uptime®

for reliability leaders and asset managers

feb/mar 17

SELECTING THE CORRECT **MAINTENANCE STRATEGY**

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ASSET RELIABILITY SOLUTIONS™

2017 CERTIFIED RELIABILITY LEADER WORKSHOPS

The Certified Reliability Leader workshop focuses on whole life asset reliability decisions and whole life value delivery through leadership. These workshops explore the WHY and WHAT of reliability, providing the understanding so you can move from failed initiatives to successful ones. Perfect for those pursuing the CRL certification or for those seeking a reliable operation.

U.S. Dates

Register early for best rates.

FEB 8 – 1 DAY
Certified Reliability Leader
Overview and Exam
Gwinnett County Water
Atlanta, Georgia

MARCH 27-31 – 4 DAY
Certified Reliability Leadership
Advanced Workshop and Exam
Reliability Leadership Institute
Fort Myers, Florida

APRIL 25-28 – 4 DAY
Certified Reliability Leadership
Advanced Workshop and Exam
(at The RELIABILITY Conference)
Las Vegas, Nevada

MAY 15-19 – 4 DAY
Certified Reliability Leadership
Advanced Workshop and Exam
Reliability Leadership Institute
Fort Myers, Florida

JULY 25 – 1 DAY
Certified Reliability Leader
Overview and Exam
Metropolitan Council
St Paul, Minnesota

AUGUST 3 - 1 DAY
Certified Reliability Leader
Overview and Exam
(at MaximoWorld)
Orlando, Florida

SEPT 25-29 – 4 DAY
Certified Reliability Leadership
Advanced Workshop and Exam
Reliability Leadership Institute
Fort Myers, Florida

OCT 20 – 1 DAY
Certified Reliability Leader
Overview and Exam
Kansas City BPU
Kansas City, Kansas

DEC 12-15 – 4 DAY
Certified Reliability Leadership
Advanced Workshop and Exam
(at IMC-2017)
Bonita Springs, Florida

International Dates

by invitation only, see website for details.

FEB 22-23 – 2 DAY EN ESPAÑOL
La Red Confiabilidad Symposium
featuring the Certified Reliability Leader
Introduction Workshop and Exam
Monterrey, Mexico

MARCH 8-9 – 2 DAY EN ESPAÑOL
La Red Confiabilidad Symposium
featuring the Certified Reliability Leader
Introduction Workshop and Exam
Lima, Peru

MARCH 22-23 – 2 DAY INTERNATIONAL
Certified Reliability Leader
Introduction Workshop and Exam
Melbourne, Australia

APRIL 5-6 – 2 DAY INTERNATIONAL
Certified Reliability Leader
Introduction Workshop and Exam
Singapore

JUNE 6-7 – 2 DAY INTERNATIONAL
Certified Reliability Leader
Introduction Workshop and Exam
London, United Kingdom

JUNE 14-15 – 2 DAY EN ESPAÑOL
La Red Confiabilidad Symposium
featuring the Certified Reliability Leader
Introduction Workshop and Exam
San Juan, Puerto Rico

SEPT 6-7 – 2 DAY EN ESPAÑOL
La Red Confiabilidad Symposium
featuring the Certified Reliability Leader
Introduction Workshop and Exam
Querétaro, Mexico

OCT 17-18 – 2 DAY INTERNATIONAL
Certified Reliability Leader
Introduction Workshop and Exam
Kuala Lumpur, Malaysia

NOV 6-10 – 4 DAY EN ESPAÑOL
Certified Reliability Leadership
Advanced Workshop and Exam
San Juan, Puerto Rico

NOV 21-22 – 2 DAY INTERNATIONAL
Certified Reliability Leader
Introduction Workshop and Exam
Dubai, UAE

NOV 28-29 – 2 DAY EN ESPAÑOL
La Red Confiabilidad Symposium
featuring the Certified Reliability Leader
Introduction Workshop and Exam
Santiago, Chile

NOTE: Event locations and dates subject to change

CRL2020 GOAL

10,000 Certified Reliability Leaders worldwide... and at least one in space!

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COURSE	WHO SHOULD ATTEND	YOU WILL LEARN HOW TO	DATES & LOCATION	DAYS/CEUs	COST
Maintenance Management Skills	Maintenance Managers and Supervis… as well as Supervisors from Operati… Warehouse or Housekeeping areas	Lea… odd-class maintenance department using planning and …est practi… drive work execution, improve …increase output and reduce waste.	Apr 25-26, 2017 (CHS) Sept 26-28, 2017(CU)	3 consecutive days 2.1 CEUs	$1,495
Maintenance Planning and Scheduling	Planner/Schedulers, … Supervisors, Maintena… Operatio… Managers	…practices. Calculate …e work. Handle common …ncies.	Feb 13-17, 2017 (CHS) Mar 13-17, 2017 (CHS) May 8-12, 2017 (CU) Jun 19-23, 2017 (CHS) Sep 11-15, 2017 (CHS)	5 consecutive days 3.2 CEUs	$2,495
Materials Management	Materials Ma… Plann… and …	…age inventory to …rchasing. Implement	Apr 11-13, 2017 (CU) Oct 24-26, 2017 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Planning for Shutdowns, Turnarounds and Outages	Members of … planners, pl… engineer…	…how to effectively …ses and strategies	Aug 22-24, 2017 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Predictive Maintenance Strategy	Plant engineers a… Industrial and M… Maintenance S…	…ting condition. Use …nology to optimize plant	Apr 4-6, 2017 (CHS) May 16-18, 2017 (OSU) Sep 19-21, 2017 (KU) Nov 14-16, 2017 (CU)	3 consecutive days 2.1 CEUs	$1,495
Prosci® Change Management Programs	Executives and Senior Leader… Supervisors; Project Teams; H… …anning Groups; Employees	…cy in change …anagement. Deploy change …t your organization. Become licensed to use …ci's change …gement tools.	Contact us to schedule a private onsite class.	Sponsor: ½-day Coaching: 1-day Orientation: 1-day Certification: 3-day	Contact us for pricing
Reliability Engineering Excellence	Reliability Engineers, Maintenance Managers, Reliability Technicians, Plant Managers and Reliability Personnel	Learn how to build and sustain a Reliability Engineering program, investigate reliability tools and problem-solving methods and ways to optimize your reliability program.	Feb 28-Mar 2, 2017 (CHS) Apr 18-20, 2017 (KU) Jun 20-22, 2017 (CU) Oct 17-19, 2017 (OSU)	3 consecutive days 2.1 CEUs	$1,495
Reliability Excellence for Managers	General Managers, Plant Managers, Design Managers, Operations Managers and Maintenance Managers	Build a business case for Reliability Excellence, learn how leadership and culture impact a change initiative and build a plan to strengthen and stabilize the change for reliability. CMRP exam following Session Four.	SESSION 1 DATES: Mar 21-23, 2017 (CHS) Apr 25-27, 2017 (PR) Oct 3-5, 2017 (MX)	12 days total (4, 3-day sessions) 8.4 CEUs	$5,995
Risk-Based Asset Management	Project Engineers, Reliability Engineers, Maintenance Managers, Operations Managers, and Engineering Technicians.	Learn to create a strategy for implementing a successful asset management program. Discover how to reduce risk and achieve the greatest asset utilization at the lowest total cost of ownership.	Jan 24-26, 2017 (OSU) Mar 7-9, 2017 (CU) Jun 13-15, 2017 (KU) Sep 12-14, 2017 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Root Cause Analysis	Anyone responsible for problem solving and process improvement	Establish a culture of continuous improvement and create a proactive environment. Manage and be able to effectively use eight RCA tools to eliminate latent roots and stop recurring failures.	Mar 21-23, 2017 (OSU) Jun 13-15, 2017 (CHS) Aug 15-17, 2017 (CU) Oct 31-Nov 2, 2017 (KU)	3 consecutive days 2.1 CEUs	$1,495
SMRP BOK Guided Study	Experienced maintenance and reliability professionals who want to attain the CMRP designation.	Review SMRP's Five Pillars of Knowledge. The guided study is an intensive review of each pillar's components designed for organizations looking to further develop their team through CMRP certification.	Jan 31-Feb 2, 2017 (CHS) Sep 19-21, 2017 (CHS)	4 consecutive days Exam on day 4	Contact us for pricing

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uptime Elements™ A Reliability Framework for Asset Performance

MSAT Mapped Services and Training

***LOCATION CODES:** (CHS) = Charleston, SC | (CU) = Clemson University in Greenville, SC | (KU) = The University of Kansas | (OSU) = The Ohio State University

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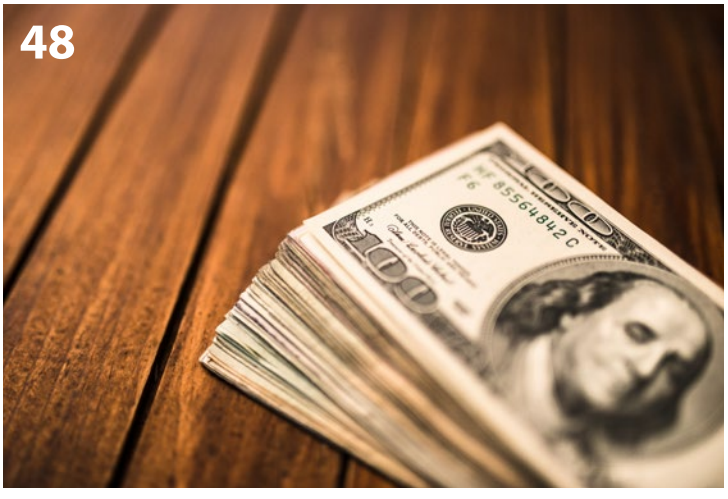
for reliability leaders and asset managers

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

Features



Articles

Editorial

Trimtab: Reliability Leaders Find Leverage on the Low-Pressure Side

I have a few uber-heroes but one of them is R. Buckminster "Bucky" Fuller, inventor and author of *Operating Manual for Spaceship Earth* (ISBN: 978-3037781265).

In response to an interview question about how one individual can make a difference in the world, Bucky Fuller said: "An idea hit me very hard once, thinking about what one little man could do to change the world. Think of the Queen Elizabeth — the whole ship goes by and then comes the rudder. And there's a tiny thing at the edge of the rudder called a trim tab. It's a miniature rudder. Just moving the little trim tab builds a low pressure that pulls the rudder around. Takes almost no effort at all. So I said that all of us, "the little individuals," can be a trim tab. Society thinks it's going right by you, that it's left you altogether. But if you're doing dynamic things mentally, the fact is that you can just put your foot out like that and the whole big ship of state is going to go."

The truth is that you get the low pressure to do things, rather than getting on the other side and trying to push the bow of the ship around against the high pressure. You build that low pressure by getting rid of a little nonsense, getting rid of things that don't work and aren't true, until you start to get that trim tab motion. It works every time. That's the grand strategy you're going for. So I'm positive that what you do with yourself, just the little things you do yourself, these are the things that count. To be a real trim tab, you've got to start with yourself, and soon you'll feel that low pressure, and suddenly things begin to work in a beautiful way. Of course, they happen only when you're dealing with integrity.

Integrity is at the top of the list of the 4 fundamentals of reliability leadership in order to get you to the low pressure side of life and work. The trim tab as Bucky called it. Life and work go better with integrity. You have more leverage with integrity. Integrity is a reliability performance tool: Do what you say you are going to do.

Integrity is followed by authenticity and responsibility BECAUSE after you create the stand – the context of reliability for everyone – and you now live and work from inside that stand – you still need to be effective. You need to be the kind of reliability leader who can rearrange the circumstances to create effective results.

What is our trim tab? Where do we find the leverage to create reliability for everyone?

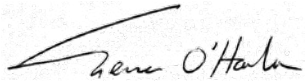
You go back to work after reading *Uptime*® Magazine to your same difficult circumstances, not enough executive sponsorship, not enough people, not enough time, not enough money, not enough talent, not enough software, etc., etc., etc., and you create what is wanted and what is needed.

I mean if you ***really want your work to matter***, you start thinking right now about what is wanted and what is needed to create reliability for everyone, and you provide it.

If you ***really want to make a difference***, if you really want to be the trim tab, when you go back to work, look around. Work it out for yourself. *What will you do to create reliability for everyone? What conversations will you have to have? What will you need to do?* AND THEN DO IT.

RELIABILITY FOR EVERYONE – BECAUSE THE ONLY OTHER ALTERNATIVE IS RELIABILITY FOR NO ONE.

Warm regards,



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Leadership for Reliability

RELIABILITY®

IN THE NEWS

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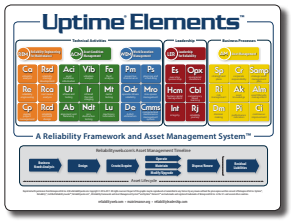
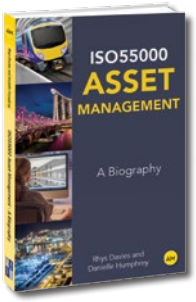
ASSET MANAGEMENT HAPPENINGS

Reliabilityweb.com is proud to introduce the updated and enhanced **Uptime® Elements™ – A Reliability Framework and Asset Management System™**. This system features an expanded Asset Management domain aligned with ISO55000. Look for more information in the April/May issue of *Uptime*!





New Release! *ISO55000 Asset Management: A Biography*

by Rhys Davis and Danielle Humphrey

The release of ISO55000:2014 Asset Management marked a major milestone in the history of the discipline of asset management (AM) the world over. This book was produced to accompany the ISO55000 suite of standards, providing some background history to its development and context to the set of requirements. The authors also provide personal interpretation of their intent. **www.mro-zone.com**

Don't miss: America's Report Card

This specially produced podcast discusses the American Society of Civil Engineers' Report Card for America's Infrastructure which depicts the condition and performance of American infrastructure in the familiar form of a school report card—assigning letter grades based on the physical condition and needed investments for improvement. The latest Report Card grades show we have a significant backlog of overdue maintenance across our infrastructure systems, a pressing need for modernization, and an immense opportunity to create reliable, long-term funding, but they also show that we can improve the current condition of our nation's infrastructure — when investments are made and projects move forward, the grades rise.

Listen here: http://uptime4.me/americas-report-card

Progress on ISO55000 Asset Management Standard

Several Reliabilityweb.com team members have been active on ISO TC251, the Technical Committee responsible for expanding awareness and adoption of the ISO55000 Asset Management Standard through the U.S. Technical Advisory Group organized through the American Society of Testing and Materials (ASTM).

Maura Abad, Global Relationship Leader, is a member of TC251 Working Group 3. This committee developed a website to communicate beneficial information about asset management around the world. Learn more at www.committee.iso.org/tc251

Terrence O'Hanlon, CEO and Publisher at Reliabilityweb.com and *Uptime*® magazine, has been an active member since the asset management standards team was initially formed. Terrence is a now a member of TC251 Working Group 6 that is redrafting ISO55002 Asset Management Guidance for implementing ISO55001.

Reliabilityweb.com will be participating with several other U.S. members in the next global meeting of asset management experts in Brisbane, Australia on March 27-31, 2017.

The RELIABILITY Conference™ Las Vegas

2017 Conference Introduces the Internet of Condition Monitoring

The RELIABILITY Conference is the event where you can go for innovation in asset management, reliability and condition monitoring. Get well-informed to maintain your organization as a viable market competitor.

Is your organization prepared for Industrial Internet of Things?

This year, we introduce the Internet of Condition Monitoring (IoCM-2017). Attend the IoCM-2017 Symposium to get up-to-speed with real world presentations from scrappy start-ups, technology subject matter experts and major equipment manufacturers.

TRC-2017 features the humorous and insightful Keynotepresentation from Tom Fishburne, Marketoonist. Tom and his company have been developing visual content marketing with a sense of humor for businesses such as Google, IBM, Vodafone, and Intuit. Be sure to check out a sample of Tom's work on page 64!

Register early for the best rates!

For more information:
www.reliabilityconference.com

ACM Project Manager's Guide Just Released!

This is a resource no organization should be without! The Asset Condition Monitoring (ACM) Project Manager's Guide provides basic information about what an ACM initiative or organizational component is, how it should be conducted and who should be involved. Check out page 44 for an overview and some key points to get you started!

Maintenance TIPS

Alignment in Your Maintenance Strategy – Calculate ROI!

More than 50% of all pump damage is caused by misalignment! Let's hypothetically assume we are operating 95 assets with a mix of 50-200 HP pumps. In this example, each of those pumps is misaligned by 15 thousands (offset). The calculation of AES returns a 23.2 months replacement interval and a 0.5% power increase in consumption as per ICI research. We encounter four saving categories: Power consumption, seal and bearing replacement and pump repair cost. If we assume that the electricity cost is 12 cents/kWh (US average) and the pump repair cost requires $100/h manpower, one can save $172,260.00 per year if all pumps are aligned to 0.05 thousands.

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www.pruftechnik.com

How Complex Should Maintenance Procedures Be?

The level of complexity depends on several factors:

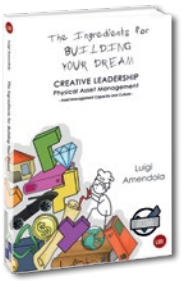
- The complexity of the task. Tasks which have multiple steps that must be performed in specific sequence or contain unusual operations must be spelled out precisely.
- What specific data is needed to complete the task with repeatable results? Critical numerical data, such as torque values and clearances, specific type of lubricant, or special tools, should always be spelled out and never left to memory.

- The criticality of the procedure's outcome. How important is it that the job is done exactly right? As the tolerance for poor outcome or any variation in the outcome decreases, the need for specific detail required to ensure a consistent outcome increases sharply.

Life Cycle Engineering • (843) 744-7110 • www.lce.com

Optimization of the Operations and Maintenance Phase

Optimal yield during this phase of the asset's lifecycle is only achieved in organizations that span a holistic focus, from lower to higher complexity. This brings about close and intimate work between the areas of operations and maintenance, given that these two areas are enablers jointly, allowing you to achieve the requirements of the business plan.



While there are many definitions of maintenance, it can be defined and directed as a process to obtain optimal reimbursements of expenses (capital). This is why you need to identify an asset management system as an integral part of the model of management of the asset's lifecycle.

