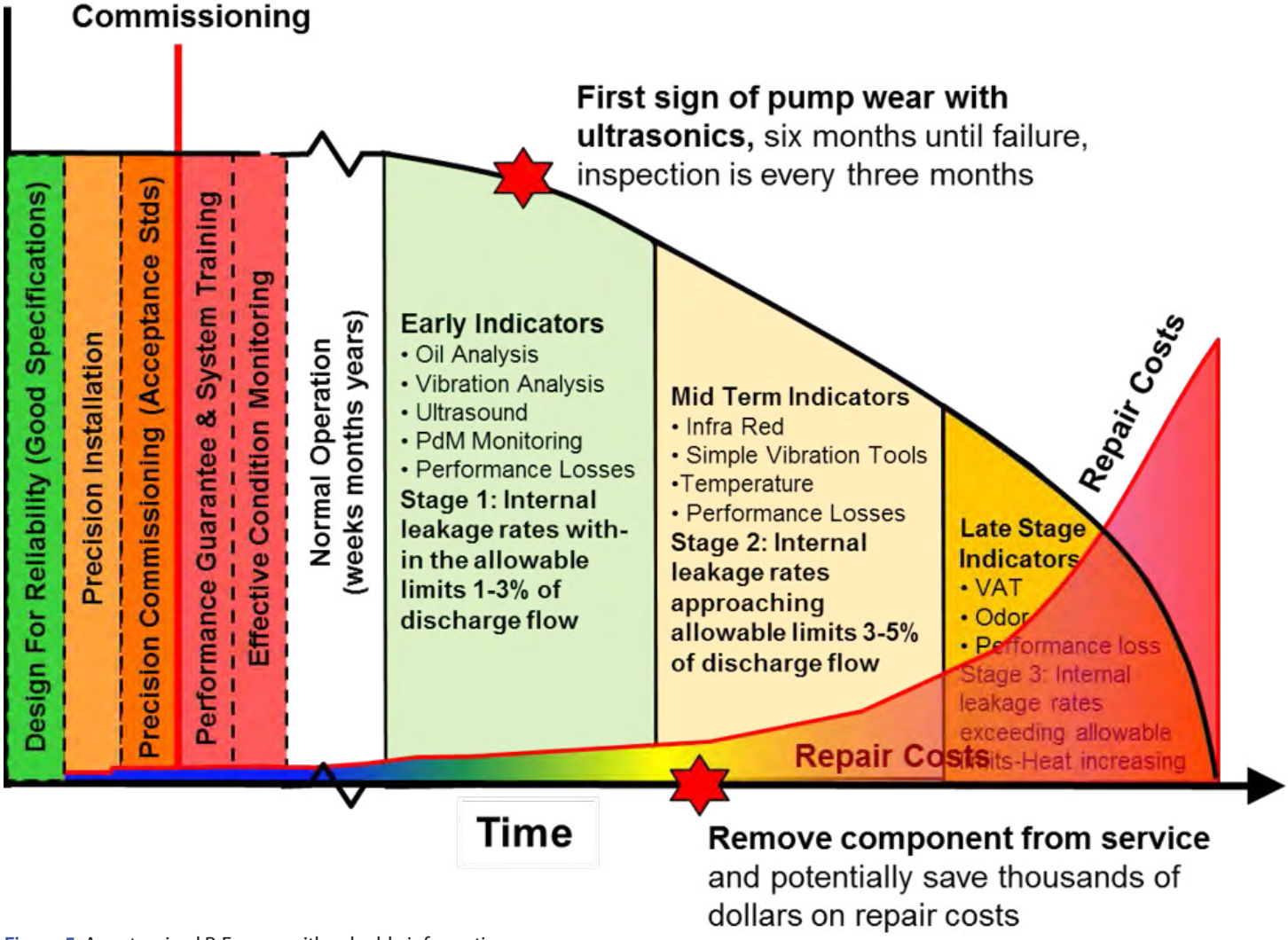


Figure 5: A customized P-F curve with valuable information

to give you a warm and fuzzy feeling, BUT if you design your hydraulic system correctly, seal the unit, properly size and place your filters and keep the hydraulic oil clean, cool and dry, you will not have these problems. These are by-products of an improperly designed, improperly installed, improperly operated, or improperly maintained hydraulic equipment down to the component level.

High-Risk Failure Modes

You want to make sure to identify and address your high-risk failure modes. Small abrasions in the fluid conductor cause skin penetration, burn injuries and eye loss. Allowing the oil to atomize and become explosive can cause equipment damage and even loss of life. A relief valve that is set incorrectly and forced open would allow the oil to reach extreme temperatures, causing a 200°F to 280°F fire, resulting, again, in equipment damage and/or loss of life.

Inspection Frequency

Many people have no idea that they DO NOT need to inspect their equipment on a weekly basis. Inspection frequency has nothing to do with age, time in service or expected life. The inspection frequency should be set by how much time there is between when the equipment can be first identi-

Figure 6: Hydraulic unit inspection items (Courtesy of: Jonathan Carman, Motion Industries Engineering Group)

fied as potentially failing until it functionally fails. This could change based on the technology being used and the rate of change in the reading.

For example, the inspection frequency of the hydraulic pump should be at least one half the time between the ability to first detect the potential failure (P) and the functional failure (F).

Remember, the technology drives the frequency. If the time between P-F is six months, then the inspection frequency would be every three months. The key is to stay on top of the new detection technologies. This will allow you to determine when to remove the component from service, potentially saving your facility thousands of dollars in repair costs and thus increasing profitability.

Figure 5 (see page 45) is a customized P-F curve that shows that several things have to happen prior to commissioning a hydraulic system. It also shows early, midterm and late term indicators and when to remove a failing component from service.

Okay, so here is the REAL spoiler. The following list identifies EVERY detection device you would ever need to detect and eliminate problems on ANY hydraulic system.

- Flow meters
- Gauges, pressure, vacuum and bypass
- Amp meter
- Heavy-duty breather to stop particle ingression (minimum) or you could use a bladder and totally seal the unit and recycle the air in the head space (preferred)
- In-line particle counter
- Test points for oil sampling and bleeding trapped air
- Temperature and level indicator

Put them in the proper place, as shown in Figure 6 (see page 45), and go work on your mechanical and electrical problems.

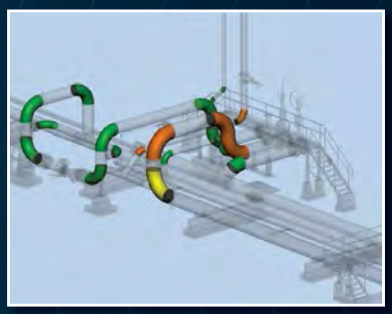
Conclusion

Conducting a FMEA on a hydraulic system doesn't have to be complicated. All of the problems will always point back to three things: flow, direction of flow and operating pressure. This information allows you to eliminate the majority of problems your facility is experiencing at the failure mode level, even including the lower levels or the due to ones.

Paul Craven, *CFPHS, manages one of Motion Industries' Repair Shops. He is certified by the International Fluid Power Society as a fluid power hydraulic specialist and has worked in the field for over 25 years. Visit the company's newest Knowledge Site, Mi Fluid Power Specialist, https://www.motionindustries.com/knowledgelinks/fluidpower/index.jsp. www.MotionIndustries.com*

Your Roadmap to Operational Readiness and Superior Asset Performance

Assess risk based on failure severity, likelihood scores and confidence assessment.



Visually navigate assets.

Achieve business goals with a risk-based approach to asset management. Bentley will help get you there.