During the operations and maintenance stages of an asset's lifecycle, optimal performance can be obtained by multiplying optimal availability by optimal efficiency (optimal availability x optimal efficiency = optimal performance).

Luis Amendola • The Ingredients for Building Your Dream
www.reliabilityweb.com/bookstore

How to Take a Proper Oil Sample

For a useful lab report and diagnosis, correct sample taking is strictly necessary.

Take the oil sample:

- During operation or immediately after a shutdown
- At normal operating temperature (max. 80°C)
- Always at the same point with the same method
- If possible never from, but before the filter
- Not after changing the oil or after considerable quantities of oil have been added
- Put the sample in a clean and dry container, preferably in the original sample bottle of an analysis kit

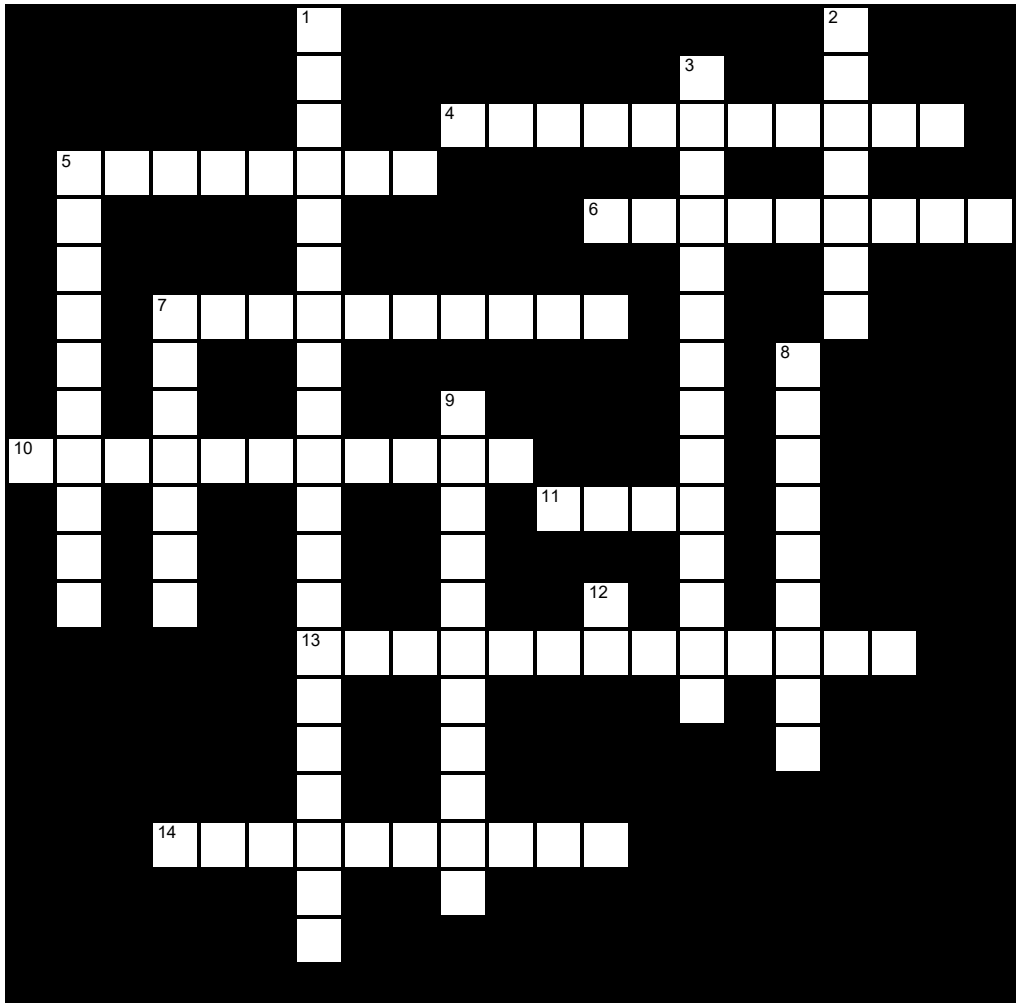
OilDoc GmbH • +49 8034 9047-700 • en.oildoc.com

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

uptime® Elements™

Created by Ramesh Gulati

Crossword Puzzle



ACROSS

4. A continuous improvement cycle consisting of plan-do-check-act is known as
5. Using an item in a way that applies stresses that are below the recommended stress values
6. A structured, pre-prepared form for collecting, recording and analyzing data as work progresses
7. Any resource (asset/system) whose capacity is less than the demand placed on it, or which controls the maximum rate of production of resources ahead or behind in the process stream
10. A comparison of a measurement of a system of unverified accuracy to a measurement of a system of known accuracy to detect any variation from true value
11. A piece of information, in raw or unorganized form, used as a basis for reasoning, discussion, calculations, further processing and communication
13. A process by which equipment or a facility is tested to verify that it functions in accordance with its design objectives or specifications
14. A phenomenon that occurs when the absolute pressure in a pump intake line is reduced below the vapor pressure of the liquid

DOWN

1. A method that allows an organization to determine the actual cost associated with each product/component, process, or service produced based on actual resources consumed
2. All work waiting to be done
3. An iterative process used to optimize preventive maintenance (PM) intervals
5. Trustworthy, something you can depend on
7. A Japanese word for Output Optimization
8. Adjusting the distribution of mass in a rotating element to reduce vibratory forces generated by imbalance
9. Any foreign or unwanted substance that can have a negative effect on system operation or reliability
12. A Japanese workplace organization technique to reduce wastage of resources and space while increasing operational efficiency

Uptime Elements Crossword Contest

Have you been completing the puzzle every issue?
Are you ready to check your intellectual skills?
Check out page 64 for "The Answers!"

Uptime® Awards 2016

Recognizing the *Best of the Best!*

Uptime Magazine congratulates the following outstanding programs for their commitment to and execution of high-quality Predictive Maintenance and Condition Monitoring Programs.

To read more about each company,
download the Uptime Award Winners' stories at:

uptimeawards.com

Jacobs Space Operations Group (JSOG)

Jacobs provides long-term engineering, scientific and technical services at eight major sites for the National Aeronautics and Space Administration (NASA). Jacobs is proud of its long-term partnership with NASA, which dates back to the Mercury Program, and to be NASA's fifth largest contractor. At the Kennedy Space Center, Jacobs is partnering with our NASA customer to support next-generation space exploration with the Test and Operations Support Contract (TOSC).

Overview of JSOG Oil Program

- Consolidated like oils, resulting in drastic reduction of shop-stocked oils
- Compatibility testing to ensure proper lubricant selection
- Standardized oil naming conventions
- Unique coding of oils by types and applications
- Selecting proper oil for application & equipment
- Procurement with verification against specifications & documentation in procurement system
- "On-dock" testing prior to issuance
- Standardized oil sampling procedures
- Labeled oil sampling points
- Customized oil sampling frequencies
- Customized alarms/limits to equipment
- Test fingerprinted oil standards
- Pharmacy for proper storage & issuance of oil
- Associate oil sample results to CMMS (Maximo) for traceability
- Re-refining of used oils
- Standardized operating procedures and work documentation
- Continuous improvement feedback and customer satisfaction surveys
- Documented and published in Lubrication Manual
- Established metrics for process improvements and cost avoidance collection

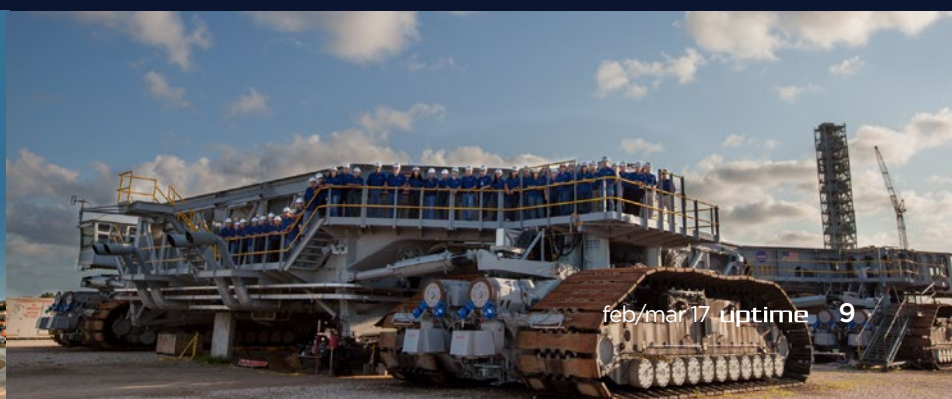
Equipment/Software

Equipment

- Spectro Scientific Q220 LaserNet Fines® (LNF) Particle Counter, Wear Particle Classifier and Ferrous Monitor
- Spectro Scientific Q1100 Handheld Infrared Oil Analyzer
- Spectro Scientific Q100 Rotating Disc Electrode Optical Emission Spectroscopy
- Anton Paar SVM 3001 Viscometer
- Predict Direct Reading Ferrograph IV
- Predict Ferrogram FM-III Ferrograph Maker
- Olympus Ferroscope

Software

- CMMS: Maximo
- Procurement/Inventory: PeopleSoft
- Emerson's OilView software



CBRE

CBRE, a Fortune 500 and S&P 500 company headquartered in Los Angeles, is the world's largest commercial real estate services and investment firm (based on 2015 revenue). The company has more than 70,000 employees (excluding affiliates) and serves real estate investors and occupiers through more than 400 offices (excluding affiliates) worldwide. CBRE offers a broad range of integrated services that include: facilities, transaction and project management; property management; investment management; appraisal and valuation; property leasing; strategic consulting; property sales; mortgage services and development services.

Best Work Execution Management Program

CBRE's Global Workplace Solutions (GWS) business line specializes in facilities management outsourcing. Its 74,000 employees across the world are responsible for managing more than five billion square feet of real estate for over 600 clients. As the world leader in technical facilities management outsourcing, GWS' Technical Operations and Reliability Engineering team envisioned a maintenance and energy program that offered clients:

- Global consistency, locally tailored approaches;
- Cost certainty;
- Reduced risk and improved reliability;
- Enhanced workplace environments that foster employee motivation;
- Clear visibility from global to asset-level financials;
- Increased corporate stewardship (e.g., sustainability);
- Improved work process, staff efficiencies.

Introducing APEX, CBRE's Asset Performance and Energy Excellence program. CBRE's global standard for asset maintenance and reliability was developed using Lean Six Sigma methodologies and the knowledge of experts both internally and externally.

APEX Team


Jack O'Connor


Tim Schipper


Brian Letendre


Steve Sloane


Paul Ausbrooks


Scott Galliher


Ken O'Connor


Craig Young


Ray Congdon


David Ireland


Marcus Berendse


Mike Doolan


Ali Mohammed


Russ Parish


Jerry Hicks

Scope	Outcomes
Created 1,800 globally optimized job plans	Completed 15,200 e-learning modules by 1,900 employees
Translated into 18 languages	Generated $75M in savings (2014/15)
Deployed to >350 facilities belonging to 52 clients across 21 countries	Improved technician productivity to 45% or better
Developed e-learning certification training	Improved client satisfaction

Bristol-Myers Squibb

Since 1943, Bristol-Myers Squibb employees in Syracuse, New York, have been developing and manufacturing new medicines that help patients prevail over serious diseases. From the early days of penicillin to the current era of protein therapeutics, Bristol-Myers Squibb has maintained a strong commitment to the Syracuse community through employment, philanthropic endeavors and environmental stewardship.

Several critical functions are located at this 90-acre site in East Syracuse, New York, including:

- Development of biologics manufacturing processes (shared with employees located at our Hopewell, NJ, facility);
- Manufacturing of biologics medicines for use in clinical trials;
- Manufacturing of biologics medicines for commercial use.

Program Highlights

The maintenance organization leverages orbits quarterly to provide visibility and focus to the single highest priority project for each individual. This has proven to be an effective way to manage these projects and to keep them on track. This also supports a more level loaded focus throughout the year. Some examples of projects already accomplished this year include: adding 10 CRLs, updating the work management SOP, training critical individuals on Maximo tools, the development of an electronic form for Maximo change controls and archival of paper-based records to support a future relocation of the Maximo Administration Team. All of these projects are critical to the success of the maintenance organization.

Our physical asset management process is focused around our Site Master Plan. This plan identifies strategic changes to the site, as well as our asset replacement needs. The engineering group manages this plan, and the plan is directly tied into the Capital Project Plan. The site is approaching 75 years old, but the current manufacturing infrastructure is only three decades old. A constant focus and investment on the right assets keep the site current with leading technology and one of the leading cost/Kg biologics manufacturing sites anywhere on the planet!

The Syracuse extended reliability team (everyone on site) is very aligned and supportive of our reliability strategy. We are open, honest, innovative, and collaborative. BMS is truly operating in alignment with reliability excellence and fully taking advantage of it to provide value back to the business. Integrity is something we live by. Yearly, we all sign a Weight of Your Signature commitment, which states that we hold our signatures to the highest integrity and consider them a legal commitment. There are times when we take on a little too much, but the site is known for delivering on time. The site often acts as a launch site for new products, proving the process at commercial scale and getting approval from the FDA and many other regulatory bodies throughout the world. This constant activity with products has enabled us to adapt with ease and handle project management very efficiently.

Human capital management is very important to BMS Syracuse. From the recruitment process onward, we take steps to invest in our most important assets. We invest in internal training, but also look outward to conferences and professional groups for learning opportunities.

LOOP LLC

LOOP LLC is a crude oil pipeline and storage company with onshore and offshore facilities in southeastern Louisiana, serving as a vital energy hub with pipeline connections to a significant portion of our nation's refineries. We can store over seventy million barrels of crude in below ground caverns and above ground tanks. Our unique pumping systems can transport crude at rates in excess of one hundred thousand barrels per hour on multiple, interconnected pipelines.

Since 2011, LOOP has created and followed a new vision of becoming "Market Driven and Operationally Excellent." Related strategies and tactical objectives were developed and implemented. The uptime or availability of assets, along with our environmental stewardship and our energy consumption reduction, are all considered critical components of our business performance to our customers. These initiatives therefore align with our vision. Our proactive programs have changed our culture. We continue to learn every day, on every job, and seek opportunities for continuous improvement.

The results have been rewarding. As we achieved a record 99.75% uptime on our main oil line assets in 2013, we remain over 99% and have now exceeded 98% uptime for over 8 years. LOOP won the Uptime Award for Best Work Execution Management Program in 2014, and we are honored to now receive the 2016 Uptime Award for Best Green Reliability Program. In 2015, LOOP handled 875,646,384 barrels of crude (36.8 billion gallons) at our Clovelly Hub in Galliano, LA: 445,309,410 barrels in and 430,336,974 barrels out. Though we recorded 12 reportable spills last year, as we report every drop of potentially hazardous fluid that enters the water, they only totaled 5 oz. in volume.

By the end of 2015, our energy consumption also decreased over 21.5% when compared to our 2012 usage—an inverse relationship to our increased throughput and equipment uptime. We convert diesel consumed for our offshore platform, support vessels and onshore facilities, as well as helicopter fuel, to a common unit of energy: a kilowatt-hour (kWh). This energy consumption is then added to our electricity usage at our onshore facilities, which is also tracked in kWhs. Then we calculate how many kWhs it takes to move a barrel of oil at LOOP (kWh/barrel). We established a 5-year goal in 2013 to reduce our energy consumption per barrel by 15% when compared to our 2012 baseline numbers. This was accomplished in less than two years. We've continued to decrease energy consumption in 2016 as we are now burning roughly 22.5% less than we did in our benchmark year.

We made a commitment after our first Uptime Award in 2014 to not camp out at success or rest on our laurels. We're now making improvements in our condition based monitoring program for field assets. In addition, we've enhanced our warehousing program to include a barcoding system that will utilize the same handheld PDAs, among many other investments in the growth and betterment of our company. One such investment we recently completed successfully—on budget, ahead of schedule, and without incident—was the replacement of our Marine Terminal Living Quarters offshore. This effort included two critical lifts exceeding 700 tons (out with the old) and 800 tons (in with the new) as shown in the below picture. A larger helipad was also installed above the quarters.

This year, we are implementing the recommendations set forth in American Petroleum Institute's RP 1173 regarding our Pipeline Safety Management System. This includes utilizing the Deming model of Plan-Do-Check-Act (or Adjust) for all our processes and programs, starting with risk assessments and mitigation evaluations at all operating facilities. Although this was a recommendation and not a regulatory compliance requirement, we've opted to get ahead of the game by improving where we can as early as we can.

Arizona Public Service (APS) Palo Verde Nuclear Generating Station

Special Recognition Award PM Optimization

Program Highlights

The preventive maintenance (PM) program at the Palo Verde Nuclear Generating Station utilizes a value-based reliability model for strategy determination. Understanding the value that reliability can add to or take away from a company's bottom line is essential in value-based maintenance strategy implementation and use.

Palo Verde determines a failure probability for a component based on the current PM strategy for the component within its operating context. The cost to maintain the reliability of a component is compared to the cost of the consequence of failure for each component. Using a sophisticated mathematical optimization calculation derives the most efficient PM strategy to maintain the required amount of reliability. PM strategy change effectiveness is measured using business intelligence software, and the strategies are adjusted and fine-tuned based on actual maintenance cost results.

This process has been used at Palo Verde—the nation's largest power producer—for the past six years. The results have been outstanding. Palo Verde has decreases in overall maintenance labor costs to maintain the power block while sustaining continued high levels of nuclear safety. In fact, the results have been so impressive that the entire U.S. nuclear energy fleet is planning to move to the use of this analysis model.

Gwinnett County Department of Water

Program Highlights

Gwinnett County Department of Water Resources realigned its organizational structure in 2014 with an objective to identify & perform the right work at the right time, use a team approach to implement initiatives, and create a proactive culture to serve as the "Benchmark for Maintenance & Operational Reliability Excellence" (MORE). Part of the realignment in Facility Operations included focused skills training and certifications for current staff. It also included the formation of a dedicated team of technicians that focus on use of precision and predictive maintenance tools and technology to identify and eliminate defects before failures occur.