Leveraging 30 years in design and visualization innovations, Bentley combines best practice engineering with performance based asset management. Bring your 2D/3D plant models and point clouds together with operational information to get the most out of your assets, Bentley's enterprise platform is designed for the entire asset lifecycle, bringing together engineering and operations for better performing assets.

Our visually oriented solution supports both greenfield and brownfield operations; bridging the gap between CAPEX and OPEX and enabling a sustainable business strategy for operational excellence and safety.

AssetWise
CONNECT Edition

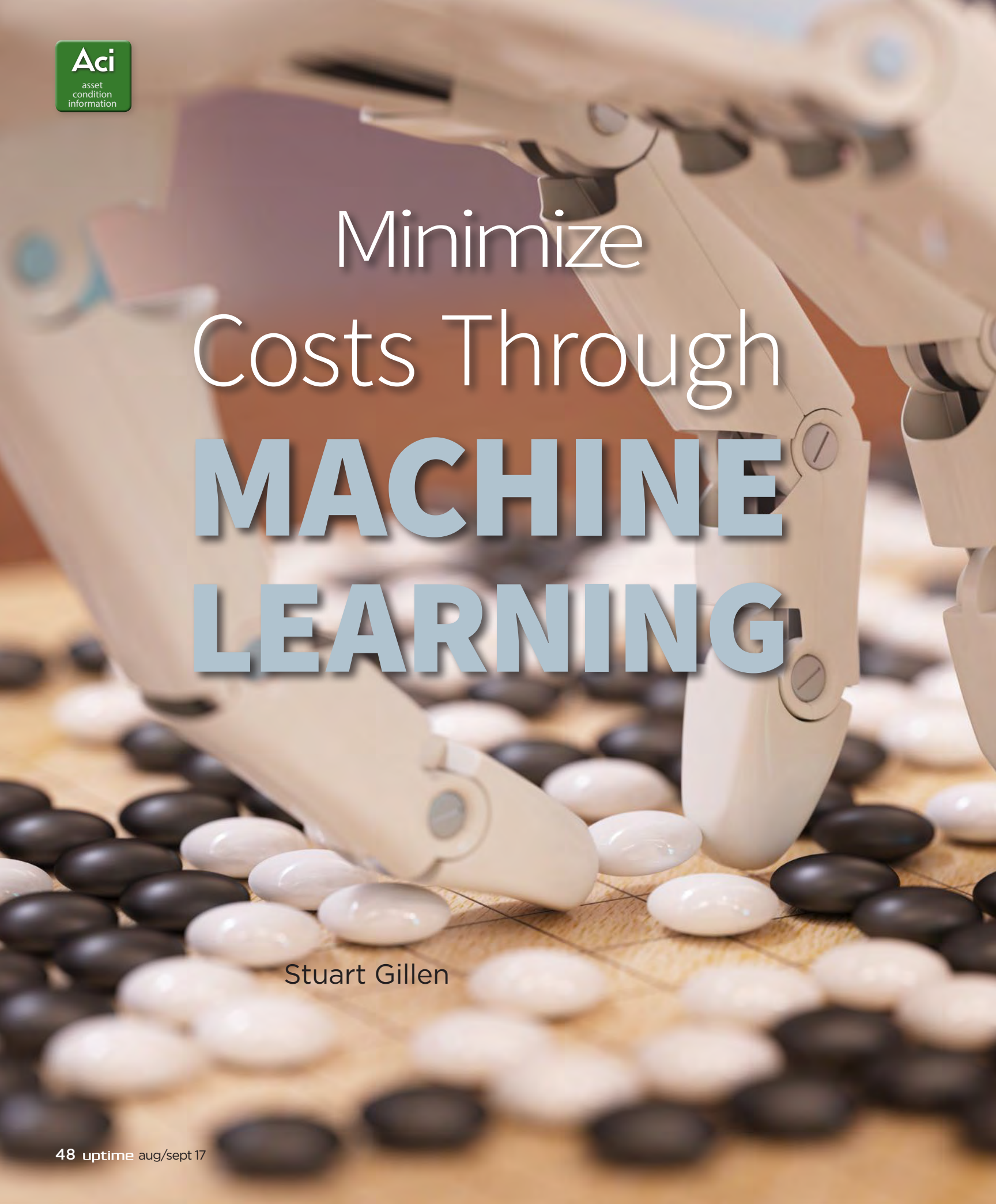
An Enterprise Platform for Asset Integrity, Reliability, and Performance:

- Asset strategy development
- Asset lifecycle information management
- Integrity and corrosion management
- Risk-based inspections
- Reliability-centered maintenance
- System reliability and process safety
- Operational analytics
- Asset health indices and dashboards
- Risk assessment and work prioritization
- ISO 55000 implementation

Learn more at www.bentley.com/assetwise

Or call 1-800-bentley

Bentley®
Advancing Infrastructure



Minimize Costs Through MACHINE LEARNING

Stuart Gillen

Machine learning is an approach of exploring and building algorithms that enable computers to continuously learn and adapt.

With utilities, unknown failures and the maintenance that goes into fixing them can add up at lightning speeds. A recent study conducted by GlobalData Power estimates that expenditures for wind turbine maintenance have been projected to rise from $9.25 billion to $17 billion by 2020.[1]

The issues stretch past the deafening cost of maintenance, too. As of 2011, roughly $40 billion worth of wind equipment in the United States was out of warranty, placing the financial responsibility on the owner of the wind farms to provide a more cost-effective operation.

It seems inevitable that costs will continue to rise and wind farms will struggle to remain as functional assets to utilities. The problems within the industry will persist and the burden will continually be placed on the owners to replace and repair turbines on their farms. Additionally, unscheduled downtime caused by unwarranted failures adds to the losses and expenditures of these companies and the industry as a whole.

The inevitable failure of wind turbines and other assets on fleets raises the question: What if there was a way to predict these failures prior to their occurrence? Actually there is. Utility operators have begun outsourcing their problematic areas to machine learning.

Machine learning is an approach of exploring and building algorithms that enable computers to continuously learn and adapt. Machine learning and deep learning techniques, a subset of machine learning, are used to understand the reasoning behind algorithms and aid in learning complex patterns. Recently, Google's DeepMind Lab team utilized deep learning mechanisms to beat a grand master in the ancient Chinese board game, Go. Go is a game where there are more potential moves than there are atoms within the universe. Because of this, new techniques in artificial intelligence are necessary to solve these types of problems. An approach that is more focused on reasoning and inference becomes essential in solving complex problems before they even exist. It is encouraging to know that a problem set with so many complexities can be solved. It means providing information like predictions of downtime eventually will become straightforward and second nature.

For utilities, utilizing machine learning means various things and can lead to a positive response across the board. It's one thing to have data across a variety of platforms and another to codify the data, thus allowing for greater knowledge retention. There is a complex relationship between sets of data, so complex that the average analysis techniques seldom can notice a difference. With the codification of these data sets and utilization of machine learning techniques, visibility can grow, thus decreasing the need for humans to manually analyze each set for comparisons.

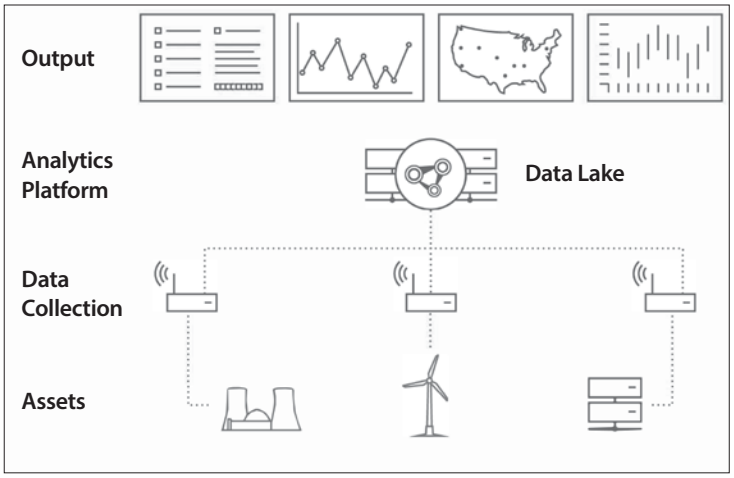


Figure 1: Organization of data for machine learning systems

With large quantities of data, systematic organization becomes key. There are four main sectors to understanding and organizing data within the utilities field: assets, data collection systems, analytic platforms and the output.

> Machine learning encourages learning from the past and adapts to the future to better strengthen and protect valued infrastructures.

Data lakes are starting to become popular and are a concept where all the necessary information from data silos are gathered into one place. From a business perspective, this consolidation makes it more efficient to access all information, thus making it easier to provide and manage evidence and insights. This enables better results in a company employing predictive and reliability-centered maintenance programs.

Unlocking this information allows a utility to employ a more holistic solution across all of its business segments. The energy chain (i.e., generation, transmission and distribution, energy trading and risk management, and cybersecurity) now can be treated as one system where data is shared and analyzed, producing targeted, efficient results to utilities and consumers. Let's further break down how artificial intelligence and machine learning technologies are providing actionable insights at each stage in the energy chain.

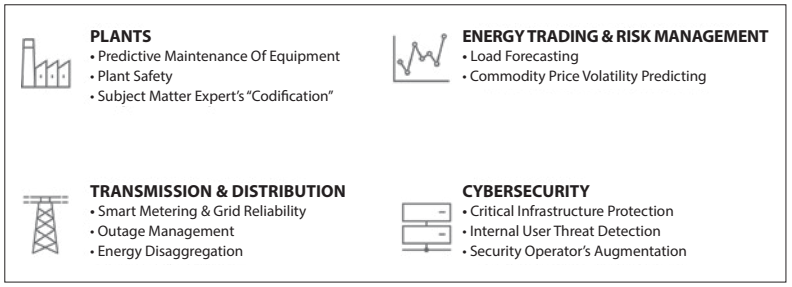


Figure 2: How machine learning can benefit different sectors within utilities

Smart meters are electronic devices that record the consumption of electric energy in one-hour intervals or less. Utilities collect terabytes of data per day, creating an ideal solution for fully utilizing machine learning within the field.

Energy disaggregation is where patterns of usage per appliance are gathered by deconstructing information from a single home sensor. This application requires the utilization of machine learning because thousands of energy "signatures" must be analyzed to find patterns of usage. The savings are immense, as homeowners can discover how much every appliance contributes to their energy bill. On the operations side, analysis of energy signatures predicts suspicious consumption values due to physically or digitally manipulated devices, sophisticated thefts, meter malfunctions and more.

Most forecasting solutions were not designed to manage the variability, complexity and volume of data that's emerging in utilities in today's world. Machine learning enables utilities to pick up on subtle patterns within data sets, enabling them to make unified and more accurate predictions across the board. This is a vital asset to the industry and consumers alike because if you can more accurately track the forecasting of energy, then pricing of power can universally improve.

Another facet to pay mind to is cybersecurity. A recent poll conducted by SAS cited cybersecurity as the number one benefit from machine learning— and with good reason. A main threat to the industry is the number of viruses that are created on a daily basis, which averages out at roughly 28,000. This creates the need to dynamically adapt to and learn from the ever-changing frontier of data and viruses alike. Machine learning encourages learning from the past and adapts to the future to better strengthen and protect valued infrastructures.

A specific example where machine learning has added value in the energy cycle is in the case of Invenergy, an energy company that owns and operates numerous wind turbine units in both the United States and Europe. The goal is simple: to provide advanced notice of gearbox failures on their wind turbines. Gearboxes are one of the most brittle components in a wind turbine and their failure accounts for roughly 85 percent of all wind turbine insurance claims.

These breakdowns easily could be reduced if there was a system in place, geared by machine learning, that notifies operators of failure prior to breakdown. Invenergy employs machine learning technologies at its facilities and is now able to get an advanced degradation warning 67 days in advance, as well as an indication (called a risk index) of impending catastrophic failures in the gearboxes 35 days in advance. This allows Invenergy to act with better knowledge and understanding of its fleet.

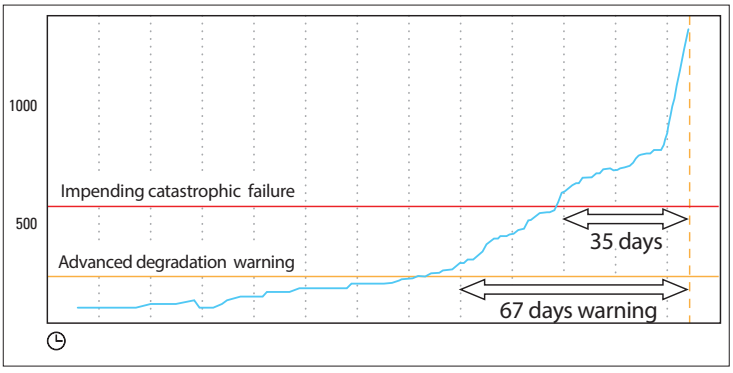


Figure 3: Results of Invenergy pilot

Whether you're applying machine learning to better understand the operation of your assets or gain insight into your own consumption, there's no denying its effectiveness within the industry. The ability to predict a failure before it happens is no longer a far-off wish. It's happening now, thus enabling sustainability while keeping costs low.

Reference

1. *"Wind turbine maintenance costs to almost double by 2020,"* Edie newsroom, Edie.net, 2015; https://www.edie.net/news/6/Win-turbine-maintenance-costs-to-nearly-doubl/

Stuart Gillen *is the Director of Business Development at SparkCognition. Stuart is responsible for driving business engagements, partner development, marketing activities, and go-to market strategy. His areas of specialty include IoT architectures, platforms, and technologies.*
www.sparkcognition.com

FACT #42

YOUR MACHINES DON'T JUST DIE... *THEY'RE MURDERED.*

Improvised or untrained lubrication practices are prematurely ending the life of machinery, costing companies millions of dollars each year. The culprits, which include lack of lubrication, overgreasing, selecting the wrong lubricant or uncontrolled contamination, are carried out by professionals at your plant. Thankfully, these needless machine deaths are preventable with a basic understanding of proper lubrication. Make sure your team is not contributing to early machine death. Get the training you need today.

PUBLIC TRAININGS

Machinery Lubrication I
Milwaukee, WI - Aug.15-17

Machinery Lubrication I
Richmond, VA - Sept. 25-27

To learn more visit **Noria.com/train** or call **800-597-5460.**

NORIA

Mro
mro-spares management

> “...the magic lies in identifying which MRO improvements to make and in which order to pursue them.”

Proactive organizations recognize that one of the critical success factors in achieving a best practices reliability program is developing a sound maintenance, repair and operations (MRO) spare parts program. That notion is quickly followed by the realization that there are potentially hundreds of improvement opportunities that typically could be associated with a materials management effort. As such, it becomes overwhelming to determine where to start.

Doug Hart

THE TOP 10

This article addresses the **practical** and **methodical** process of identifying and pursuing the Top 10 areas to focus your materials management improvement efforts. It shares insights into executing a successful MRO overhaul at your facility by pursuing the following key items:

1 **ASSESSMENT**: Assessing the current spare parts program and determining the improvement areas on which to focus is the first order of business. Although a typical maintenance storeroom can benefit by a number of different improvements, the magic lies in identifying which MRO improvements to make and in which order to pursue them.