As part of the program development, Facility Operations recognized the need to reintroduce alignment fundamentals, training, and precision tools to support and enhance their program. Formal training was conducted in 2015 for half of all trades technicians in Facility Operations, including the PdM team. New alignment systems were purchased for plant maintenance to utilize for installation after repair. The PdM team then began addressing misalignment identified through vibration analysis across all facilities.

Field training for technicians and analysis indicated that not all contractor-installed assets were precision aligned and within tolerance. Some assets that were checked during field training were 30 times tolerance. With thousands of critical rotating assemblies, GCDWR began planning a proactive approach to ensure all critical assets are within tolerance to eliminate bearing, coupling, and belt failures caused by misalignment.

As the implementation of the MORE program increased the efficiency of Facility Operations, more technicians were added to the PdM Team. These additional team members allowed for GCDWR to implement a Proactive Precision Alignment program that targets its most critical rotating assets to ensure they are properly aligned. Phase one of this program includes 255 highly critical rotating assets. Results to date have identified that 48% of all assets inspected were out of alignment, some by as much as 35 times tolerance. The second phase will include several hundred less critical assets and should begin in spring of 2017. Facility Operations plans to continue this program until all critical rotating assets have been inspected for proper alignment.

Special Recognition Award Best Precision Alignment Program

Kansas City Board of Public Utilities

Special Recognition Award Innovative Use of Photography for Maintenance

At BPU, our mission is “to focus on the needs of our customers and to improve the quality of life in our community, while promoting safe, reliable and sustainable utilities.”

Program Highlights

Extensive use of photography in maintenance

For capturing:

- Initially received asset conditions
- Current asset operating state
- End of life asset state
- Asset name plate to attach to Maximo asset
- Item master data for visualization of inventory
- New exposed underground construction
- New construction
- Change of state in current assets

For communicating:

- Each asset’s individual story in its own operating context
- Problems to stakeholders
- Sucesses to stakeholders
- Our maintenance and reliability efforts via presentations
- Data to Maximo for locations, assets, item master and inventory

For training:

- Specific training for photographic equipment we use, so that everyone takes pictures the same way and knows how to use the equipment we have.

RIO TINTO Iron Ore Canada

The Iron Ore Company of Canada (IOC) is a leading Canadian producer of iron ore concentrate and iron ore pellets that serves customers worldwide. The company operates a mine, a concentrator and a pelletizing plant in Labrador City, Newfoundland and Labrador, as well as port facilities in Sept-Îles, Québec. It also operates a 418-kilometer railroad that links the mine to the port.

Mission and Values

Securing our future together as a successful supplier of iron ore products to the global steel industry.

Challenge

IOC management realized that in order to achieve our business objectives, the company would have to invest in improving the maintenance and reliability of the production assets to enhance their capacity utilization and availability, ultimately leading to improved overall equipment effectiveness and higher production targets.

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- Power Distribution
- Operate for Reliability
- Condition Monitoring and Hydrocarbon Management Audit
- PM & Spares Optimization
- Defect Elimination

Special Recognition Award Root Cause Analysis

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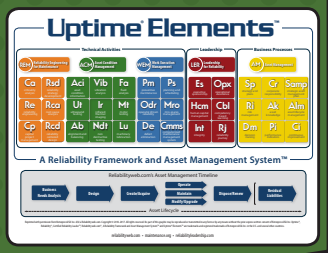

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SELECTING THE CORRECT **MAINTENANCE STRATEGY**

Mike Johnston

Determining the proper maintenance strategy for a site's assets can be a daunting undertaking. There's a fine line between profitability and reliability, and frequently, a facility's strategy usually favors one or the other. When weighted toward running equipment past its design or capabilities, it can lead to frequent, unplanned interventions and associated costs of labor, material and lost production. When the arc of the pendulum swings too far to over maintaining an asset, the availability can be seriously hindered and impact profitability. It's important to find that "sweet spot" between these two approaches to ensure there's an appropriate amount of maintenance that still drives profitability. The question is how to find it.

Equipment in the refining and petrochemical industry (e.g., pumps, vessels and exchangers) is clearly different from the equipment in an automotive assembly line facility or in the food and bottling sector, which will affect the maintenance strategy decision. However, some equipment care methods are universal. This article breaks down the process to analyze, develop, agree and deploy a new or augmented maintenance strategy into five phases.

> It's important to find that **'sweet spot'** between (profitability and reliability) to ensure there's an appropriate amount of maintenance that still drives profitability. The question is how to find it.

PHASE 1

Establish a Team

To lay the groundwork for a cost-effective maintenance strategy, a team must be established if one does not already exist. A dedicated crew comprised of members of the reliability, maintenance, production and engineering groups needs to be convened. Having people from various departments will help bring a variety of perspectives to the table and help cover all bases.

This process cannot be regarded as a short-term, get it done quick event. Each team member must make a commitment to his or her role in the maintenance plan of action. To ensure an accurate and effective strategy is put into place, the multidisciplined team of stakeholders need a certain level of autonomy from management. By giving them more freedom, members of the maintenance team will be better equipped to think freely and execute work properly.

	CONSEQUENCES					PROBABILITY				
						1	2	3	4	5
Severity	Classification	Safety	Equipment/ Maintenance Cost	Production	Environmental	< 1% Remote	1% - 5% Extremely Unlikely	5% - 25% Very Unlikely	25% - 50% Unlikely	> 50% Likely
5	Disastrous	Multiple fatalities, > 5. Large effects on large external inhabited zones- several fatalities	Extensive damage >$8M	Major loss, not recoverable. More than 3 days lost production	Major pollution with sustained environmental consequences external to the site	5	10	15	20	25
4	Catastrophic	Lethal effect on several persons (several fatalities). Lethal external effect - one fatality, several physical injuries	Major damage $6M-$8M	Major loss. Up to 50% not recoverable Up to 3 days lost production.	Major pollution external to the site. Evacuation of persons	4	8	12	16	20
3	Major	Lethal effect on one person and/or several permanent invalidities. Permanent external effects	Localized damage $2M - $6M	Medium loss, not wholly recoverable through normal production < 24 hours lost production	Moderate pollution, within site limits. Product liability	3	6	9	12	15
2	Serious	Permanent injury, lost time accident. Non-permanent external effects	Minor damage $200K - $2M	Minor loss, recoverable through normal production 2 to 8 hours lost production	Spill or release of pollutant requiring a declaration to authorities but without environmental consequences	2	4	6	8	10
1	Moderate	No permanent injury, recordable with no lost time/medical treatment. No external effect	Slight damage < $200K	Little to no effect. Production easily recovered. < 2 hour lost production.	Minor spill or release of pollutant, not requiring a declaration	1	2	3	4	5

Figure 1: Critical risk matrix

PHASE 2

Critical Analysis

First, the team must establish an asset's importance in the production chain by defining whether it is: 1) critical, 2) vital, or 3) secondary to production. This is a very crucial step and undoubtedly will be the first challenge to manage group consensus. Maintenance strategy team members may have conflicting opinions on what constitutes the most critical assets, depending on their perspective and respective positions within the organization. Fortunately, there are tools to help the team move beyond their opinions and make objective decisions.

Historical repair data from the site's computerized maintenance management system (CMMS) and overall operation efficiency (OOE) information, if available, will help drive the analysis and assist in resolving divergent opinions. Based on the mean time between failure rate (MTBF/R), the most pressing issues can be identified and agreed upon. Whether these particular assets are critical or not will be determined as the exercise progresses. Note: Assets that have a spare are *generally* not defined as critical and could be removed from the initial list and examined later.

The criticality matrix (*Figure* 1) is a particularly useful tool to evaluate, categorize and prioritize an asset's necessity. In the Figure 1 example, anything ranked 15 or higher would be categorized as critical. The middle rankings of 5 to 9 could be deemed vital, with the lower levels assigned as secondary.

This matrix includes both the cost of maintenance and the cost associated with lost production. Although vital, lost production revenue is frequently overlooked when evaluating the urgency of maintenance work. This monetary value could be potentially much greater than the cost of maintenance labor and material, and therefore, should not be omitted from the ranking. The potential cost of lost productivity alone may place an asset in a higher bracket than initially classified. If a site already has a matrix, upgrading it may yield more accurate results. However, it is important to note that starting from scratch will add time to the progression of the work and delay defining the strategy to deploy.

PHASE 3

Analysis of Current Strategy Versus Preventive Maintenance/Repair Data

Once the team has agreed to the preliminary criticality ranking, the next step is to evaluate the existing maintenance strategy for that particular asset, if there is any. In this initial review, gaps between the repairs and maintenance strategy are noted for additional investigation and future improvement. From this point, the team should decide on how to group together equipment for analysis. There are three ways to do this: 1) compile a comprehensive list of all data on all the assets at the site before moving to the next phase; 2) address each asset individually, conduct the gap analysis, define and deploy an altered strategy as a pilot and monitor the results; and 3) conduct the analysis in clusters, grouping together equipment from different departments.

Then, different processes can be applied to cross-check matrix results and confirm the initial rankings. For example, a failure mode and effects analysis (FMEA) provides a qualitative analysis to determine system reliability. A root cause analysis (RCA) or 5 Whys analysis also can be utilized by the team to help determine cause and effect relationships. Employing a range of tools can help identify potential failures, consequences, or circumstances not considered during the criticality ranking.

Consider the following challenges a refinery may face:

- The bearings on Asset A have a history of failing every seven to eight months. A preventive maintenance task has been established to automatically replace these bearings every six months to preclude the anticipated failure. However, there has not been an adequate analysis conducted as to *why* the bearings are failing.
- Asset B has a task to replace the gearbox lubricating oil biannually, but maintenance is concerned that this is an instance of over maintaining the unit. No problems have ever been detected when the oil is drained and replaced.

> The potential cost of lost productivity alone may place an asset in a higher bracket than initially classified.

- Asset C has a task to annually break and clean a coupling and confirm proper alignment, although no misalignment has ever been detected in past inspections.
- Asset D has an annual task to check wiring and its terminations in the maintenance control center (MCC) for loose connections and burned insulation. In five years, only two problems have ever been identified, both were unsubstantial.

At this juncture, any existing maintenance strategy and any current controls for prevention and detection should be reevaluated. The historical and potential failures should be listed for the components, with their respective controls and strategy, to identify what is and isn't working. Once this list is compiled, the team can progress to Phase 4.

PHASE 4

Define/Create the New Strategy

Using the list created in Phase 3, the team embarks on what is possibly the most arduous task of the entire exercise — developing and agreeing to a new or altered maintenance strategy. At this point, the crew must decide what activities might increase reliability, productivity and overall equipment effectiveness (OEE) and reduce failure. There are five major avenues that can be explored and applied to arrive at a suitable maintenance strategy for a given piece of equipment and its components.

1. **Preventive Maintenance (PM)**: Regularly performed standard repair, replacement, inspection, cleaning and lubrication.
2. **Predictive Maintenance (PdM)**: Employing condition-based monitoring technologies, such as vibration analysis, thermography, tribology, acoustic analysis, wear particle analysis, or x-rays.
3. **Proactive Maintenance**: Applying the results of the data derived from PdM to preemptively drive the work at the opportune time, with FMEA/RCA conducted after any subsequent failure to determine the cause and undertake corrective action to reduce or eliminate possible recurrence.
4. **Redesign/Enhance**: Occasionally, there is a component of an asset that does not lend itself to maintenance easily, or at all. This may be an inconveniently located bearing or a component that is not sufficient to meet the demands placed on it. In this case, either an enhancement or a redesign of the item could be implemented, possibly working with the original equipment manufacturer.
5. **Run to Failure**: Do nothing, wait for failure to occur and then correct it.

The team must determine which of these methodologies, or a combination of them, should be used for the job. They will have to consider a variety of factors. For example, if a company needs to get new tools or the implementation is difficult, employees may need additional training, costing valuable time. A strategy's cost-benefit, return on investment and length of time between application and anticipated improvement will all influence the decision. The ideal situation would be if a site can increase productivity and reliability without any production downtime.

> The team embarks on what is possibly the most arduous task of the entire exercise — developing and agreeing to a new or altered maintenance strategy.

Possible solutions to Phase 3 challenges:

Asset A: In the example of bearing failures, FMEA or RCA can determine the cause of premature malfunction. The reason could be anything, including poor design; incorrect, insufficient, or over lubrication; inappropriate lubricant; improper installation or misalignment; the wrong application of parts; or operating the unit past its designed envelope. Once the root cause has been identified, the appropriate strategy, redesign, or enhancement should be put in place. In this case, the solution could be improving a bearing pedestal that lacks the rigidity needed to dampen an inherent natural harmonic frequency.

Asset B: The gearbox lubricant oil replacement dispute is a prime candidate for a combination of tribology and vibration analysis. The strategy could be to replace the oil at the next calendar driven cycle, or even immediately, and then begin conducting oil analysis, starting with, perhaps, a quarterly frequency. A vibration analysis could be conducted to check for internal wear or damage. The vendor that supplies the oil for the gearbox may conduct an oil analysis as part of its services. Depending on the cost of the oil, the labor to replace it and the lost production while the unit is down for the oil change, this may be a very viable alternative to an automatic biannual oil replacement.

Asset C: Rather than disassemble a coupling for which no issues have been reported, a monthly vibration check could be performed with the motor and driven unit bearings to identify any misalignment via the axial readings of the vibration signature. An annual lubrication may still be required, but the downtime to perform this function would require less time and replacing the lubricant would only require the labor of one oiler, not two millwrights.

Asset D: The MCC in the example should be inspected using a thermography preventive maintenance technique. These checks can be performed with little to no effect on regular production, while providing a more accurate representation of the condition of the wiring, terminals and any other components contained in the MCC. Remedial action should only take place if the thermography indicates potential problems.

The most rarely used maintenance strategy is the run to failure option. This is generally applied when the costs of labor and material do not warrant any strategy. For example, a 1/4 HP motor with sealed bearings on a conveyor segment would run to failure. This motor likely would be one the site has in its stores or an item that local vendors have in stock. Very little is gained from performing maintenance on such a low priority component.

Before implementing a new maintenance strategy for a piece of equipment, the asset should be cleaned, lubricated and rebuilt beforehand so it goes into the next step performing at its optimal design capacity. Otherwise, the unit will, by and large, continue to require attention through unplanned outages and will not gain much through improved reliability. For example, performing tribology on a leaking gearbox or conducting a vibration analysis on bearings that are already exhausted and nearing failure would be a waste of time.

Regardless of which strategy is selected, all activities should be performed by the operators. Simple, autonomous PM tasks, such as cleaning, checks, inspection and lubrication, can be passed to the operator staff with minimal training. This approach frees up the trained maintenance staff to concentrate on more critical activities that may require a broader, more in-depth skill set.

PHASE 5
Updates

Once the new strategy is in place, it must be monitored for effectiveness and completeness. If technological solutions, such as PdM, were implemented, a baseline must be acquired with the initial inspection. This provides the denominator to measure against going forward. If it appears the new strategy is not meeting expectations, additional analysis needs to be performed to determine the gaps for what is lacking in the current approach. This is the check-act portion of the Deming Cycle (Figure 2), which is frequently over-

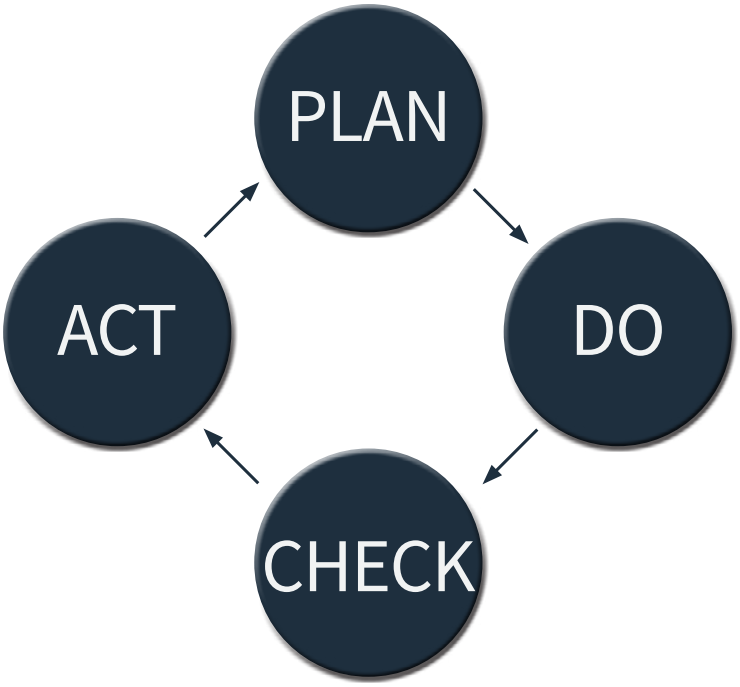

Figure 2: Deming Cycle of continuous improvement

looked or disregarded, to ensure a dynamic, sensible approach is employed to extend the life of the various components that make up an asset. The team may need to go back to Phase 3 and work through the process to identify missing or ineffective methods to close any remaining gaps.

CONCLUSION

There is no one size fits all strategy for effective maintenance. A certain level of flexibility is necessary to roll with the punches and embrace the appropriate strategy. Continuous improvement is an ongoing process. It requires monitoring, record keeping and updating to take place throughout the lifecycle of an asset and its components. Team members, circumstances and situations within a company may change over time and the maintenance strategy needs to keep up. Ensuring a proper, continual maintenance approach must be a high priority for maximized productivity and guaranteed optimal equipment performance. Employing the proper maintenance strategy that ensures the right work is performed at the right time with a minimally invasive methodology will help drive improvements in reliability, thereby stimulating increased productivity and the lifecycle of an asset.

***Mike Johnston**, CMRP, is a Senior Consultant at T.A. Cook Consultants. With over 30 years of professional consulting experience across North America and the UK, Mike is an expert in delivering maintenance excellence solutions to clients in asset heavy industries. He provides strategic turnaround, maintenance work processes and uptime improvement advice to businesses in the oil and gas, petrochemical and chemical industries in North America.*
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AN ASSET MANAGER'S GUIDE TO HARVEST MANAGEMENT COMMITMENT

James Mourafetis

The Oct/Nov 2016 *Uptime* article, "An Asset Manager's Guide to Building a Meaningful Company Vision," explained why it's essential to have a company vision at the department level in order to gain collaboration and create excitement among department level managers. Next, this article explains why it is crucial for the enterprise asset manager to guide department level managers toward an understanding of how to translate their vision into a top level, order of magnitude for change. In other words, a company vision is only good if it can be sold to the executive level team of your organization.

In order to do this, the enterprise asset manager must translate the department level vision into an order of magnitude across the spectrum of short-, mid- and long-term operational and financial benefit for the organization. Then, even after having that credible story line, the real challenge becomes gaining actual commitment over time based on the right level of trade-offs, not only among managers within the same department, but also with interrelated departments. Here are five steps to accomplish this:

1 Develop the value-added order of magnitude potential

The barometer is the gauge for change. The problem is, which measure should you choose? Remember, what you want to measure is related to what the asset's intended purpose is and, fundamentally, that's it in order to measure magnitude. Don't be consumed by the key performance indicators (KPIs) launched at you by various department managers. Those are only meant to distract from what's important.

One recommendation is to come up with one operational measure for the asset that translates into financial expense, both in operating expense (Opex) and capital expenditure (Capex) offset. Refer to Figures 1 and 2 from the February/March 2015 *Uptime* article, "EAM to Improve Asset Utilization & Reduce Costs." You need a simple measure to quantify the percentage of time an asset is performing what it is intended to do, then convert that into operating expense improvements or capacity-enabled capital expense offsets.

2 Assess retirement dates of key stakeholder managers, both within the department and across interrelated departments

At this point, it must be an exciting time for you to have department level visions drafted and managers positively energized, and to have an understanding of what is considered good in terms of operational performance, real costs and real capacity opportunities. Now, day two sets in and that's when key department managers and their direct reports begin to internalize how a new world will impact their sacred cows. *This is the first real risk facing enterprise asset management (EAM) implementation.*

A critical action by you, the EAM champion, is to develop a key stakeholder commitment map. Then, based on the information you can acquire, develop a timeline chart listing projected retirement dates for key stakeholders.

In the world of company politics, it's those with influence who determine the direction of an initiative, whether it be large or small, regardless of the good intentions of those who try to bring about change. That's why it is more important to understand which strategic relationships are a threat to the progress of the EAM journey than to know which ones support you. This is a very important map that you need in order to develop a proactive strategy to manage these critical relationships. Moving key stakeholders from "working against you" and "casual relationship" (blue and green, respectively, in Figure 1) to "aligned with you" (red in Figure 1) should be 90 percent of your effort along this journey.


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END
FACTORS
SPECIFIC
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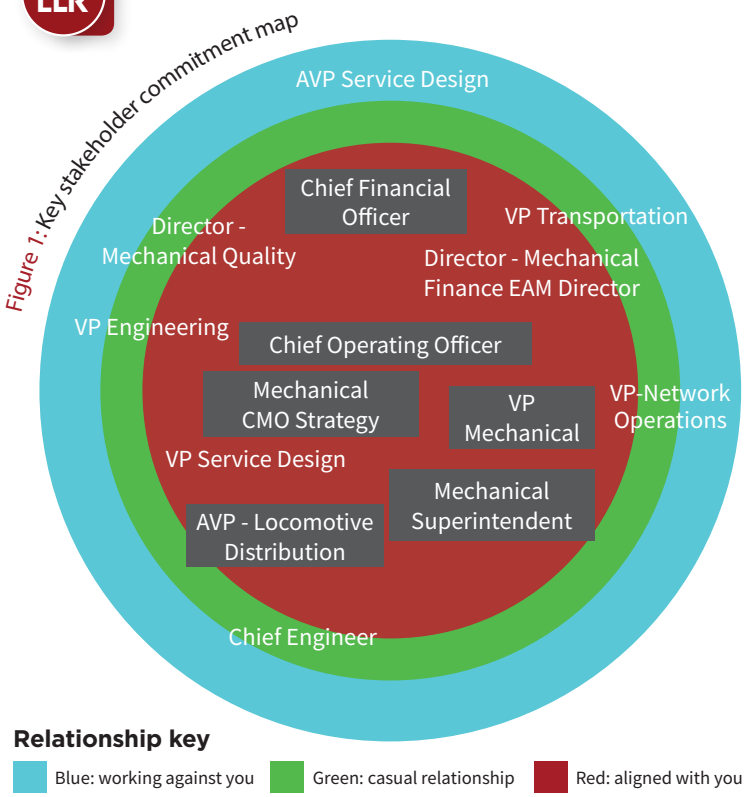


Figure 1: Key stakeholder commitment map

Based on the key stakeholders you have identified and what their relationship is to supporting, attacking, or being neutral to the organization's EAM initiative, you need to now assess when their careers expire. This is an extremely critical action on your behalf; your strategy for managing the key stakeholders depends on their longevity within the organization.

Consider this example for a railroad: If you have uncommitted, but non-threatening support for EAM by the chief engineer and he or she is retiring within six months, then your strategy may not need to focus on getting him or her to red (Figure 1). Instead, your strategy may be to ensure that the relationship to support the EAM initiative does not turn to blue. On the other hand, if you know the vice president of transportation is destined to be the chief operating officer and he or she is somewhat committal to the EAM initiative, but not fully on board, then this is a key strategic relationship to develop.

3 Develop a trade-off matrix

As you are thinking about how to transition from a more traditional function-based to an EAM-based organization, you eventually will reach an inflection point that will challenge the fundamental approach to how your organization determines capital investment and how it operates assets to run the business. This crossroad is the look in the mirror by top management that leads to the fundamental question of whether to transition the organization to an asset-based management system. This type of system ultimately means better use and reliability of assets over the current model of suboptimizing the use of assets to maintain reduced variable operating expenses.

Trade-off Matrix		Network Operations	Mechanical	Transportation	Engineering - Track Maintenance
Functional Department	Key Action	Trade-offs			
Service Design	Redesign train plan to increase frequency of train consist trips	Increased number of road crews	Increased maintenance inspection & repair of locomotives and railcars	Increased yard crews to assemble train consists	Increased number of inspections and repairs with reduced number of hours of track time
Service Design	Reduce terminal dwell	• Road crews waiting on trains to get into terminals • Reduced overall network velocity	Reduced time to perform train inspections	Risk of reduced on time departure performance	Increased time of trains over the right of way means less time to inspect and maintain tracks
Locomotive Distribution	Reduce fleet size to increase asset utilization	Increased opportunity for train delays waiting on locomotives to arrive to terminals	Increased pressure to improve locomotive availability	Risk of reduced on time departure performance – waiting on locomotives	N/A
Mechanical	Increased maintenance work scopes to improve locomotive fleet reliability	Reduced availability of locomotives	Increased maintenance costs	Risk of reduced on time departure performance – waiting on locomotives	N/A

Figure 2: Trade-off matrix

100-Day Deliverables	Network Operations	Mechanical	Transportation	Engineering	Technology	Finance	Asset Steering Committee	Chief Operating Officer
Sign-off on 1-2 year projects	■	■	■	■	■	■		
Define technology needs, develop investment requirements	■	■	■	■	■	■	■	
Define capital needs, supply to capital committee	■	■	■	■	■	■		
Define Federal Railroad Administration (FRA) needs, start now to define & align with long-term initiatives	■	■	■	■				
Define labor agreement needs, start now to define & align with long-term initiatives	■	■	■	■				
Integrate key initiatives, define trade-offs between key stakeholder departments							■	
Set top level asset goal setting into performance management								■

Figure 3: 100-day deliverables

4 Now the politics begin: Hold coffee shop talks

The one thing about meetings learned from firsthand experience is that in order to have a successful meeting that includes powerful stakeholders in the room, you first need to meet with the powerful stakeholders independently to gain their approval beforehand. The meeting then simply becomes a formality and a showing to their brethren that they support the action. If you don't work the coffee breaks to gain their support, keep in mind that there is the possibility of a grand disaster and perhaps the end of the EAM journey.

> " Without the 100-day meetings, the EAM initiative will inevitably dismantle over a period of several months. "

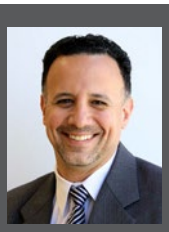
5 Have department managers present their commitments to the executive level team

Establishing a meaningful governance process that holds department managers accountable for the progress of the EAM journey is like having the gravitational force at the center of the Milky Way galaxy. This requires a series of updates to occur with accountability of the management team reporting in 100-day deliverables to the top managers (e.g., chief operating officer or president and the rest of the executive reports).

In the railroad example, weekly meetings occur by department level EAM managers to ensure projects within the work streams are progressing. The updates then evolve to the monthly asset group team, which consists of the department managers and their supervisor, typically a vice president. The vice presidents, facilitated by you, present their 100-day progress of actions to the executive leadership. The purpose of this meeting is to ensure accountability by the vice presidents to their executive leadership that progress is being made on their EAM journey. It also ensures that roadblocks to EAM progress are being resolved, since the trade-offs among departments become true points of contention. *Without the 100-day meetings, the EAM initiative will inevitably dismantle over a period of several months.*

Next Steps

As you can see, the EAM journey cannot begin without significant front-end strategy building and socializing in order to ultimately use these tools to gain stakeholder commitment. The challenges and roadblocks at this point are high, as entrenched values, norms and personal interests are building a major offensive to your organization's EAM journey. But no worries, the fun has just begun. There are still many more barriers to overcome. Are you still committed to your EAM initiative?



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Cmms

The Changing Face of ASSET DATA CAPTURE

Stephen Crampton

Photographic Explosion

In less than 10 years, the consumer digital camera essentially completely replaced film cameras, which had been in the market for over 100 years. In an even shorter period of time, the smartphone has, in turn, sent the consumer digital camera the way of its film based cousin.

Since the introduction of the first smartphone in 2007, there has been an explosion in the use of the mobile device. By some estimates, 20 percent of the world's population purchased a smartphone in 2015 alone.

Unless you've been living under a rock for the last 20 years, none of this should be news to you. More than likely, you have a smartphone with a high resolution camera and it is with you all the time! And because the phone is always with you, how you view photos has changed. No longer are photos reserved for capturing images of people and places; they are now used for capturing information. And, instead of taking notes, you take photos to capture information since it is fast, accurate and free.

Even in hazardous areas of industrial facilities, you can purchase smartphone cases that are certified intrinsically safe to allow your mobile phone to be taken with you virtually anywhere.

While it has become second nature for people to take vast amounts of photographs on their smartphones, management of these large photo archives has not really kept pace with the ability to capture these large libraries of photos.

Amazing new Cloud photo sharing and storage services have emerged to try and bring this back under control, geared around traditional photos of people and places. With some storage services, you can automatically group faces, places, or things.

Libraries of Equipment Photographs

The most accurate information an organization will have about its assets is information that is physically attached to the equipment. Organizations are increasingly using photographs to capture this information. Historically, these photos of equipment have been loaded on a shared directory and, more often than not, they are lost. To make these raw images useful to organizations, they need to be assembled into a library.

Organizing vast amounts of raw data into some sort of meaningful order so relevant information can be retrieved is nothing new in the digital age. Libraries have been around for centuries and what turned them from buildings full of books into repositories of information was the cataloging of individual books and the classification of the content of the books. These two innovations were essential to the retrieval of relevant information from vast stores of raw data.

There are various plates and labels that can be attached to an item of equipment. These plates and labels generally contain essential information for the efficient management of the asset in question. But, if the photos that contain these items are not classified, they cannot be easily retrieved. For example, if you're looking for the labels fixed by a service contractor to a compressor, how would you find them if all you knew was that you had photos of the compressor?

Capture Components and Assemblies

Consider a valve and its actuator, each with its own nameplate. Organizations will typically take a photo that includes both nameplates in a single image, with each nameplate defining a different model and serial number, and often a different make. Once again, if you put all this information against a single tag, how do you know what nameplate belongs to which component?

> *"No longer are photos reserved for capturing images of people and places; they are now used for capturing information."*

Cataloging Equipment Photographs

Just as photos are able to quickly, efficiently and accurately record information about your life, they are an amazing resource for documenting equipment that is physically installed at a location at a particular point in time. It is commonplace now for organizations to take photos of their equipment, but it also creates challenges that are different to those you encounter when taking photos of people and places.

When it comes to equipment, the important thing is to link the photo to a unique equipment ID, typically a tag. Sometimes, a tag may be present on the equipment, but many times it is not. In the same way, photo storage services group photos by face, place or thing, when it comes to equipment photos, you need to group them by equipment ID. This process is called cataloging of the equipment photo against the equipment ID.

Today, there are quite a few applications that will allow you to capture photographs of equipment against a record, notably mobile solutions from most enterprise asset management providers. However, for every one of these in use, there are even more people who continue to take photos, then go back into the office and try to remember which photo was taken against which asset and rename the photos with the equipment ID/tag number – a laborious and error prone process.

A Classification System for Equipment Photographs

Just as with traditional libraries, in order to efficiently retrieve information from vast quantities of photographs, it is necessary to apply a classification system to the photographs. If a photo has been classified at the time of capture, then you know what its contents are likely to be and what sort of information you are likely to be able to extract from that photograph. If all you know is that it is somehow related to an asset tag, then there could be literally anything in each image and it would be difficult to extract the information you are looking for from the image archive.

Efficiency of Capture Is Critical for Success

Capturing photos provides a simple way to quickly obtain a vast amount of information. But, efficiency is key to success. If you have to return to the office to organize and catalog this information, the cost is too high and most of these efforts deliver poor results. But with such extensive use of smartphones, this is no longer an issue. Apps delivered on these devices allow for widespread adoption.

Apps running on smartphones allow photos to be efficiently captured against assets and their individual components, as well. At the time of capture, these photos should be classified to indicate what the contents of the photos are to allow for further interrogation of the vast quantities of images that now can be captured.

Changing the Future of Data Capture

Asking people in the field to key in data is a great opportunity to generate errors, but experience shows that photos can be efficiently captured and usually with great quality. The use of mobile apps on smartphones gives organizations the opportunity to change the way they ask their field personnel to capture information about their assets.

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OPERATOR DRIVEN RELIABILITY AND ULTRASONIC INSPECTION

Jim Hall

Operator driven reliability (ODR) is a process that involves operators in the maintenance and reliability of their equipment. ODR selects tasks previously performed by maintenance technicians and reassigns these tasks to operators. However, ODR is only effective when operators are focused on specific tasks. Operators must be properly trained and coached in the performance of each task.[1]

It's been proven that ODR can make a difference. But, how much more of a difference can be realized with more fundamental training? Finding qualified technicians with the skills needed to perform even the basic maintenance tasks is becoming harder and harder. The same young adults that used to spend time in school learning mechanics, paint and bodywork, metal working, or graphic arts are spending their afternoons and evenings with a video game and joystick fantasizing about destroying alien invaders.

> Ultrasound is a technology that is not just affordable, but the return on investment (ROI) is often instant.

Industries today include automation that is more mechanical and electropneumatic. Not to mention technology that is so advanced that training anyone can take years.

What experience from sitting on a couch, at a desk, or at a computer prepares you to repair your car or truck? Or, prepares you to do menial tasks around the home? Bring back those vocational schools that can prepare students to carry on and fulfill the needs of industry and manufacturing.

[1] Credit: Introduction, Uptime® Elements™ Passport Series for Certified Reliability Leader ODR Booklet

Now granted, many people have gone to online videos to learn how to tear apart a modern day washer or dryer to remove a sock or change a belt. But, you cannot stop a production line to allow someone to view a video on how to find a vacuum leak or what to listen for on a motor bearing. These are basic, yet fundamental, tasks that every operator should know.

So, where are the industrial plants, manufacturers and utilities going to find these needed resources to fill these positions? Recent online research of this topic found many places where several high-tech companies realize the need to train today's millennials. This Internet search also found several statements about millennials from many sources, but the next section highlights those that were more on target.

Millennials: Zero Tolerance for Outdated Training and Technology[2]

Millennials are the first digital natives. When you start using computers, tablets and cell phones while still in diapers, you have a whole different perspective on technology and its role in everyday life. The "lunch and learn" presentations and half-day sessions used in training today are about as old school as dial-up Internet to this generation. As difficult as it is to imagine, PowerPoint® isn't popular anymore.

So, how do you attract, train, and retain millennials? Here are some tips provided by T.J. Bain of Instructure.

GET SOCIAL – Include elements for social sharing and engagement. Seventy percent of millennials have friended a manager or coworker on Facebook®.

STAY BITE-SIZED – Millennials switch between tasks up to 27 times per hour. That doesn't give you much time (around 2.2 seconds or less) to get your message across. Think short videos (under 5 minutes) and resource libraries for self-guided study.

FOSTER COLLABORATION – Eighty-eight percent of millennials would rather collaborate than compete at work.

GIVE FEEDBACK (AND FAST) – Ninety-five percent of millennials work harder when they know where their work is going. Remember, this is the instant gratification generation, so provide same day feedback, if possible.