2 **METRICS**: In order to measure the effectiveness of your MRO materials management program, it is imperative that key performance indicators (KPIs) are in place. By identifying and utilizing both leading and lagging indicators, you will be equipped to objectively and accurately measure the current level of program effectiveness and ensure that deficient areas are trending in a positive direction.

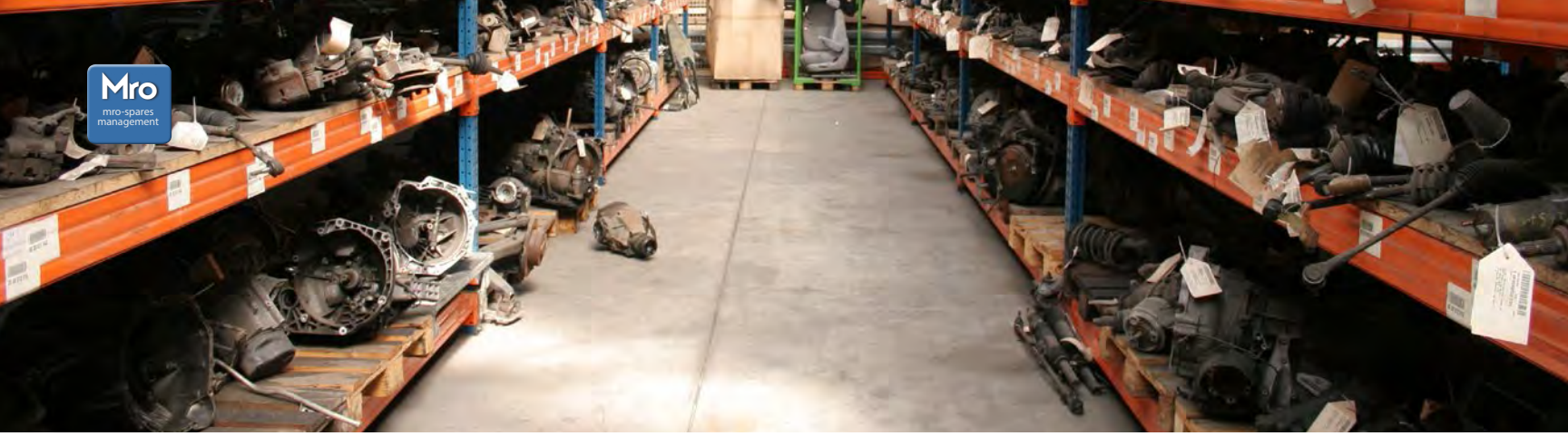
When establishing the method and distribution list for communicating storeroom metrics, be sure to share the information in a timely and visible manner. Above all else, ensure that something is done with the insights from this information. Nothing kills the credibility of an information gathering initiative faster than not reviewing, analyzing, or doing anything with the information. Lastly, be sure to celebrate success along the journey. Recognizing individual and team accomplishments can go a long way in fueling positive morale, especially in the midst of a long and arduous improvement effort.

3 **STANDARD OPERATING PROCEDURES**: It is important to identify the standard operating procedures (SOPs) by which the materials management program will be carried out. Pace setting organizations develop visual process flow maps that illustrate the steps in the various MRO processes, as well as the associated narrative documentation in which to train and provide support.

Items to address include:

- Position Descriptions, Functional Roles and Responsibilities;
- Processes, such as:
  - Add to stock request and approval;

IMPROVEMENTS TO PURSUE IN YOUR MRO SPARE PARTS PROGRAM



- Non-stock parts request, approval and purchasing;
- Receiving, stocking and notifications;
- Stock request;
- Issuing and withdrawal;
- Stockout notification;
- Returns and reservations;
- Bill of materials (BOMs);
- Inventory level establishment and adjustment;
- Standardization and change control;
- Cycle counting and inventory variances;
- Obsolescence identification and disposal.

It is important to communicate and train all pertinent personnel on the MRO processes and procedures. This includes both departmental staff and "customers" of the storeroom.

As with many improvement initiatives, a critical success factor is ensuring that it is dynamic. Be sure to periodically review and update required process and procedural improvements. This step aids in meeting the current needs of the organization and avoids the pitfall of following old, out-of-date SOPs, which is frustrating for all involved.

4 **DATA**: In the scramble to load parts data prior to the go live deadline for the computerized maintenance management system (CMMS), many organizations admit that the quality and accuracy of their parts data is quite inferior to what it should be. Although there are many attributes to what constitutes good spare parts data, this short list captures the primary items:

- Utilizing a standardized taxonomy of naming and numbering conventions;
- Ensuring all pertinent stock and non-stock parts are identified and loaded in the system;
- Identifying any duplications that need to be removed from the system;
- Capturing key attribute data, such as manufacturer, model number, supplier, price, lead time, where used, etc.

5 **INVENTORY MANAGEMENT**: One of the key elements in the MRO storeroom contributing to plant reliability is having the right part available at the right time. The science of continuously reviewing and adjusting min/max levels and reorder points is a key discipline and one that many organizations struggle with. The practice of frequently reviewing inventory turns and modeling the optimal inventory levels requires time and commitment to the process.

Whether you utilize your CMMS or a third-party tool to analyze usage and optimize inventory levels, be sure to factor in item lead time and criticality and impact to the process and organization. This should be an ongoing effort. Lastly, resist the temptation of removing the item from inventory just because of inactivity. Remember, as your maintenance effort improves, equipment reliability increases, therefore, the frequency of failure and need to replace critical spares decreases.

6 **BILLS OF MATERIALS**: Capturing bills of materials (BOMs) is a labor-intensive and somewhat tedious task that many companies procrastinate performing. The value in pursuing BOMs identification for your critical equipment is the assurance your storeroom is carrying only the materials you need to support a highly reliable operation. It is common for some parts to be used in multiple locations, so it becomes necessary to identify where each part is used so adequate inventory levels can be realized.

Often, two types of BOMs exist. The first is the original equipment manufacturer (OEM) BOM, which is a more exhaustive list of all the parts associated with the component. The second is an MRO BOM, sometimes referred to as a planner BOM. This is a shorter, more practical list of wear items or known to fail items. This is the recommended BOM to pursue.

It is important to identify a BOM process that includes:

- Equipment Number;
- Inventory Item Number;
- Inventory Item Description;
- Quantity Required;
- Manufacturer, Vendor, Supplier;
- Manufacturer, Supplier Part Number;
- Material Class and Subclass;
- Item Lead Time.

7 **STOREROOM MANAGEMENT**: This is the ABC's of materials management and although it includes many activities that are not as thrilling to pursue, they are the deal breakers of your materials management program. Some of these blocking and tackling items include:

- Storeroom Design, Organization and Layout;
- Lighting, Signage and Labeling;
- Shelving, Cabinetry and Dispensing Machines;
- Free Issue Areas;
- Bin Replenishment Programs;
- Developing Roles and Responsibilities;
- Screening, Interviewing, Hiring, Training, Coaching, Reviewing, Rewarding and Disciplining Storeroom Personnel.

8 **KITTING**: A real value-added function that the storeroom can provide is performing parts kitting for planned maintenance activities. By working with the maintenance planners, the required spare parts

> Nothing kills the credibility of an information gathering initiative faster than not reviewing, analyzing, or doing anything with the information.

can be identified, reserved or ordered, pulled or received and staged. This productivity enhancement saves maintenance personnel time in obtaining the parts they need while ensuring parts are on-site and available when required.