[2] Referenced from "An informative guide to working with Millennials" by T.J. Bain; Published on LinkedIn, November 11, 2015: https://www.linkedin.com/pulse/informative-guide-working-millennials-t-j-bain?forceNoSplash=true

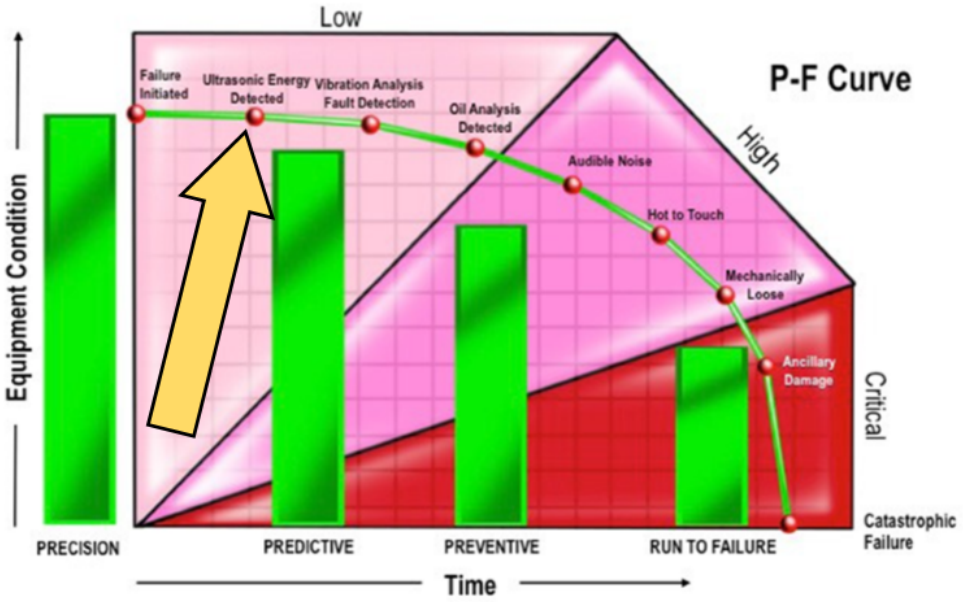


Figure 1: Ultrasound, the earliest detection of equipment condition

SET THE FRAMEWORK, THEN SET THEM LOOSE – Tell millennials what's expected of them and then get out of their way! This generation is all about discovery, curiosity and maintaining control of their own destiny.

Establishing a Millennials-Friendly ODR Program

The key to having an operator driven reliability program is to have a person trained in the basics, such as ultrasound predictive maintenance (PdM), infrared imaging and vibration analysis. Of these technologies, ultrasound has the lowest learning curve and is easiest to implement. Yet, very few operators understand the concept of how to use ultrasound, let alone its benefits.

So, why ultrasound? Ultrasound is that one technology that anyone can learn with little training. Technicians can greatly increase their confidence in the operation of the equipment they are assigned just by attending an ultrasound Level I course.

Ultrasound is above the human hearing range, defined as sound above 20,000 hertz or 20 kHz. What's noisy to you is not detected by the ultrasound receiver, therefore, ultrasound can be used in a noisy environment. Ultrasound is the earliest detection of bearing defects. Think of ultrasound as an early detection system for motor bearings, leakage, electrical faults, etc.

Think of a gearbox with a clicking sound. When first noted, it was hardly noticeable; it probably didn't even scale an additional decibel above the previous reading. But, after several hours, days, even months, the operator hears the clicking sound and it's becoming more and more pronounced. Bingo! Now, rather than later, a work order is initiated and the shutdown or loss of production is avoided.

Although ultrasound is the earliest detection tool compared to vibration and infrared technologies, this early detection means ultrasound can be very subjective. But, that's also why decibel readings and recorded wav files play a large role through waveform analysis and the diagnostics of motor bearings. Is it vibration analysis? No.

The Benefits of Ultrasound

Ultrasound, vibration and infrared are all complementary to each other. But, ultrasound has other benefits, such as detecting vacuum or pressure leaks and motor bearing defects, electrical scanning of switchgear (e.g., arcing, tracking and corona), and hydraulic inspection of valves, solenoids and steam traps. Depending on the manu-

Figure 2: Operator learning to use ultrasound instrument that allows the individual to find temperature of bearing as well as datalog decibel reading, tachometer, accelerometer, as well ultrasound sensors, bluetooth and record bearing sound for further diagnostics.

facturer or industry, there are many more benefits, such as an onboard camera, digital recorder, data logger, laser pointer, on-screen fast Fourier transform (FFT) and/or time series and even a strobe (i.e., optical tachometer).

One area of ultrasonic testing (UT) training that many either fail to comprehend or never actually think about is how to use ultrasound in a noisy environment when there's competing ultrasound. Don't lose out on potential profits. Avoid downtime and save energy by learning the basics!

Besides being the simplest of the technologies to learn, ultrasound is a technology that is not just affordable, but the return on investment (ROI) is often instant. So, why aren't you employing this technology in your facility?

Meeting ODR Goals With Ultrasonic Inspection

The purpose of operator driven reliability is twofold. The first goal is to free up maintenance technicians by involving operators. With operators performing tasks that maintenance technicians usually perform frees up maintenance resources to be redeployed on higher level predictive and reliability focused tasks.

The second goal is to find tasks that create less downtime for the operators to perform than if a maintenance technician was required to perform the task.

Both ODR goals must be balanced against operational tasks already assigned to operators to prevent any loss of production caused by the operator performing maintenance reliability tasks on the equipment.[3]

ODR Workforce Development

ODR personnel are focused on the operation of a particular asset. However, as the whole maintenance program evolves, ODR personnel need to evolve within. They need to be able to change a filter, tighten a bolt, secure a panel or housing and perform other basic maintenance.

Very basic skills should be owned by ODR personnel. For instance, these basics include leak detection and ultrasonic inspection of motor bearings, along with other minimal tasks, such as how to change a filter.

Dean Cotton, CRL, CMRP, and the Society for Maintenance and Reliability Professionals (SMRP) Florida Education chairperson, shares his opinion regarding ODR and workforce development. "Manufacturing operators coexist with their machinery day in and day out. Due to the nature of continuous operation and a desire to improve, operators gain the craft knowledge of what their machinery needs on a daily basis. The key to ODR is giving its operators the basics or essential skills to perform rudimentary, routine PdM on a daily or biweekly basis and as needed for troubleshooting.

"While many advanced manufacturing plants might have four to 10 PdM technicians, this may not be enough to cover even a modest sized plant due to the thousands of assets. By leveraging the operators, say fifty percent of the operator workforce of 200, you now have an additional 100 PdM basic technicians for ODR. Having an increased insight into the condition of the machinery ahead of an actual catastrophic failure or even functional failure is a key component to a successful PdM Program. This isn't a replacement for PdM technicians, but an extension for increased reliability. Your next generation of PdM technicians could come from ODR."

He further points out, "Using ODR ultrasound for pre- and post-preventive maintenance (PM) surveys will help to focus the maintenance performed during the PMs. With pneumatics, the best time to catch a leak is as early as possible for savings, rather than months or years later when the savings have leaked away.

"In the end, everything comes down to risk and value. With available resources and minimal training (i.e., low risk, high value), operators can significantly increase the granularity or resolution of a PdM program and increase overall reliability with minimal costs."

ODR personnel should be taught to be leaders who can perform tasks on equipment under their responsibility. Or, as some refer to as, they "own it."

Figure 3: Today's ultrasound instrument is more than just air leaks and steam traps. This instrument is touch screen, temperature, laser, optical tachometer, camera, record audio, datalogging, Bluetooth and more. Operators with little or no experience will have a better understanding and ownership when they utilize these instruments.

How about a leak on a pneumatic line that maneuvers a product into place to be drilled? You want to empower them to find defects and report them. Other tasks will need input prior to repair in most cases, especially in a unionized plant.

Teaching the basics of ultrasonic inspection should be part of ODR workforce development. As a receiver of sound, an ultrasound instrument is a translator of high frequency sound waves that, once received, are amplified, heterodyned, or demodulated to a low frequency so you can discern

[3] Credit: Chapter 3, Uptime® Elements™ Passport Series ODR Booklet

Figure 4: Technician using ultrasound to locate air leak on robotic arm. (Photo courtesy of All Leak Detection & Locate, LLC)

them and, perhaps, diagnose a problem by listening with headphones.

Here's an example of how ultrasonic training can be valuable. As part of a maintenance team's training, the group had trouble looking for a vacuum leak on an asset. The plant had purchased an ultrasound instrument 24 months earlier and had very little luck locating vacuum or pressure leaks in this one area. One team member described how the ballast from the fluorescent lights emitted competing ultrasound and interfered with finding the leak. The operator had entered the area where the suspected vacuum leak was and began scanning using the headphones and the instrument set at 40 kHz. After just two to three minutes of scanning, the individual gave up trying to identify the leak.

> ODR personnel should be taught to be leaders who can perform tasks on equipment under their responsibility.

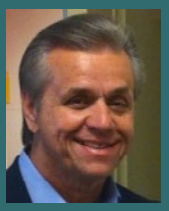
This particular asset was a printing operation that uses vacuum to hold the paper in place during the operation. Shutting down the operation and finding the leak was a large job requiring many man-hours and the loss of production was substantial. But, the decision was made to hit the stop button, shutting down the asset.

Had this operator been taught the basics in the use of ultrasound, particularly how to locate a leak in a noisy environment, he/she may have learned how to utilize the frequency tuning option, lowering or raising the frequency one to two kilohertz to eliminate or simply greatly reduce the interference, this unscheduled downtime may had been avoided.

Another operator in a paper mill in southwestern Alabama had several steam traps to inspect, but didn't know that another department within the plant had an ultrasound kit that had been purchased just to locate compressed air leaks. Had the operator and others been trained in the use of ultrasound, they would have known about the contact module that was included in the ultrasound kit. This contact module would have allowed the end user to ultrasonically inspect the traps' condition.

Conclusion

When implementing an operator driven reliability program, you must clearly understand why ODR is being implemented. In other words, it must be made clear that implementing ODR is going to produce additional equipment availability or reliability, or is going to free up maintenance resources to be redeployed in higher level predictive or reliability activities. An organization needs to have the proper focus in order to be successful in implementing ODR.



***Jim Hall** is Executive Director of The Ultrasound Institute (TUI) and contributing author for Uptime Magazine. He specializes in training maintenance personnel in the use of airborne ultrasound equipment and the development of integrated maintenance programs. Jim has been in the ultrasonic market for over 25 years and has the ability to provide easy and understandable information to all levels of maintenance personnel. He has trained many Fortune 500 companies across numerous industries in the use of airborne ultrasound. www.theultrasoundinstitute.com*

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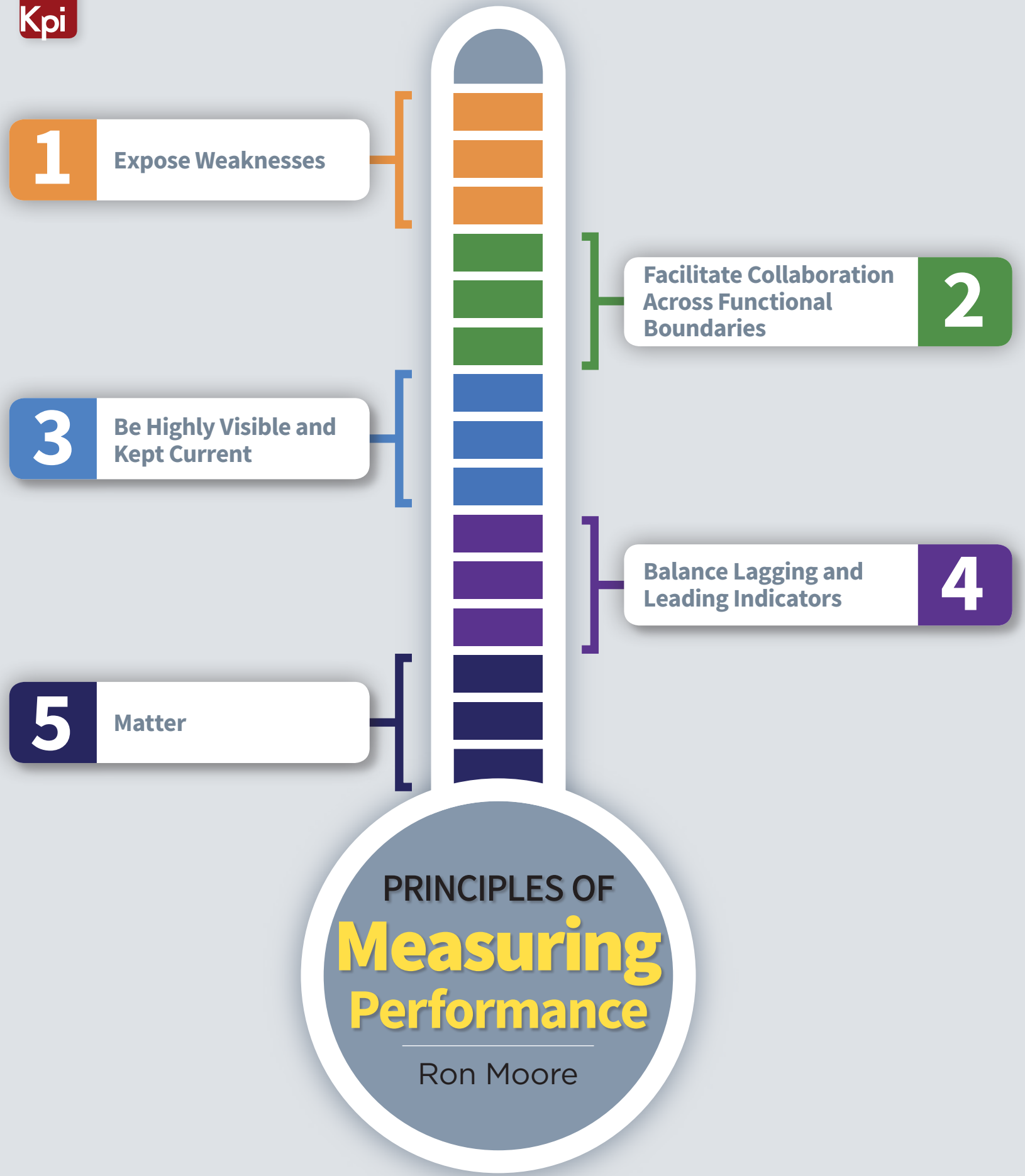
1
Expose Weaknesses
2
Facilitate Collaboration Across Functional Boundaries
3
Be Highly Visible and Kept Current
4
Balance Lagging and Leading Indicators
5
Matter
PRINCIPLES OF
Measuring Performance
Ron Moore

Engineer and management consultant Joseph M. Juran said, "If you don't measure it, you don't manage it." It's a fairly accurate statement. But, another question might be: "If you do measure it, does that help you manage it?" Far too often, experience shows that it does not, for a host of reasons. Some of these include: having too many measures leading to complexity and confusion about what's important; a lack of focus; measuring the wrong things; not measuring things that are truly important to the business; having measures that are in conflict across functional boundaries; or not displaying the measures prominently or, if displayed, not keeping measures current, resulting in employees considering them unimportant (after all, if you don't keep the measures current, how important could they be?).

This article does not describe what you should measure, except perhaps in the form of examples to illustrate a point, but rather shares thoughts to consider about key principles to follow in developing your performance measures. Your performance measures must do the following.

1. Expose Weaknesses

Your performance measures must expose your weaknesses so you can improve them. Another way of saying this is: "Do you want to look good, or be good?" Far too often, measures are "gamed," that is, jiggered to look good, but on further review are really just a sham. The most common of these is planned and scheduled maintenance. You can have excellent schedule compliance – just don't schedule much work and leave a lot of buffer time for reactive work or idle time/lost productivity. Your schedule compliance will be excellent, but your costs will be high. The objective of planning and scheduling is to get more work done more efficiently, not to simply look good.

Another common one is overall equipment effectiveness (OEE) and its brother, asset utilization. If you want to show high OEE, don't use your maximum demonstrated sustainable rate or pick one that's determined over a long time period to discount all the upsets in your system. And, don't count short stops, start-up and shutdown losses, planned weekend or night maintenance, and so on. Again, the question is, do you want to look good, or be good? If you want to be good, **measure all your losses** from ideal and then **manage them**!

Other examples that might be used to expose weaknesses include: unit cost of production (ideal vs. reality); on time, in full delivery (target of 100%); returns/claims (target of 0); injury rate (target of 0); production schedule compliance (target of 100%); maintenance schedule compliance (100%); and any other measures key to your business success. It's unlikely you'll ever achieve any of these levels of performance, but the point is not that. It is to identify your losses from ideal, your weaknesses, and then manage them, making business decisions about the value and impact of eliminating any particular loss. However, all these measures must be balanced against one another, which leads to the next principle.

2. Facilitate Collaboration Across Functional Boundaries

The extensive research of Edgar Schein indicates that the process of organizing creates naturally competing groups – shifts, plants, divisions, etc. That is, people and groups are naturally competitive! He goes on to say that **as task interdependence increases, teamwork and collaboration become increasingly critical for organizational effectiveness**.

Taking his research to the next logical step then, performance measures must facilitate collaboration, not conflict, across functional boundaries. This principle is particularly relevant in functional groups with high task interdependence, for example, between production and maintenance across shifts, between purchasing/stores and maintenance and between marketing and manufacturing. Far too often, examples where performance measures facilitate conflict across these functional boundaries are evident. For example, when production is held accountable for meeting the production plan with quality product, but this comes at the expense of not doing maintenance in a timely way, that is to the detriment of maintenance schedule compliance (unless you just don't schedule much work) and to the long-term detriment of the business. Or, when maintenance is held accountable for maintenance costs, but does not control those activities (e.g., design, purchasing and operations) that induce most of the defects that result in a maintenance requirement. Also, when maintenance is held accountable for quality and timely repairs, but does not control spare parts stocks. Another example is when purchasing is held accountable for keeping parts inventory low, but does not control the store room. Or, when marketing and sales do not consider the ability of production to deliver a quality product at a reasonable cost in a timely manner. The list goes on relative to the conflicts that can be created when silos are created and measures within those silos result in conflict, not collaboration.

> "Not everything that can be counted counts, and not everything that counts can be counted."
>
> ~ Albert Einstein

So, how do you get collaboration? By having superordinate goals that take priority over group interests, by constantly asking, what's the right thing to do for the business, and by having cross-functional measures that assure collaboration. For example, to facilitate collaboration between production and maintenance, have one production plan, which includes the maintenance plan, and hold BOTH accountable for maintenance and repair costs, production and maintenance/preventive maintenance (PM) schedule compliance, and on time delivery. To facilitate collaboration between purchasing/stores and maintenance, hold BOTH accountable for inventory turns on parts and stockout rate/service level. To facilitate collaboration across shifts, demand consistency and standard work across all shifts that work in partnership and don't reward a single shift for performance, but rather reward all shifts for steady performance across all shifts. Other examples could be cited, but this should be sufficient to get your thinking started for using cross-functional measures to facilitate collaboration.

Related to cross-functional measures is the concept that **performance measures cascade** from the executive suite to the shop floor. As previously noted, they must facilitate collaboration across functional boundaries. And, the same can be said up and down the organization, they must, likewise, facilitate collaboration and be supportive, both upward and downward.

3. Be Highly Visible and Kept Current

Performance measures should be highly visible and their display kept current. Too often, certain measures are kept in someone's office, operating in a silo mentality and not shared with employees, except to complain or criticize employees for their lack of performance associated with these measures. Alternatively, they are displayed, but are weeks or even months old, suggesting a lack of importance to those who see them daily. If performance measures are not updated in a timely way, they couldn't be important and employees will behave accordingly.

4. Balance Lagging and Leading Indicators

Performance measures must have the right balance of leading indicators (i.e., the things you do) and lagging indicators (i.e., the results you get). Too often, you see mostly lagging indicators, but this reflects what has already happened and, as the old saying goes, is like looking in the rearview mirror. A far more important issue would be to measure the things you're doing so you get the right results and then drive those with greater energy.

Here are some examples of leading indicators, but you should select those that you think are most appropriate for you. For operators, they might include:

- Process conformance/nonconformance;
- Number of alarms, disabled alarms;

- Number of spills, loss of containment;
- Operator care, PM conformance;
- Equipment downtime, delay times, life;
- Housekeeping conformance;
- First pass, first quality yield;
- Other process specific measures directly influenced.

For maintainers, they might include:

- Maintenance/PM schedule compliance;
- Percentage of equipment aligned and balanced;
- Seal life, number of seals used per month;
- Bearing life, number of bearings used per month;
- Lube compliance;
- Number of leaks per month;
- Other specific measures directly influenced.

Experience indicates that much more attention needs to be given to the leading indicators, engaging the shop floor in doing the right things. If you do, you'll get the right business results.

5. Matter

Performance measures must matter, that is, be used for driving behavior. Albert Einstein once said, "Not everything that can be counted counts, and not everything that counts can be counted." So, you need to do your best to count the things that "count" or matter to the business, while recognizing you won't be able to count certain things, like culture, except in a very subjective way.

However, you can use specific measures to drive the culture of the organization in a positive manner by engaging the workforce in improvement. People do want to change, if given a compelling reason for change, if there's something in the change for them and if they participate in developing the changes so they have a sense of purpose and control. Those changes must be measured to reinforce the new behaviors.

Conclusion

Finally, it's unlikely you'll be able to get everything presented in this article exactly right. Indeed, these principles inherently lead to imperfections within any functional group. However, if followed, the business, on the whole, will be better for it. You will have made great strides in thinking at a systems level, not a silo level, and your business will benefit from it.

Ron Moore *is the Managing Partner for The RM Group, Inc., in Knoxville, TN. He is the author of "Making Common Sense Common Practice – Models for Operational Excellence, 4th edition," "What Tool? When? – A Management Guide for Selecting the Right Improvement Tools, 2nd edition," and "Where Do We Start Our Improvement Program?," all available from the Reliabilityweb.com Bookstore, and of "Our Transplant Journey: A Caregiver's Story" and "Business Fables & Foibles," both from Amazon.com, as well as over 60 journal articles.*

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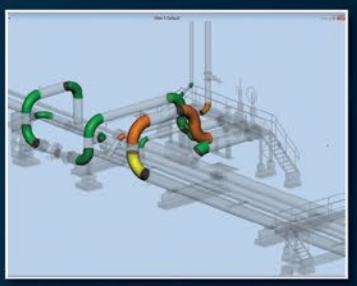

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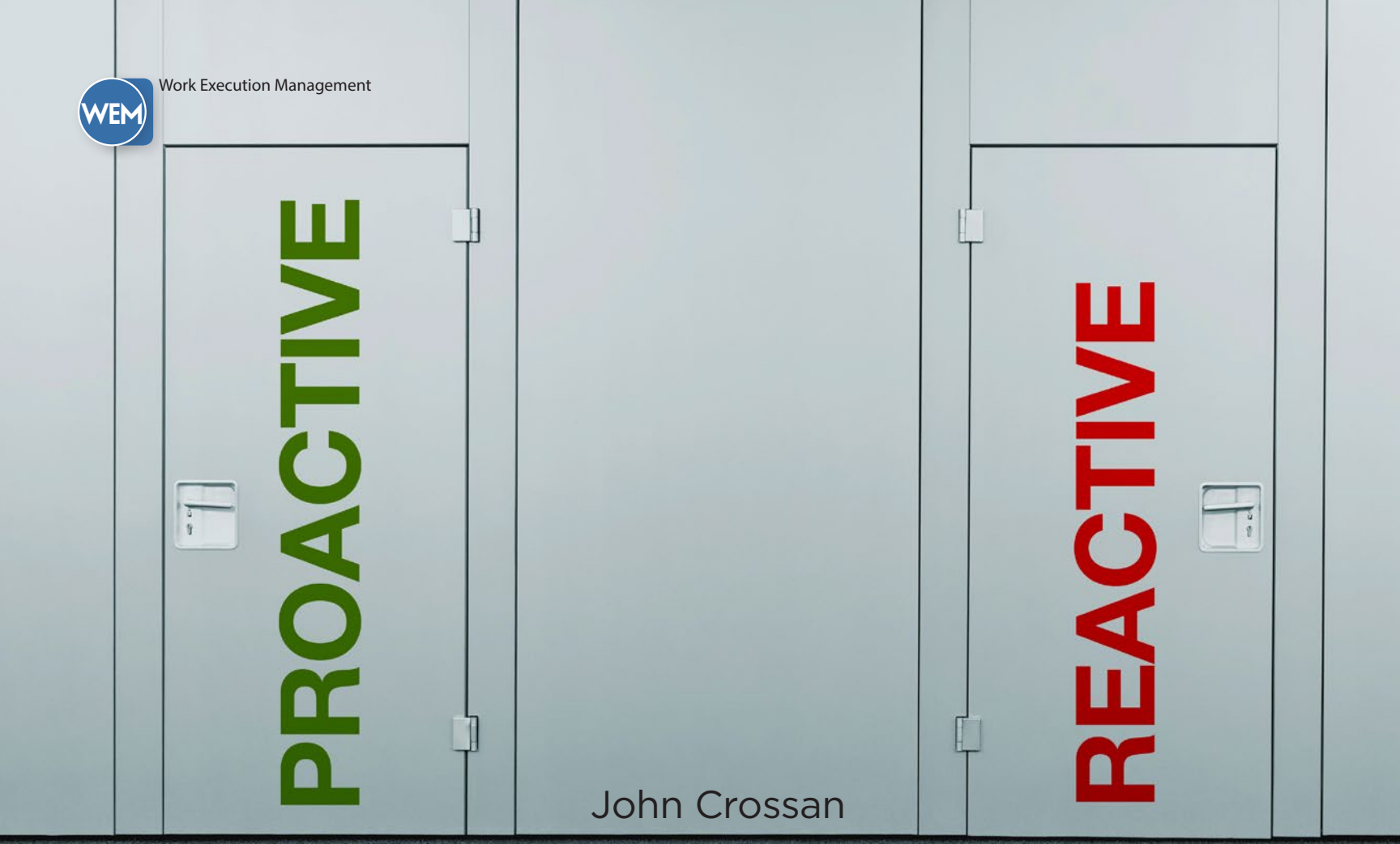


John Crossan

Do We Really Want to Be PROACTIVE? (Part 2)

In Part 1 of this article (Dec/Jan 2017), we talked of how good managers must always try to keep their organizations energized, moving forward and upward. To do this, they must find ways to constantly disrupt complacent, status quo thinking and behavior.

But finding the right way is vital. Managers cause damage when they constantly demand immediate, unplanned, crisis response to equipment failure issues, when this level of response is not needed. This fosters reactive behavior and hurts efforts to develop a proactive culture, as well as damaging overall reliability and organizational improvement.

SO, THE QUESTIONS THEN BECOME:

How Do We Do Both?

- Deal effectively with issues in a proactive way?
- Keep the organization energized?

1. Recognize the Constant Crisis Problem

Just like with any addiction – because that's what using the constant crisis mode is – the first step is recognizing that there's a problem. The constant game of Whack-a-Mole, even though we seem to like playing it, isn't making us any better. In fact, it's really hurting us. Until we realize this, we're not going anywhere. We need a better game.

Of course, we need to energize folks to deal with issues, but we have to do it in a different way. This is a management culture issue.

2. Understand Issues and How to Deal With Them

Recognize that daily loss issues are just symptoms of processes that need to be improved. Just fixing symptoms and never addressing the underlying process deficiency won't make us any better. We need to deal with both.

With equipment failures, it's not simply replacing a broken part as quickly as we can. We have to look for the reason the part broke and determine some ways to eliminate that cause.

But then, we also have to determine why we didn't know that it was getting close to failure, and fix that detection process, too.

Recognize that daily loss issues are just symptoms of processes that need to be improved.

The manager's job is to constantly coach those most directly involved with any issue, to deal with it correctly, in the right time frame. It's also to make sure they analyze and put the longer term, corrected process steps (e.g., preventive maintenance (PM) inspections, operational process improvements, equipment fixes, equipment improvements, checklists, training, etc.) in place to assure that particular issue does not recur.

Those involved have to do the work to own and value the process. People will resist processes introduced by others if their input is ignored.

Dealing with issues isn't just something that has to be done and gotten out of the way quickly.

Done properly, it's actually the mechanism that continuously improves the organization.

Daily Shift Meetings at the line and department level, followed by a management group meeting that has rotating wider participation, are the best places to do this. It's a standard process for dealing with all types of loss issues, that provides not just the mechanism for fixing them, but also, and more importantly, for communication, learning, developing and energizing.

It's where people hear constantly about how they, themselves, are systematically and successfully dealing with plant issues by improving their processes, and they feel good about it.

It's always easy to get tied up in fixing specific issues. But, the manager's job is to improve the processes and the people of the organization.

Most places do a pretty poor job of routinely and widely communicating when issues have been fixed and small improvements made. Folks typically only hear about the negatives, about the failures, and we wonder why nobody seems to feel particularly good about the place, or about each other.

For those impatient with a problem and want to "Just Fix It," it's key to emphasize that it's always easy to get tied up in fixing specific issues. But, the manager's primary job is to improve the processes and the people of the organization. That's his or her task always, and it's much, much more than just dealing with some single issue as fast as possible.

Process for Dealing With Issues:

1. Just Mitigate the Situation

- When an equipment issue arises, unless it's a simple fix, it's simply not possible, or there's the risk of greater damage, just mitigate the situation.
- Don't try to make the permanent fix, just stop the bleeding.
- This is difficult, and even feels dishonorable, for some folks, as they've always been told: "Do it right the first time." But, as we talked previously, it's pretty much impossible to make that correct permanent fix, to "Do it right", just at the drop of a hat. All we really do is waste our valuable time and resources.

2. Every Day Review the Major Loss Issues From the Previous Day

- This includes Processes, Equipment, Quality, Safety, etc., to determine importance and urgency, and to communicate and highlight what needs to be improved. This is done in the daily meetings that must, absolutely, happen every day.
- Set an expectation that when an issue happens, some work must be done quickly to assess its seriousness and get information gathered and documented before it gets lost or forgotten.
- This should be done by those immediately involved, in a non-blaming manner. People can't be afraid to give complete information. We need to develop everyone's capability and build the trust to be able to do this part well.
- Usually, when this process starts, some information is brought to the meeting, but it's usually not complete enough to make good decisions. Question what is known and not known to coach correct information gathering.

- If the information is not sufficient, task the appropriate individuals to gather complete information about the issues and report the next day (unless it just can't wait). Over time, people will get much better at this.

3. Analyze and Plan

- With more complete information available, set an appropriate time frame and assignments of individuals from Operations and Maintenance. They will analyze to determine the problem, the process fix, plan the needed repair and determine the appropriate time frame for the repair. Obviously, the maintenance planner has a key role in this, but he or she doesn't do it all.
- This detail work and, particularly, developing solutions is never done in this meeting, no matter how tempting.
- Emphasize the essential inclusion of those who operate in that area. This work is shared across the organization. Managers and technical staff assist, particularly in developing a systematic approach when starting out, but do not control.
- Always emphasize that issues come from process failures, not from any individual's behavior. Individuals making mistakes is just another process failure of some kind, that needs a fix.
- Set the follow-up date to make sure this analysis and planning work gets done.

> It's pretty much impossible to make that correct permanent fix at the drop of a hat. All we really do is waste our valuable time and resources.

4. Monitor the Analysis and Planning

- Insist this prep work gets done correctly and completely by the follow-up date.
- Review the process and proposed solutions briefly in the meeting for completeness, involvement and communication.

5. Make the Fixes

- Implement the process improvements developed. Schedule the repair and do it in the appropriate time frame.

6. Review for Effectiveness and Improvement

- Set a later date to do this and broadly communicate the results and successes.
- Repeat the process if further action is needed.

Large whiteboards in the meeting room may seem, in today's world, like an old-fashioned way to process information, but the constant, bigger visibility by all, of the issues, responsibilities and follow-up dates is essential. Access by computer screen is still not immediately, and continually visible enough to everyone.

This process, combined with our maintenance work management processes, has to make sure that issues don't get forgotten or bypassed forever. People need to have confidence that their issues and improvement ideas will be dealt with (often by themselves).

The manager has to make sure that this essential, routine meeting process absolutely happens every day and attendance is not optional, even if there are important plant activities. Visiting senior managers, for example, are invited to the meetings. The meetings are not canceled because of them. Even on days when it seems there are no important new loss issues, the process always goes on. There are always issues ongoing, and the process itself is an important improvement issue, that folks are counting on being there.

No matter what, just keep plugging away with this process. Absolutely guaranteed, things will get better.

I still remember sitting in one of these meetings one morning, after months of working at this. And all of us suddenly just looking at each other in surprise, when we realized that, for the first time, there really weren't any significant losses from the previous day. Still plenty of smaller issues, but not the size we were used to.

3. Energize the Organization by Fixing Processes and Communicating Successes

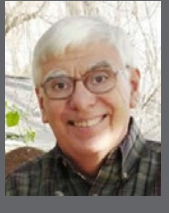
The energizing effect comes from constantly using issues as a way to develop people and processes. Making sure our processes are owned, valued and constantly improved by those who use them and the resulting productivity improvements are communicated and celebrated ongoing. Making sure people know they are empowered and responsible to improve their processes.

If processes are constantly improved by dealing with issues properly, the issues get smaller and smaller. They impact the organization less and less. They're dealt with routinely at the action level, always in a non-blaming manner, and this is a source of satisfaction to those folks. This energizes people continuously and the lack of a sense of urgency is not a problem. The excellent book, "Drive" by Daniel Pink, gives examples and many references on this.

Involving everyone, especially operators, in issue resolutions and improvements, and developing their role in constant equipment monitoring and care, gets them involved, interested and builds the ownership that is the vital ingredient for success. It also builds capability and off-loads the maintenance team a great deal from minor trouble calls.

SUMMARY

Organizations do have to be constantly energized. The sense of urgency for improvement has to be developed and constantly maintained. But, it has to be a rational, well placed, non-frantic, nondestructive sense of urgency that constantly improves the people and processes of the organization, moving them to routinely and systematically act proactively. Not constantly driven directly by the manager, but fostered by his or her behavior and coaching, and owned and maintained by the people in the organization themselves. To give people reasons, and foster an environment where they will constantly push for improvement in a way that's healthy for them and the organization.



John Crossan *consults in manufacturing and maintenance improvement. He spent 40 plus years with major companies in operations and engineering. For much of the last 14 years of this, he mainly focused on improving operations by fostering the installation and ongoing implementation of basic manufacturing and maintenance processes, incorporating lean concepts, across some 30 varied plants in the U.S. and Canada.*

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NEW

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PROJECT MANAGER'S GUIDE FEATURES COMPLETE PROJECT PLAN

Dave Reiber

Reliabilityweb.com just released the *Asset Condition Monitoring (ACM) Project Manager's Guide* and, based on its contents, it's a resource no organization should be without. For several years, I have been involved in asset management and managing condition based asset teams, but never have I seen a more complete project plan than what is presented in this guide. Not everything in the *ACM Project Manager's Guide* will work for everybody, but there are sections in the guide that will adapt to every situation. No matter where you are on your asset condition monitoring journey, at the beginning or with a mature program, this guide contains information that will help to grow and sustain every ACM program.

I, along with my coauthors, Jack Nicholas, Jr., and Terrence O'Hanlon, am excited to share this document with all condition monitoring leaders and practitioners. Please be sure to make time to read the *Asset Condition Monitoring Project Manager's Guide*, but in the meantime, here is an overview and some key points to get you started.

Editor's Note: *Dave Reiber, a coauthor of the newly released Asset Condition Monitoring Project Manager's Guide, gives* Uptime® *readers a preview of the guide's contents and the key components that will help organizations position their asset condition monitoring program to achieve success.*

How to Use the ACM Project Manager's Guide

The *Asset Condition Monitoring (ACM) Project Manager's Guide* provides basic information about what an ACM initiative or organizational component is, how it should be conducted and who should be involved. The material is presented to help an organization determine if it is ready to undertake ACM. The guide also identifies ideas and practices an organization must embrace or improve and notes pitfalls to avoid in order to enhance its chance of success.

The *ACM Project Manager's Guide* is probably best used as a road map to ensure you are not missing key ingredients and checkpoints along the way. The most important ingredient is the development and nurturing of a reliability culture from top to bottom and bottom to top.

The five phases of the asset condition monitoring initiative are spelled out with detail and validation checkpoints. All phases need to be addressed and verified to assure the project continues to move forward with success. The ACM teams (steering and task) must be the leaders of the reliability culture as it grows and gains momentum.