A few nuances in establishing a maintenance spare parts kitting program include:

- Determining roles, for example, who is performing which tasks between stores and maintenance planning personnel;
- Utilizing the reservations feature within the materials management module of your CMMS;
- Identifying the optimal location(s) to stage the kitted parts;
- Developing a return process for unused items;
- Documenting the process and creating associated SOPs narratives;
- Communicating and training on the process.

9 **OBSOLESCENCE**: By developing and executing an active practice of identifying parts within your inventory that support plant equipment that is no longer in operation, you will free up valuable shelf space and untold dollars of your MRO inventory. Another benefit provided by an obsolescence effort is that your cycle count team only will be reviewing items that should be in inventory and not wasting time counting items that shouldn't even be in stores.

Be sure to form a team of internal subject matter experts (SMEs) who are qualified to condemn the potential obsolete parts under review. Having a process that analytically and practically identifies and then confirms or denies whether items are actually obsolete is an important step. Without this step, it is common to witness companies dispose of a part just to have them scrambling to locate it a few months later!

It is important to recognize that you have several options when it comes to discarding condemned inventory. Far too often, the first inclination is to simply throw items in the dumpster. In reality, there are some financial and strategic benefits to pursuing other options first. Some of them include:

- TRANSFER the items to an on-site area that can use them;
- RETURN the items to the supplier or OEMs for cash;
- EXCHANGE the items with the supplier or OEMs for active items you purchase from them;
- RETURN them to the supplier or OEMs for credit on future purchases from them;
- TRANSFER to a sister company that can use the items;
- CONSIGN TO SELL by enlisting the supplier, OEM, or third-party to resell on your behalf;
- DIRECT SELL via eBay, Craigslist, or an auction site;
- DONATE to a charity, school, church, etc.;
- SCRAP by contacting a scrap yard to remove and pay for them;
- DISPOSE of them; Now, it's dumpster time, but don't forget to write them off!

10 **REASSESSMENT**: Last, but certainly not least, incorporate a step to review your MRO program and identify any deficiencies remaining in your materials management effort that need to be addressed. At this point, it is likely that considerable effort has been dedicated to improving some of these key MRO areas. But, effort alone does not ensure proficiency; therefore, it is a good practice to periodically reassess your program to measure how effective it is performing. It may be advisable to include external resources during this review to provide an objective evaluation.

***Doug Hart**, CRL, CMRP, is an 18-year industry veteran with extensive experience identifying problems and implementing maintenance and reliability consulting improvements. Doug shares practical and valuable insights gained as a materials manager for private industry and an MRO consultant with organizations genuinely committed to implementing maintenance reliability best practices. www.emerson.com*

Opx operational excellence

Back to Basics for True Operational Excellence

Amin Elsherif

Many companies are beginning to search for and implement sophisticated maintenance and reliability (M&R) tools and technologies in hopes of finding the next best thing to help achieve operational excellence (OE). Terms, such as asset performance management (APM), predictive analytics, machine learning, Industrial Internet of Things (IIoT), the Cloud, connected plant, etc., are making their way into everything M&R. As game changing as these concepts *can* be, adopting advanced technologies without first addressing the basic fundamentals of M&R is like building the world's finest home on a crumbling foundation.

Organizations are not often successful in achieving desired results from technology implementations because they tend to skip over the M&R fundamentals in their haste to chase the OE prize. It is important to understand that technology alone will not provide the solution. Rather, the solution lies within the implementation of the fundamentals of M&R management, which has a direct and significant impact on OE.

Companies are often keen to follow standards, such as ISO55000 for asset management. However, it's important to know that these standards merely set guidelines for a management **system**, not the specifics of how the compliance is actually executed. From the start, companies striving to achieve OE need to ensure that M&R fundamentals are solidly in place, as these fundamentals are essential in helping businesses achieve their objectives, while providing a sound platform on which to improve through innovation and automation.

M&R Fundamentals

Time and again you hear of the use of shortcuts and bypasses leading to catastrophic failures — failures that could have been prevented if these shortcuts were not used. In most cases, the root causes include a lack of fundamental practices necessary to assure reliability of processes, safety of personnel and protection of the environment.

Building M&R fundamentals starts by making sure organizations have developed and established their M&R standards, as well as their guiding principles, procedures and work practices. Equally important is designing and implementing meaningful key performance indicators (KPIs) based on monitoring the health of not only OE objectives, and more importantly, the effective implementation of the OE program itself.

One of the fundamentals of M&R is a continuous improvement work management process, represented as a continuous clockwise cycle in Figure 1.

Figure 1: The fundamentals of M&R management – continuous improvement work management cycle

1. **Work Identification:** The cycle begins with maintenance work identification. Whether preventive, predictive, or corrective, each is prioritized based on risk. All proactive work is identified through a risk-based work selection process.
2. **Planning:** Once work is identified, the maintenance planning process begins to ensure correct actions are put into place to safely, efficiently and effectively complete the work.
3. **Scheduling:** The maintenance scheduling process is then set up to enable the most efficient application of properly trained and qualified resources, and the availability of the right parts and materials to support the work.
4. **Work Execution:** The success of the work execution step depends heavily on work package quality and the appropriate utilization of standards, procedures and proper skills. One measure of the desired outcome is zero rework.
5. **Analysis and Continuous Improvement:** The continuous improvement of the M&R process depends on the ability to analyze and measure performance metrics and KPIs, identify gaps and opportunities, and initiate actions to drive improvement through this continuous cycle.

Building on Fundamentals to Achieve Operational Excellence

It is important to understand that achieving OE depends on the appropriate consideration of people, process and technology, as illustrated in Figure 2.

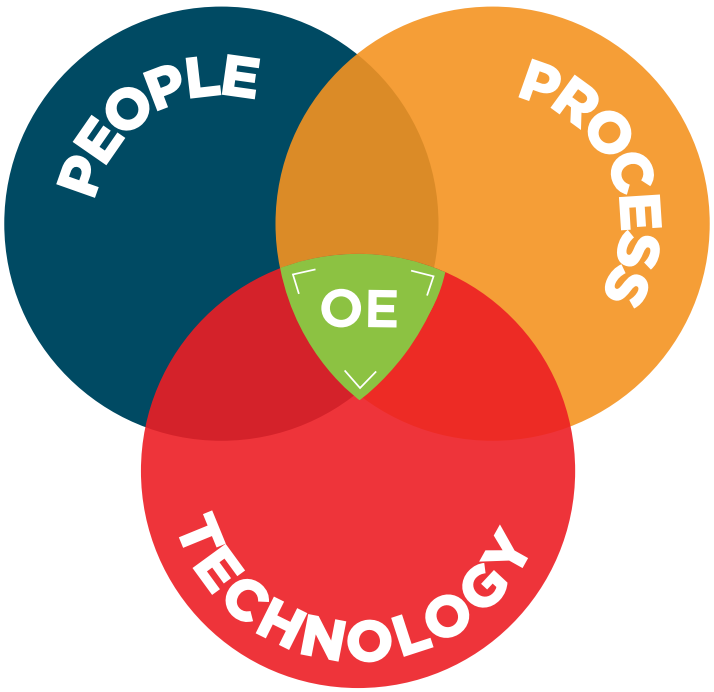


Figure 2: Operational excellence classification model

The operational excellence classification model is a commonly used management method designed to identify, implement, monitor and assess controls to manage risk. OE requires that the correct *people* are in place to assure the right *processes* are employed, fully supported by the right *technology*, including tools to both administer the process and support lifecycle decision-making.

Experts estimate that as much as one out of every three maintenance dollars is wasted, which puts more focus on maintenance management because, in some cases, maintenance is seen as the single most controllable cost. The maturity of M&R practices has increased the demand for higher availability; lower maintenance costs; higher quality of work; and better safety and environmental compliance. To improve effectiveness and overall cost performance, many equipment strategies have shifted to a more predictive or condition-based approach, rather than a fixed, interval approach. Knowing when a potential failure is likely to occur allows organizations to realize the maximum lifetime from equipment without the negative effects of full functional failure, particularly production loss. However, as more and more strategies shift toward a condition-based approach, the ability to manage such a program is even more challenging, especially if M&R fundamentals are not strong.

Vision, Framework and Road Map

As mentioned earlier, it is important to have an M&R vision and incorporate it into the overall corporate business objective. An example of an M&R vision is:

"We commit to the rigorous application of M&R best practices, resulting in world-class levels of safety, asset availability and cost performance."

This vision can be achieved by determining the current gaps in best practices, as well as the necessary changes required in the key categories of people, process and technology.

1. **People** – Focuses on areas, such as roles and responsibilities; value-based decision-making; competent and accountable resources; front line ownership of equipment and process; and fostering a culture of reliability.
2. **Process** – Concentrates on aligning with clearly defined business objectives, which focus on topics, such as asset lifecycle management; integrated organizational processes and workflows; best practices to be embedded into standardized processes; aligned KPIs and metrics; internal and external benchmarking; risk-based equipment strategies; risk-based spare parts strategies; strategy-based budgeting; and strategic alliances with key suppliers.
3. **Technology** – Focuses on the ease of access to integrated data; systems configuration and functionality aligned with processes; ability to input and capture source data simplified by technology; integrated and linked documentation to equipment; managed KPIs through automated dashboards; effective control of lifecycle asset information; and fully leveraging next generation technology to support OE management by exception.

Best performers continually search for competitive advantage and effective management of M&R fundamentals that represent a significant opportunity. As organizations are challenged to improve work efficiency, many initiatives have taken small steps toward achieving competitive advantage. However, an examination of practices by best performers shows that to achieve world-class performance, a fundamental shift in the mind-set of workers and the nature of work is needed. A holistic and evergreen approach to asset management processes provides the capability to change the nature of work and drive a reliability-centered culture. This is the true underpinning of operations excellence (OE). However, the reality is that OE is a journey, not a destination.

Amin Elsherif *is Principal Engineer, Reliability at PinnacleART. Amin is a Maintenance Management Professional (MMP) and holds over 25 years of progressive experience in the oil and gas industry. He serves on the national Plant Engineering and Maintenance Association of Canada (PEMAC) board of directors and is a past President of the PEMAC Fort McMurray chapter.*
www.pinnacleart.com

Joel Levitt

The Myth of WORLD-CLASS MAINTENANCE

We're all guilty of using the term "world-class" when referring to a maintenance department or program. Clearly, world-class is important because there are books (2,951 on Amazon, but not all are about maintenance world-class), papers at conferences and consultants doing extensive assessments all based on world-class maintenance.

So, where does world-class come from and who gets to say what it is? The first question is easy to answer. Calling one's self "world-class" makes one feel better about one's activities. But the criteria is defined by each person who uses the term. Some leading practitioners and major consulting firms have informally agreed that what they see as being needed in maintenance is world-class. Others not in their camp are somewhat at their mercy.

There are several misconceptions about world-class maintenance:

MISCONCEPTION #1: There is a world-class standard. Actually, there isn't.

MISCONCEPTION #2: Everyone should aspire to the world-class standard (if there was one in the first place). Realistically, they shouldn't, since being inappropriately world-class might cause bankruptcy!

MISCONCEPTION #3: ISO55000 defines world-class maintenance. Sorry, ISO55000 is not concerned with world-class maintenance at all.

One thing is abundantly clear. What is considered a world-class maintenance program in one industry might be just a run-of-the-mill program in another and even suicidal in a third. Compare, for example, two industries, such as lumber processing and pharmaceutical manufacturing.

LUMBER: The cost of just the log before it is processed is over 80 percent of the COGS (cost of goods sold, including all costs plus factory overheads and maintenance), so 20 percent is left for everything else, including maintenance, overhead, etc. In the lumber processing industry, you process a lot of trees to get a bit of gross profit. While maintenance is important (not the least reason is to avoid fires), the raw costs are essential to manage. Over maintenance is as great a sin as under maintenance. The sweet spot is hard to hit since it moves daily with the lumber market.

PHARMACEUTICAL: The total of all manufacturing costs is 27 percent of the COGS. Here, the actual maintenance cost is less important to the success of the company. The heavy hitters are keeping within validation (i.e., FDA oversight) and avoiding even a hint of product contamination so as not to ruin a batch of product, which might be worth $500,000 or more. The sweet spot is to do everything they can think of to make the system as reliable as possible.

Now, back to world-class. What if you designate what is required to be world-class for a pharmaceutical manufacturer and apply it to a lumber processor? What would happen to the viability of the lumber processor if you put in place pharmaceutical maintenance standards? It literally would be suicidal!

Can you apply the endlessly debated maintenance standards for an automotive assembler and compare it to the needs of a theme park? No, and it seems silly to compare maintenance efforts between industries. While there is often a great deal to learn from maintenance operations outside your industry, comparing a nuclear power plant to a chicken processor and calling one world-class is not the way to learn.

Access to World-Class Requires Thought

There is access to world-class, but it takes some thought. Every organization has a reason for being. In the Uptime® Elements™, this is called the AIM or the published mission, vision and values of the organization. It is that organization's reason for being.

World-class should be a measure of how well the existing organization's structures, policies and procedures deliver value to the AIM for the long term. You might look at the long-term numbers for how a company is doing with its assets within an industry:

Gross profit for Nucor	**15.79%**
Gross profit for X (U.S. Steel)	**1.27%**

And then make a conclusion about whose practices are, indeed, world-class. In order to simplify things, it should be noted that gross profit is being used as a proxy for world-class. If viewed over the long term within an industry, this is a fair assumption. In some industries, such as refining, power generation and transit, there already is a great structure for this type of comparison. In other industries, company secrets might (properly) block this kind of comparison.

Conclusions

- Don't get too upset about your maintenance effort when compared to some world-class standard.
- Don't worry if you do not have all the software or technology bells and whistles that are introduced.
- Worry every day whether you are providing value toward your AIM safely and for the lowest long-term cost.
- Be alert for ways you can increase the value provided from your assets or reduce the risks in your business.
- Become the world's expert in providing more value with lower risk for your particular asset base.

Joel Levitt, *CRL, CPMM, is the Director of Reliability Projects for Reliabilityweb.com. Mr. Levitt has 30 years of experience in many facets of maintenance, including process control design, source equipment inspector, electrician, field service technician, maritime operations and property management. He is a leading trainer of maintenance professionals and has trained more than 17,000 maintenance leaders from 3,000 organizations in 25 countries in over 500 sessions. www.reliabilityweb.com*

Cmms
computerized maintenance management system

A+ Q

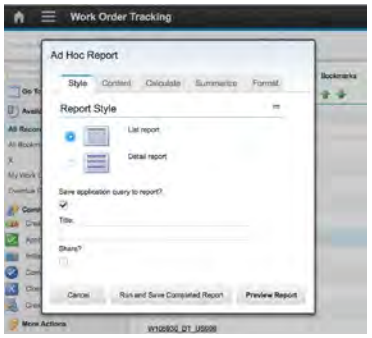
Uptime® Magazine recently had the opportunity to sit down with featured MaximoWorld presenter, Pam Denny. Pam is a Senior Analytics Architect for the IBM Maximo® Business Intelligence Portfolio. This suite of BI tools includes Analytics, KPIs, Ad Hoc and Enterprise Reporting using BIRT, Cognos® and Watson Analytics™. Ms. Denny works with clients and business partners regularly to identify future product needs, while also increasing their understanding of Maximos BI's existing features.