Asset Condition Monitoring defined by the Institute of Nuclear Power Operations (INPO): *"Those activities involving continuous or periodic* ***monitoring*** *and* ***diagnosis*** *in order* ***to forecast*** *component* ***degradations*** *so as-needed, planned* ***maintenance*** *can be performed* ***prior to*** *equipment* ***failure****."*

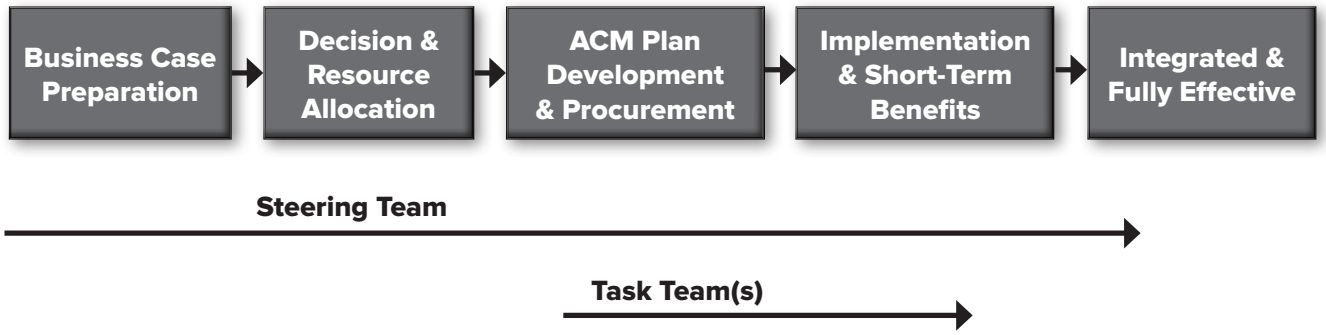

Figure 1: The five phases and timelines for steering and task teams, and who should be involved in these phases

The philosophy of asset condition monitoring is emphasized by this definition and the words in **bold**, which can be related to something people are familiar with: personal health.

- ***Monitoring*** *means watching carefully.*
- ***Diagnosis*** *means to determine health status.*
- ***Forecast*** *means to project or predict future status.*
- ***Degradations*** *mean deficiencies relative to best possible health.*
- ***Maintenance****, in the context of the definition, means to return the health to normal.*

The framework used in the *ACM Project Manager's Guide* is from the Uptime® Elements™ – A Reliability Framework and Asset Management System™. The Uptime® Elements™ chart, shown in Figure 2, provides a map of theory by which to understand reliability leadership and begin creating a culture of reliability. The proven approach to successful asset condition management (ACM) and work execution management (WEM), using the **green** and **blue** colored elements, respectively, must be supported by the reliability engineering for maintenance (REM) **orange** elements on the left side of the chart. These comprise the technical activities which must be supported by the leadership for reliability (LER) **red** and business process asset management (AM) **yellow** elements below in Figure 2. The combination of technical excellence and empowered leadership at all levels is by far the most significant indicator of a successful reliability strategy and program, and an organization that delivers significant results to all stakeholders.

Creating a Reliability Culture

This section is perhaps the most valuable piece in the *ACM Project Manager's Guide*. It ad-

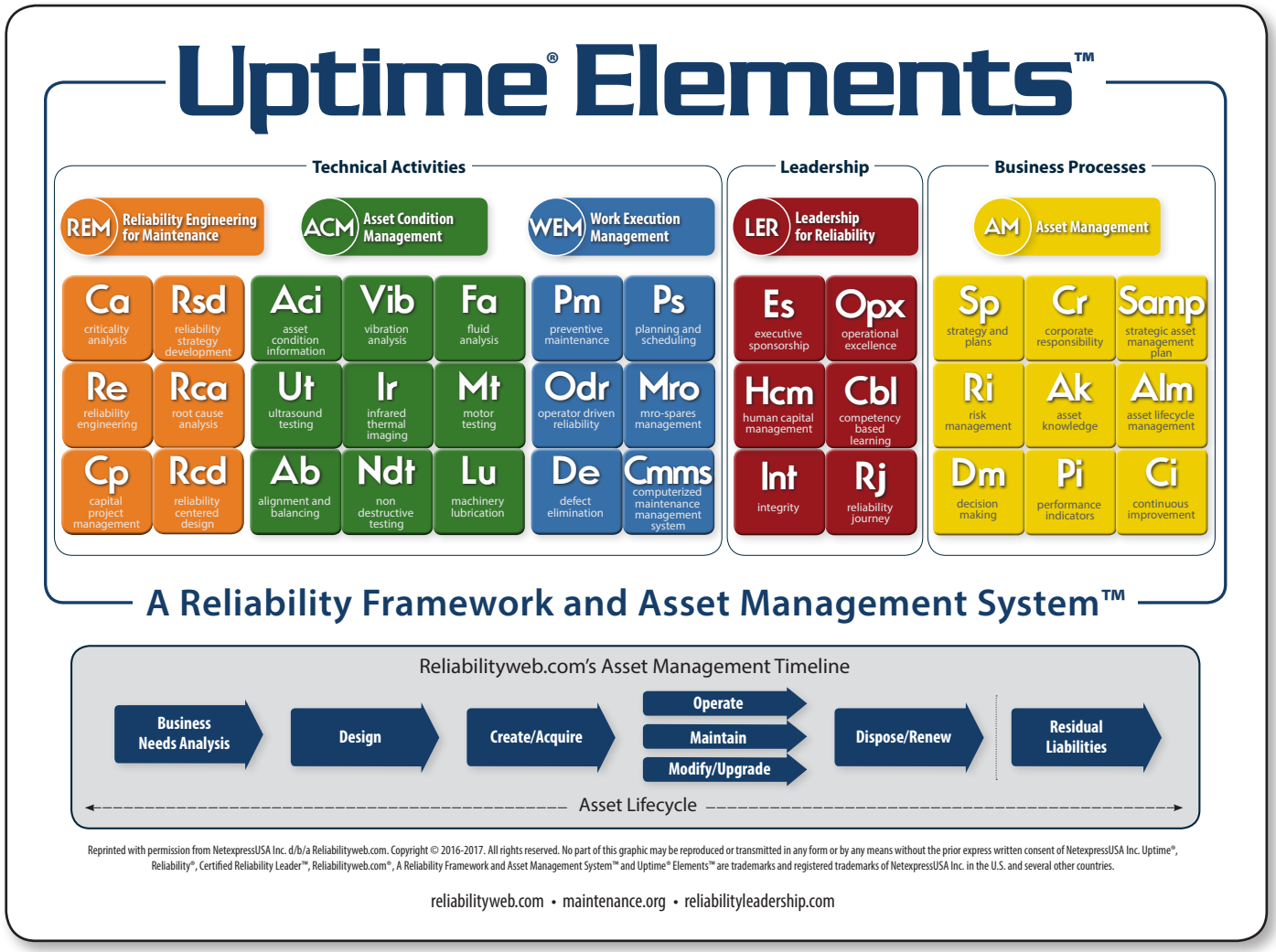

Figure 2: Uptime® Elements™ – A Reliability Framework and Asset Management System™




dresses the necessary culture change. In the past, organizations would try to make significant change to a process or the way they run the business, but there was always resistance to change. Many leaders within the organization, although well-meaning, just assumed the masses would simply line up and do as they were told. This doesn't happen, at least not as a permanent process change. A team accepts and institutes change only after it buys into it. In other words, they must see what's in it for them. This is not easy to accomplish. It takes time and due diligence to address all stakeholder input and then proceed, with the good ideas coming from the team. When team members become owners of the change, they become the best promoters of change.

As the guide points out, regardless of how good your asset management system and reliability strategy may be, your organization's culture will determine its performance. Culture is built from within. A reliability culture must be cultivated and managed by leaders who aim to engage employees in delivering performance excellence in an organization. The reliability culture objective is the most important element of a successful program. All other objectives rely on the success of your team to acquire this reliability way of life.

The ultimate measure of a reliability culture change is when leadership nurtures, but the whole team acts the same way every day, whether the boss is watching or not. Everyone is working toward the same AIM, aligned with the goals and objectives of the business plan. It is difficult to stray from a successful vision when all personnel are focused this way.

Risks and What to Do

There is a section in the *ACM Project Manager's Guide* committed to identifying and mitigating common problems. This section cannot possibly identify every issue, but it does bring to light many of the common issues so the team can address them before they get out of hand. An example of a few are highlighted in Table 1.

Table 1: Example – Risk Factors to Mitigate, Pitfalls to Avoid and What to Do About Them

Risk Factor or Pitfall	What to Do (Best Practice) to Mitigate or Avoid
Candidates selected for ACM teams lack computer literacy	Write ACM team member position descriptions that mandate and test computer literacy (e.g., in CMMS work order writing and reporting finds) as a prerequisite for application
Inability of ACM team candidates to excel in complex ACM technologies and pass certification exams	Write into position descriptions all reasonable technical requirements and courses that must be attended and certification obtained; Set time limits for all technologies to be assigned and levels of competency that must be achieved; Setting expectations shows support and encourages ownership by practitioners
Lack of appreciation by managers, supervisors, team candidates and coworkers of the difficulty in achieving competency in complex ACM technology, resulting in reduction in capability expectations or change to an outsourced program	Include a summary of requirements in manager and supervisor ACM orientation briefings, especially for new managers; See recommendations above and below for team candidates and coworkers

Conclusion

In talking with other maintenance professionals who have led asset condition based projects, they all agree that having access to a document, such as the *ACM Project Manager's Guide*, would have been a great reference as they worked through the many issues presented during the process. As they noted, life would have been a lot easier.

On behalf of my coauthors, we are pleased to provide this reference guide to assure success in your ACM reliability journey.

Dave Reiber, *CRL, CMRP, is Senior Reliability Leader for Reliabilityweb.com. He has 20 years' experience as a leader in enterprise asset management and asset condition monitoring as the former Global Training Lead for Enterprise Asset Management and Predictive Maintenance Business Lead for General Motors. Mr. Reiber is a seasoned international trainer with deep experience in handling diverse cultures and languages. He received a Chairman's Honor Award for Leading Team in developing global maintenance business process and a CIO award for successful enterprise asset management deployment in Liuzhou, China.*

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WHY ORGANIZATIONS LEAVE MONEY ON THE TABLE

Kevin R. Strader

> Is the culture at your facility one that seeks to understand why something failed or is it in a mode where you need to get back up and running as fast as possible?

Why are organizations leaving money on the table by not investigating failures that cost them money? One would venture to say that all manufacturing companies have failures each year that cut into their profit. The prevailing question is: What do you do when that failure occurs? Do you simply fix the equipment, get back up and running, and return to whatever you were working on at the time? Or, do you stop what you are doing and diligently try to understand why the failure occurred and put measures in place to prevent recurrence? Is the culture at your facility one that seeks to understand why something failed or is it in a mode where you need to get back up and running as fast as possible? How about your commercial team and management external to your facility? Is there perceived pressure and a lack of understanding that have driven your organization to a place where failures are not fully understood?

Consider this scenario. Suppose you were working on your taxes on April 14th. In order to take full advantage of every deduction, you wanted to make sure you accounted for all charitable contributions. You log in to your bank account to get a record of these contributions and to your horror, you notice that $10,000 has been wired out of your account without your consent. What are you going to do? Are you going to continue doing your taxes or are you going to stop, call the fraud department and get them busy looking into the problem? A likely guess is the latter would occur and you probably would spend some time investigating it yourself. Granted, you might return to your taxes in order to get them done by April 15th to avoid penalties. However, once completing your taxes, you would probably return to the issue of the $10,000. You would probably stay in contact with the bank regarding what happened and how to prevent it from happening again.

This is exactly what workers are not doing with failures that are costing their companies money when they do not fully investigate and seek to understand them. They are not stopping what they are doing to investigate these failures and determine the physical, human and systemic root causes. Why are they doing this? Why hasn't anyone articulated the importance of this issue to the organization and the value of learning from its failures and preventing recurrence?

Suppose for a minute you did nothing about the lost $10,000. What do you think would happen a few months down the road? You guessed it. The criminal would come back and steal another $10,000. That is exactly what happens at facilities when they don't fully investigate production failures. When you do not eliminate the defects from your system by getting to the systemic causes, you allow a similar failure to occur later on down the road.

So, what should be done when a failure occurs?

First, you must preserve evidence. Evidence is key to any investigation. Without evidence, you do not have an investigation.

Second, you must study the evidence. If you are responsible for investigating a failure, it is imperative that you follow up expediently to study evidence. It is not right to ask operations or maintenance to preserve evidence if you are not prompt at studying it.

Third, you must do your best to understand the physical root cause before putting the equipment back in service. This is hard, as there is always pressure to get the equipment back up and running. This means the culture of the organization must be one where folks are prompt at looking at the failed equipment. You must have a sense of urgency around analyzing the evidence, thinking about possibilities as to how the equipment failed and ruling these in or out based on the evidence you see. Once you have a good idea of the physical root cause, then you need to do your best at not reintroducing this defect back into the equipment when putting it back together. You also need to have a management philosophy, whereas if you are prompt at responding to a failure, then the organization will give you the breathing room to dig into the issue to prevent recurrence. This usually equates to a few extra hours…not days.

Fourth, you must convene a team to investigate the failure. Conducting failure investigations with just one person is just plain sloppy. Conducting an investigation with just one person is basically pencil whipping the investigation to satisfy a requirement and not taking it seriously. You cannot properly investigate a failure by simply relying on the reliability engineer to do it alone. The team should have at least an operations representative, a maintenance representative and a reliability engineer.

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Bristol-Myers Squibb
Nicholas Lenzi
CH2M
Calvin Lyon
DC Water
Vinay Maithani
Emerson Process Management
Sivakumar Mancikavelu
Emirates Global Aluminium
Emily Marcum
Honda North America
Alian Marriaga
Pepsi Beverages Company
Randy Martin
Banetti
Christopher Mendoza
Pepsi Beverages Company
Adam Muthwill
Pepsi Beverages Company
James Neal
DC Water
David O'Neill
Bristol-Myers Squibb
Jerry Overton
City of Dayton / WRF
Thomas Pann
Metropolitan Council
Robert Parsons
Westar Energy
Joey Pate
Weyerhaeuser
David Ivan Perez
Medtronic
Sam Prak
Honda
Mike Preston
Merck
Zach Pusnik
Acquisition Logistics Engineering
Matthew Quick
Fluid Life
Edgar Quintana Pérez
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David Reiber
Reliabilityweb.com
Justin Reid
Enbridge Energy
Angela Remeika
Honda
Philip Rettinger
Central Arizona Project
Jonathan Richards
Bristol-Myers Squibb
Troy Robb
Citizens Energy Group
Eric Robison
Honda Anna Engine Plant
Dillen Rocha
Pepsi Beverages Company
Thivanka Rodrigo
PBF Energy
Herman Roest
Hilmar Cheese Company
Benjamin Rowland
ARMS
Carla Rumazza
Bristol-Myers Squibb
Dave Rump
Honda Anna Engine Plant
Julie Sachar
Bristol-Myers Squibb
Karl Schimmoeller
Honda Anna Engine Plant
Joshua Schumann
Honda Anna Engine Plant
Chris Seibert
Honda Anna Engine Plant
Luke Sestito
Sanus Connect
Brad Shacter
Bristol-Myers Squibb
Abdelrahman Dirar Sharfi Abdelrahman
Siemens
Mark Shierman
The Fluid Life Corporation
Mark Shirley
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Alexander Sinigaglia Nazario
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Shaiju Soman
Emirates Global Aluminium
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CBRE
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Shitiz Sud
Sadara Chemical Company
Edward Taggart
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Fifth, you need to use a process for conducting the investigation. Using a fault tree and 5 Whys is usually sufficient. Again, evidence drives the investigation. Asking "why" or "how" and then using evidence to either rule in or rule out possibilities is a practical way to conduct the investigation.

Sixth, you must identify the three types of root causes: physical, human and systemic. Investigations often stop at physical root causes. Why? Because it is easy to stop there. Physical root causes identify what flaw caused the particular failure. However, simply identifying this cause does not necessarily eliminate future failures from occurring.

You must identify the human root cause: what someone did to introduce the flaw into the system. This is a hard one since no one wants to place blame on a coworker. That is why it is ***imperative*** that you not stop there. Most people do not show up for work to do a bad job. You must understand why this individual introduced a flaw into the equipment. Understanding this leads to the final and most important type of root cause.

You must identify the systemic root cause. This cause answers the question as to why an individual made the decision he or she made. Identifying this root cause and putting mitigating actions in place will not only prevent failures from occurring in the equipment being investigated, but it will also prevent future failures from occurring in other equipment. Identifying this root cause has far-reaching positive consequences.

Many companies have become serious about eliminating safety events, whether personal or process. They have done a great job in understanding these events and putting systems in place to eliminate future events from occurring. Due to this dedication, most industries are much safer.

It is time to have this same dedication about reliability. It is time to start learning from production losses to prevent future failures from ever occurring. In doing so, companies can become even more profitable through increased reliability.

Just remember: If it were your money that was lost, how would you respond?

***Kevin R. Strader**, PE, CMRP, CRL, is a Global Petrochemicals Availability Engineer for BP. He is responsible for helping sites improve turnaround (TAR) performance and reliability. This is accomplished through the implementation of systems and processes, as well as ongoing coaching and training in the areas of TAR planning, execution and reliability improvements.*

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ARMS RELIABILITY

6 SUCCESSFUL STRATEGIES

for the Not So New Challenges of Today

Heinz P. Bloch

The challenges facing any industry sector today are the same that existed decades ago and were delineated at many conferences and meetings. They are still the same challenges because acting on pre-existing ones would have added to the workload.

It was decided in the intervening years to continue the chase after the magic bullet and pay hefty fees for consultant conceived generalities and, occasionally, more automated predictive maintenance (PdM) devices. In other words, the lessons learned and explained decades ago were often disregarded by managers whose focus was short-range.

The focus *today* is even more short-range than it was 20 or 25 years ago. As you read this article, keep in mind that the people you come into contact with can be divided into three groups:

1. The ones who already know the subject and understand what course of action to take in the best interest of stakeholders. They probably amount to five percent.
2. The ones who are not teachable. Trying to communicate with them will be both frustrating and a waste of time. Twenty percent fall into that category.
3. The ones who are presently uninformed. Let's assume they would see merit in you showing them the benefit derived from listening to you. Let's even assume they would be inclined to act on your advice. If you've kept track of the numbers, they would be the remaining 75 percent.