WIRAM Women in Reliability and Asset Management

The Association of Asset Management Professionals hosts the Women in Reliability and Asset Management special interest group with the objective to increase diversity, with a special focus on women in reliability leadership and asset management. Each issue of Uptime will feature a piece from a WIRAM Leader. Look for the WIRAM logo. To get involved and learn more, please visit: www.maintenance.org.

> "...#1 issue with using the analytics tools: If the data is not consistent and complete, it just doesn't work.

Cognos



AdHoc Reporting

Watson Analytics

What tools are most likely used in Maximo® for data gathering and analysis?

Maximo clients use a variety of analytic tools. Each client is unique due to varying industries, business requirements and the individual skill sets and requirements of their users.

The analytic tools that Maximo clients use include those provided by Maximo, our business partners, or from the clients themselves.

We have found that Maximo clients typically do not use a single analytic tool. Instead, they rely on a variety of analytic tools for their varying use cases and users.

The more popular analytic tools include:

1. **Application Analysis Tools**
   These include result sets, application exporting and KPIs. These tools are accessed by users multiple times a day to provide a listing of records and statuses.
2. **BIRT Reporting**
   BIRT provides embedded functionality for day-to-day operational reports. It targets Maximo users who require a very guided user experience, including the ability to click on an icon and have a report and its attachments print.
3. **Cognos® Reporting**
   Cognos® reporting enables a more interactive data analysis experience targeting weekly or monthly reports and data drill down analysis.
4. **Watson Analytics™**
   Watson Analytics™ enables users a unique analytic experience in providing data quality scores, natural language processing and predictive analytics.

With increasing industry emphasis on big data and analytics, we see an even greater emphasis on analytic tools and their ability to immediately supply information to Maximo users. This information enables our Maximo clients to realize the full power and benefits of utilizing Maximo in their organization.

How do you see the QBR tool used and how effective is it?

QBR or query based reporting is an excellent ad hoc reporting tool! Instead of waiting days, weeks, or months for the IT department to create reports, Maximo users can quickly create their own reports for their unique business or project needs. And they can do this without the traditional, deep report development skills like Java or JavaScript.

Maximo users can create a QBR report by going to any one of the Maximo applications. From there, they access the QBR report writing wizard. It guides users through selecting the application query to their report and then defining key characteristics, like data sorting and grouping. In Maximo 76, users also can add calculations and summary functions to their report.

Once users complete the wizard in defining their QBR report, they can run it a single time, save it to run in the future, or share with others.

QBR quickly empowers Maximo users to immediately create content for their ever-changing business and project needs!

There are a lot of reporting tools available today, in particular the Cognos and Watson Analytics tools used frequently by Maximo. These seem to be a powerful combination, yet some folks are a little nervous about going to these. What do you think holds them back?

Watson Analytics is a cloud-based service and some clients are concerned about security and control of their systems in the Cloud. However, Watson Analytics has been certified to SOC2 and ISO27001 standards, so we hope to see more clients moving to this next higher level of analytics.

What can you tell us about clean data vs. incomplete or corrupted data?

This is the #1 issue with using the analytics tools. If the data is not consistent and complete, it just doesn't work. As an example, when trying to use Watson Analytics with Maximo data, you will find out very quickly if you are getting consistent required data from your users. If there are significant breaks in the consistency of data collection, it is impossible to get meaningful results.

Where does Watson Analytics fit? What are your suggestions to get started?

Watson Analytics extends the Maximo analytic portfolio into new and exciting areas! It is a self-service analytic tool, targeting Maximo business users who want to analyze data.

Watson Analytics provides unique features not available with tools like BIRT or Cognos, including:

- Scoring of data to tangibly measure how ready the Maximo data is for analysis;
- Utilization of natural language querying to explore Maximo data;
- Guided, visual discoveries of your data to uncover items you may not have thought to explore.

Maximo business users can utilize Watson Analytics without the traditional analytic skill sets of data scientists or statisticians. The only requirement is an understanding of the data and a desire to explore it.

And it's so easy to get started with Watson Analytics. Download the free, 30-day trial, then go to Maximo and extract a subset of data into an XLS file. You can do this from any application's list page or from the application's exporting or result sets. Then, upload this data into your Watson Analytics account to begin your data analysis.

WIRAM

Women in Reliability and Asset Management

Connecting Leaders to Evolve Reliability and Asset Management

JOIN WIRAM

- Professional peer group
- Expand your network
- Opportunities for local group leadership
- Learn leadership skills and traits
- Monthly networking webinars
- Face-to-face roundtables at industry events
- Publish thought leadership papers
- Connect with STEM students

JOIN US

@WomenAssetMgmt

http://uptime4.me/wiram02

http://uptime4.me/wiram01

http://www.maintenance.org/pages/wiram

AMP™
Association of Asset Management Professionals

QUESTIONS: **maintenance.org**
888.575.1245 • 239.333.2500

THANKS TO OUR SPONSOR

interloc
100% Maximo®
consulting services. mobile solutions.

Maintenance TIPS

How to Improve Workforce Efficiency

The workforce is a valued resource within any organization. We invest in our workforce to ensure they are fully capable to meet our needs. So, it only makes sense that we would want our workforce to operate as efficiently as possible; wrench time above 65 percent. Understanding the combined workforce availability and our weekly/daily schedule workload is crucial. Availability is not just the resources' hours they work, but should exclude vacations, training, and other exceptions. Our workload should be as accurate as possible; hours on job plans and estimates on work orders. True efficiency comes when we can easily manage and see our workforce availability against our weekly/daily schedules in one visual representation. Check out the AKWIRE Visual Suite for Maximo at www.solufy.com.

SOLUFY • (877) 476-5839 • www.solufy.com

Improve Lubrication Practices to Decrease Maintenance Budget

When someone talks about the cost of lubrication, our minds immediately jump to the oil or grease that is applied to the machine. The focus is on how much is spent on oil or grease and is it really possible to significantly lower the cost of the lubricant? In most cases, the answer to this question is "no", since most companies spend less than 1-2 percent of their maintenance budget on lubricants.

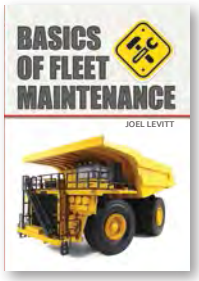
Did you know?

When the process of lubrication is performed suboptimally, those costs can add up to 10-30 percent of a plant's maintenance budget!

Precision lubrication involves a whole lot more than the oil or grease that's applied; it's the process by which we select, store, apply, keep clean, sample, and eventually change out or reapply the lubricant.

Des-Case Corporation • (615) 672-8800 • www.descase.com

Case Study on the Costs of Buffing



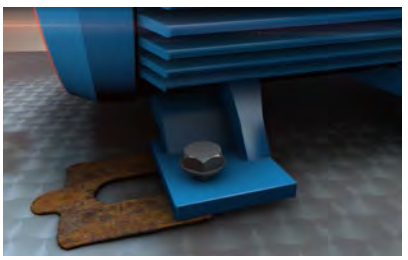
Buffing is the removal of a tire before it is necessary.

Other considerations of buffing usable tread:

- The last few 32nds of an inch of a worn tire actually last longer than the first few 32nds.
- The MPG increases as the tire wears—with less rubber there is less rolling resistance.

Joel Levitt • Basics of Fleet Maintenance
www.reliabilityweb.com/bookstore

Alignment & Soft Foot Checklist



Several points should be checked prior to laser alignment in order to avoid problems later and to achieve good results.

1. Foundation: A solid, rigid foundation is essential for a successful alignment.
2. Machine Mobility: It is advisable to set both machines with about 80 mils of shims underneath the feet in case one machine needs to be lowered. Also, jacking bolts provide a safer and more accurate way to make horizontal moves.
3. Rigid Couplings: Must be loosened to achieve accurate readings.
4. Coupling Play: This can be avoided by turning the shafts a few degrees before starting measurements and then taking readings in the same direction.
5. Bearing Play: Check for excessive bearing play.
6. Soft Foot: Check for soft foot.

Soft foot can severely affect the operating condition of a machine, which will undoubtedly shorten its life expectancy. Here are a few simple tips to help avoid soft foot in your machines:

a. Eliminate rust, dirt and any other contamination from the contact surfaces of the machine feet, shims and frame or foundation.
b. Never insert more than four shims at a time beneath a single machine foot. More than three shims may cause a spring effect.
c. Eliminate external forces on the machine, such as those from connected piping, conduit, auxiliary supports, etc.
d. Use high quality, clean and uniform shims when shimming is necessary.

LUDECA, Inc. • (305) 591-8935 • www.ludeca.com

For other Maintenance Tips and great information, visit: www.reliabilityweb.com.

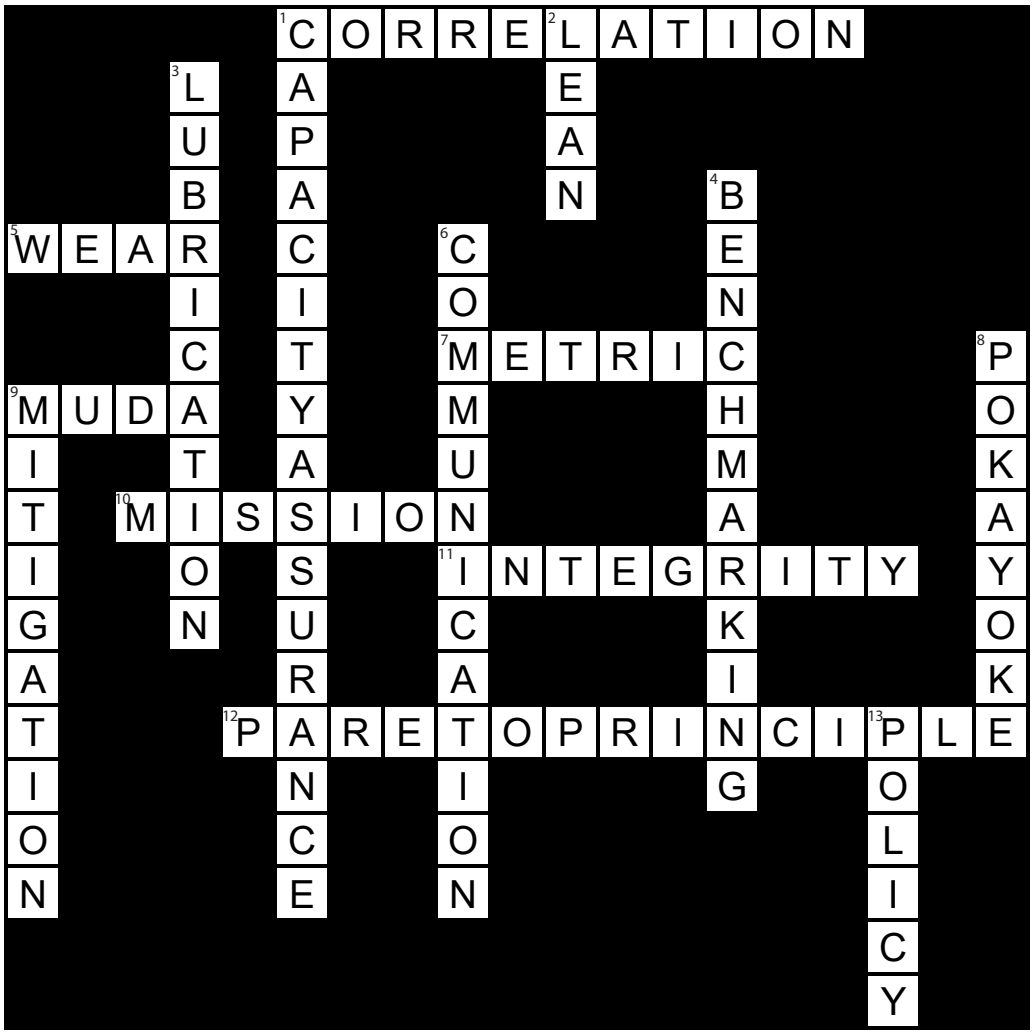
uptime® Elements™

Crossword Puzzle

Created by Ramesh Gulati

ANSWERS

JUNE/JULY ISSUE



ACROSS

1. A measure of the relationship between two data sets of variables
5. Attrition or rubbing away of the surface of a material as a result of a mechanical action
7. A standard measure to assess performance in a specific area
9. The Japanese lean word for waste or non-value added work
10. An organization's purpose
11. A concept of consistency of actions, values, measures, principles, expectations and outcomes
12. A principle that states that the critical few items, e.g., asset failures, parts, etc., should receive attention before the insignificant many

DOWN

1. A new, positive name of maintenance
2. A practice of waste identification and elimination
3. A practice performed to reduce friction and heat
4. A process of identifying, learning, and adapting outstanding practices and processes from any organization to help an organization improve its performance
6. Exchanging information between individuals through a common system of symbols, signs, or behavior
8. A Japanese term for a mistake proofing device to prevent a defect
9. A method that eliminates or reduces the consequences, likelihood, or effects of a hazard or failure mode
13. Intentions and direction of an organization as formally expressed by its top management

The RELIABILITY Conference™ Las Vegas

April 23-27, 2018
South Point Hotel, Casino and Spa
Las Vegas, Nevada

Co-located with Internet of Condition Monitoring Symposium

CALL FOR PAPERS!

The RELIABILITY Conference (TRC)

TRC-2018 is best known for its broad range of case studies from select organizations. These organizations discuss the elements of asset performance resulting from reliability and asset management. TRC is also notable for world-class solution providers enveloped into a 5-day reliability community.

The Internet of Condition Monitoring (IoCM) Symposium

IoCM-2018 has an objective to deliver innovative presentations about the impact of wireless sensing, artificial intelligence, machine learning, predictive analytics, cognitive computing, remote monitoring and cloud-based asset condition management.

Innovation and adoption is moving at a rapid pace. IoCM-2018 will provide the latest information on what the future looks like for existing assets and new assets as well as the successes and challenges organizations are facing.

RECEIVE
recognition from your industry peers.

CONTRIBUTE
to a vast publicly available maintenance reliability and asset management body of knowledge.

PROFILE
your company as an industry front runner.

SAVE
Free 4-day pass ($1,699 value) includes all meals, entertainment and access to all session. Plus, free spouse pass.

SHARE
your knowledge and network with other professionals.

SUBMISSION DEADLINE: August 31, 2017
Visit reliabilityconference.com for more details and to submit abstract.
Questions? 888.575.1245 or 239.333.2500

RELIABILITY WEB.COM

GET UP CLOSE WITH OUR HANDS-ON PRECISION LUBRICATION DEMO.

BOOK THE EXPERIENCE AT YOUR PLANT TODAY!

Experience the best way to observe and learn how Des-Case products can protect and clean your lubricants throughout their lifecycle. From storage, to transfer, and while in-use.

Learn more at **reliabilityexperience.com**

DES-CASE®