Quite obviously, if you are a vendor selling a product, you want to concentrate on Group 3. If you consider yourself a stakeholder, you really have a stake in your company being prosperous. Then, there are the user-purchasers. They, too, are stakeholders. Their stake is in seeing their companies prosper. Needless to say, if both sides prosper, you have a win-win situation. And you know how you can be guaranteed a win-win situation? Think of the three Cs: communication, cooperation and consideration (CCC).

CCC is not a play on words or a catchy play on letters, or something made-up because it sounds cute. Rather, practicing CCC is good for business. It's good for developing products. It's good for developing people. It's even good at keeping a marriage together!

Challenge #1

The Uninformed Workforce

Regardless of your job function, employer or employee, manager or non-manager, fixing eyes on today or on the future, it's important to know the whole story.

- Today, organizations deal with a largely uninformed workforce. This adjective is not to be misunderstood, even a genius can be uninformed.

- The fact is, in 1953, the United States was in first place worldwide in terms of math skills and science education. Today, the country ranks 35th of 64, called "unimpressive" by Pew Research Center in February of 2015. Why should this be of interest to you? Because the folks who are now in school or have just started work are the present or future reliability technicians and equipment or process operators. They need to be approached with much forethought.

- The root causes of an uninformed workforce go back very far and can be traced to a generally shallow leadership. Shallow leaders cannot, or will not, give guidance or mentoring, or provide a nurturing environment. In-depth guidance, appropriate mentorship and nurturing take time, effort and dedication. Today, all of these attributes are in short supply.

In contrast, an **informed** worker:

1. Identifies a problem;
2. Outlines the options;
3. Recommends a solid and well researched solution.

Challenge #2

A Lack of Accountability

Accountability, or the lack of it, becomes a huge challenge. Intellectual dishonesty exists on a widening scale. Aaaaah—dishonesty! Everyone assumed that a prominent German automobile manufacturer made clean diesel engines, but now everyone knows better. Or, what about those advertising campaigns about clean coal. What happened?

Today, it's not uncommon to see engineers trying to imitate the conduct and behavior of lawyers. The (understandable) aim and job of lawyers is to claim a client's limited responsibility, to make a compelling argument in favor of non-culpability of their clients or to completely shift accountability.

In sharp contrast, it should be a reliability engineer's aim and job to clearly define and outline safe and sustainable asset management. Substantive asset management is a detail task, which, regrettably, is either unappreciated or remains unrewarded. It should come as no surprise that such detail tasks are, therefore, widely shunned. In some companies, an incompetent manager is paid far better than a highly principled and well-rounded engineer.

Challenge #3

Tight Budgets

Budgets are defined by the lowest possible outlay. The cost estimating manuals at engineering, procurement and construction (EPC) firms often only show the least cost equipment. If these manuals showed operating, maintenance and catastrophic failure optimized equipment, the budget would need a multiplier of, for example, 1.09. Offering to build plants at 1.09 times someone else's offer, the EPC would lose out to the competition. Why? Because EPCs are selected on the basis of bid price or some other yardstick that has little to do with how reliable your plant will be five years after it starts producing.

Industry-wide, much lip service is paid to asset reliability. However, asset reliability and lowest initial cost of assets are almost always opposites. They can only be reconciled or optimized by experienced and well-informed professionals. Assuming these experts are still around, they must be given early access to management. However, few, if any, are granted that access. But **access** is one of the solutions.

Because true experts are no longer groomed and nurtured, or because they are brought in far too late in a project definition and execution sequence, companies are now stuck in an endless cycle of reinventing "new" initiatives. **Grooming and nurturing** is one of the solutions.

In short, actionable implementation strategies require lots and lots of details. These details need to be learned, conveyed and supervised. You don't get what you expect; you get what you inspect.

Challenge #4

The Reward System

As you examine industry trends, you often see an unhealthy risk and reward system. Today, relatively few workers are motivated to learn because learning is not always rewarded. But, the fault is absolutely not on one side only. Both sides are responsible. Industry leaders are not rewarding the one who brings them the facts and all too often, not enough time is allocated to capture and convey facts. Worse yet, facts and opinions are commingled. Strong opinions reap rewards, even promotions.

> *"Think of the three Cs: communication, cooperation and consideration."*

Majority opinions may vastly outnumber factual findings. Here's an example you can relate to: Hurricane Katrina did not hit or devastate New Orleans in August 2005. The levies that kept back Lake Pontchartrain broke and the federal government and the original construction decisions of its U.S. Army Corps of Engineers were, in fact, responsible for the widespread flooding.

Here's an example of a typical reward system in place in many organizations: A supervisor with precise detailed experience is dissuaded in his pursuits by an inappropriate and often unjust risk and reward system. Someone will send him the signal: "We don't need you. We don't have enough failures here to justify paying you more than we pay so-and-so." This supervisor quickly learns that only the quick fixers are rewarded. Those who prevent things from breaking are often viewed as laggards or sluggish performers.

These are all harsh and unpopular judgments. They cause great annoyance because they allude to the need to drastically change course. Verbalizing an unpopular judgment is like telling a mother her baby is ugly – usually not a well-received message, regardless of the facts in evidence. But, you will gain nothing by telling a mother your opinion.

In contrast, a plant asset can be valued on the basis of facts, carefully leaving off unsupported opinions. You, your employer, your clients and society as a whole may gain immensely if they're consistently told the truth about your company. Yes, changes will be required and making them would have to start with conceding the futility of continuing on a course that years ago was already recognized by unbiased observers as leading to complications down the road.

6 SUCCESSFUL REMEDIES

Experience-based remedies are needed for serious challenges. No sweeping initiatives are needed, but the prevailing mind-sets must change. Accountabilities must be defined and adhered to and many of the present reward systems must change.

These six steps have been successfully implemented by smart companies and can be copied or duplicated and implemented without hesitation:

1. Shared educational responsibilities, grooming of successors: Pick people with potential and treat them well. They will no longer be uninformed.
2. Leading by example: Be intellectually curious and be very resourceful. The day still only has 24 hours, so delegate! Again, they will become informed!
3. The end of reliability and maintenance being subservient to operations ("switching hats" is strongly advocated). Note how both sides will be fully informed!
4. Specifications developed for reliability and lifecycle cost. Entire budgets must be governed by reliability thinking.
5. Disallow operating in the safety margin of machines. Finally, one can achieve something very valuable.
6. Nurture absolute accountability by assigning project managers to live with their decisions. The results will be truly astonishing!

And did you notice the three Cs embedded in these six points? You have come full circle!

Note: This article is based on many of the observations found in the author's most recent book: "Petrochemical Machinery Insights" (Butterworth-Heinemann, September 2016) and his keynote presentation at the Maintenance & Reliability Symposium (MaRS), August 17-19, 2016.

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DEFECT ELIMINATION

FROM A CMMS PERSPECTIVE

John Reeve

> **Defect elimination removes unplannable work.**
>
> – Terrence O'Hanlon, CEO and Publisher, Reliabilityweb.com and *Uptime* magazine

> **Every defect is a treasure if the company can uncover its cause and work to prevent it across the corporation.**
>
> – Kiichiro Toyoda, founder of Toyota

> **"One operator can destroy an asset faster than 10 technicians can repair it."**
>
> - Keith Mobley, Principal SME, Life Cycle Engineering

Defect elimination may be the most significant initiative within a maintenance reliability program. It may also provide the largest return on investment in terms of asset reliability and plant uptime. From a computerized maintenance management system (CMMS) perspective, defect elimination can be used to focus on recurring failures and significant events, and also to address potential failures.

What Is Defect Elimination?

Winston Ledet, a widely known consultant and instructor on proactive maintenance, refers to defects as: "Anything that erodes value, reduces production, compromises HSE (health, safety and environment), or creates waste." A defect can lay hidden from view and may not become apparent until it causes a failure.

Defects can include leaks, looseness, vibration, excessive heat, missing or broken parts, wrong materials or parts, poor documentation and lack of precision maintenance. Defect elimination also can include the process of mistake proofing. Staff members should make a list of work-arounds currently in place, poorly written procedures and maintainability, safety and ergonomic issues. Studies have shown that up to 84 percent of equipment failures can be linked to human factors. Although bad in itself, this is something that can be corrected.

The 3 Main Causes of Equipment Failure

A defect can be introduced during the design phase, installation phase, or operational phase. Figure 1 shows the three main causes of equipment failure. What is significant is the 84 percent due to human factors. It is very important that the staff determines the true cause in order to prevent recurrence. Using a cause code hierarchy, the staff can drill down to the likely cause. Cause 1 may be entered by a maintenance technician, Cause 2 by the supervisor and Cause 3 by the reliability engineer.

Is Anyone on Staff Actively Looking for Defects?

Probably not. If most maintenance activity includes scheduled preventive maintenance (PM) and predictive maintenance (PdM), along with repair work, where is the activity to find and remove defects? The maintenance staff and engineer will probably look at the just finished repair work, but not be concerned with all the possible defects in the plant. But what if they were? What if there were proactive efforts to find existing defects and eliminate them before they cause a real failure? If you stop a problem from occurring, you can save all the costs that would have resulted if the problem had gone through to completion. Maybe there would be value in involving all maintenance staff in identifying defects plant wide.

According to David Jonathan, CMRP, "(the) failure of assets is the consequence of unattended early defects."

Is This Just Another Management Initiative?

Defect elimination introduces a new way of thinking. Management should realize that this strategy will reduce work in the long run, as well as improve asset reliability. Many organizations are flat-out busy performing repair maintenance and are stuck in reactive maintenance. In addition, they may be overwhelmed with the amount of preventive maintenance tasks on top of day-to-day repair activities. With that background, many organizations will struggle to see a way out and certainly aren't keen on another management directive that adds more chaos to their already busy routine. So, the question remains, exactly how will this program get implemented?

It's Hard to Imagine Future Perfect

The average expected lifetime for most assets should be 25 to 50 years or longer with excellent asset care. With a failure mode based PM/PdM library in place, you can be assured you have the ideal maintenance tactics as determined by reliability-centered maintenance (RCM) analysis. Figure 2 (page 56) illustrates what future perfect might look like. Some might call this the precision domain.

There Are 3 Possible Domains

From a maintenance management perspective, there are three possible domains: reactive, planned and precision (see Figure 3, page 56). But, few look past the planned domain, as they view anything else as impossible. With defect elimination, the goal is to first **eliminate work** to make room for more **value-added work**.

Many organizations simply don't have enough time to perform all the planned/scheduled work. There are too many interruptions, as in reactive maintenance. This is called the reactive domain, where the equipment is in charge.

Well-meaning individuals will speak strongly about moving to better planning and sched-

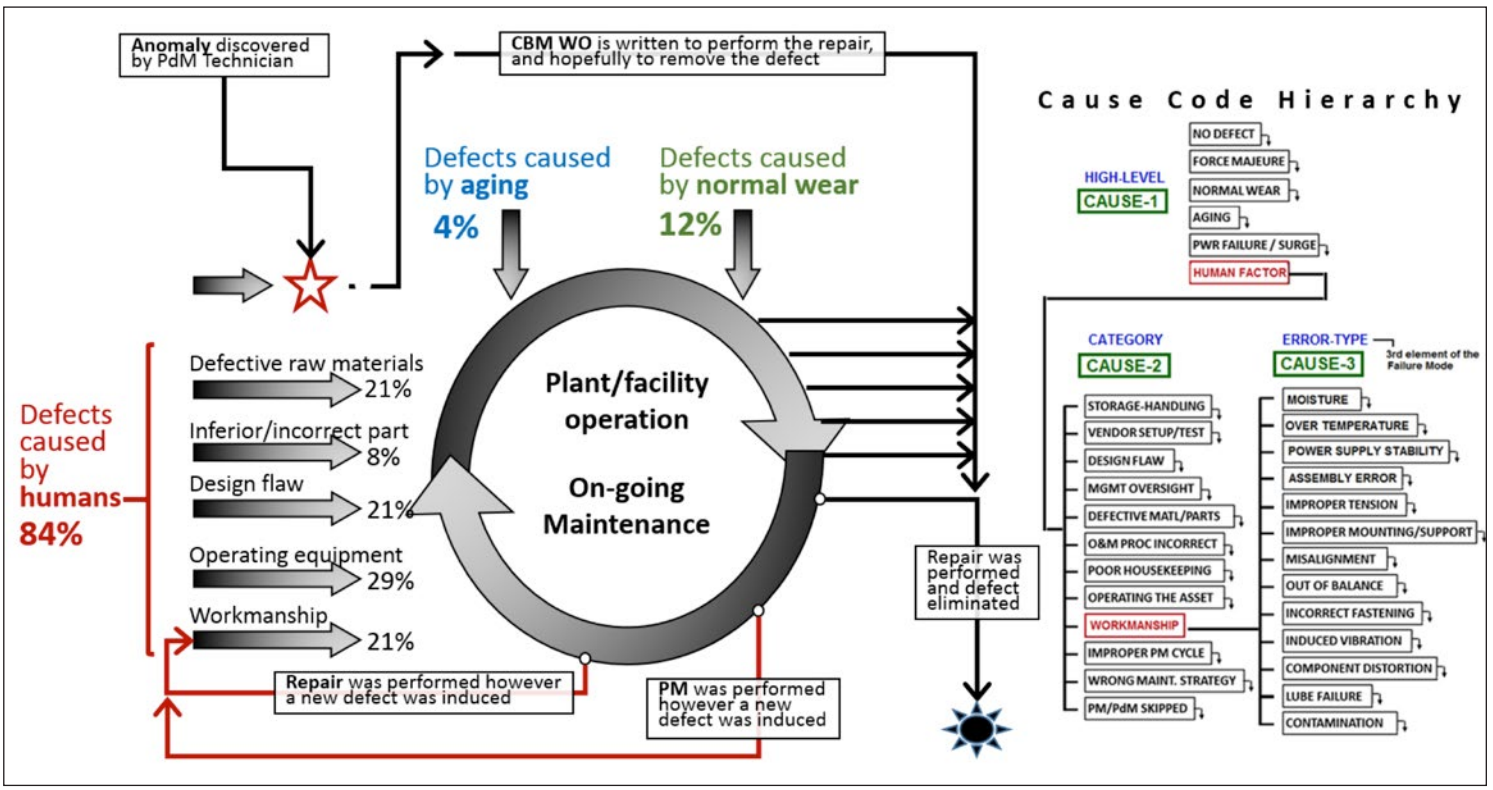


Figure 1: The world of defects

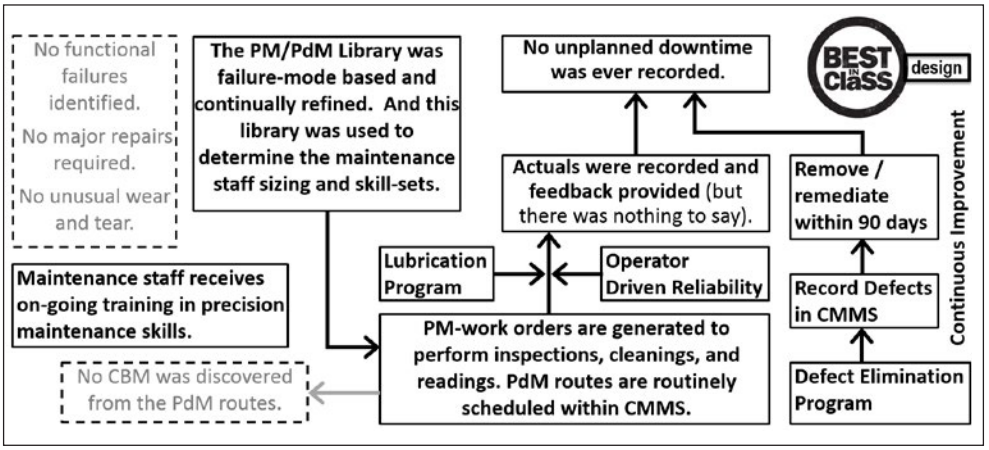


Figure 2: The perfect world

uling. And out of frustration, management may reinstate the PM program with renewed emphasis and vigor. New scheduling software may even be purchased to improve planning and scheduling techniques. This strategy is called the planned domain. Unfortunately, there seems to be even more work than before and, worse yet, the maintenance staff is making decisions on their own as to "what PM/PdM to cancel." More often than not, they will fall back into the reactive domain. At least in the reactive domain, they could perform all the work (although at a higher cost).

The precision domain is future perfect. This occurs when the entire organization is involved in defect elimination. Operators have been trained to identify failure modes and maintenance technicians are skilled in precision maintenance. Cross-functional action teams eliminate defects on a daily basis. They feel empowered and are proud of their plant's performance. The operations and maintenance (O&M) staff, with help from engineering, is now in charge of asset performance.

Using a Combination of Strategies

Figure 4 (page 57) shows the results of a study performed by Winston Ledet and MIT Sloan School of Management Senior Lecturer Mark Paich. It singled out improved planning, scheduling, PM/PdM strategies and their benefits toward plant uptime. If you combine all three of these strategies, you can realize a 5.1 percent increase in uptime. But, the largest increase in uptime occurs when you optimize planning and scheduling, PM/PdM and defect elimination in concert.

Traditional Maintenance Strategies Versus Defect Elimination

Traditional or western style management is: "If we could just have accurate failure data, the latest condition monitoring technology, the best CMMS software and proper staff training, we could improve uptime and reduce reactive maintenance."

Traditional Strategies

Improvement initiatives in the U.S. and Europe primarily focus on removing defects through better planning, scheduling, tradespeople skills and predictive technologies.

Specific techniques include:

- ✓ Improve master data;
- ✓ Emphasize PM program;
- ✓ Establish a PdM (condition based) program;
- ✓ Perform root cause analysis;
- ✓ Optimize planning efficiency and scheduling compliance.

Defect Elimination

As DuPont discovered, maintenance reliability could best be improved using a process of defect management. Japan achieved greater results by removing defects early in life or avoiding putting defects in the equipment in the first place, which, in turn, eliminated the work that came with these defects.

Per Winston Ledet, the primary focus of defect management is to eliminate the work (whereas the traditionalists try to optimize it).

Action Teams Are Needed

A cross-functional team might consist of O&M technicians, but may also include an HSE representative, warehouse coordinator, maintenance engineers, supervisors, inspectors, planners and schedulers, and a reliability engineer.

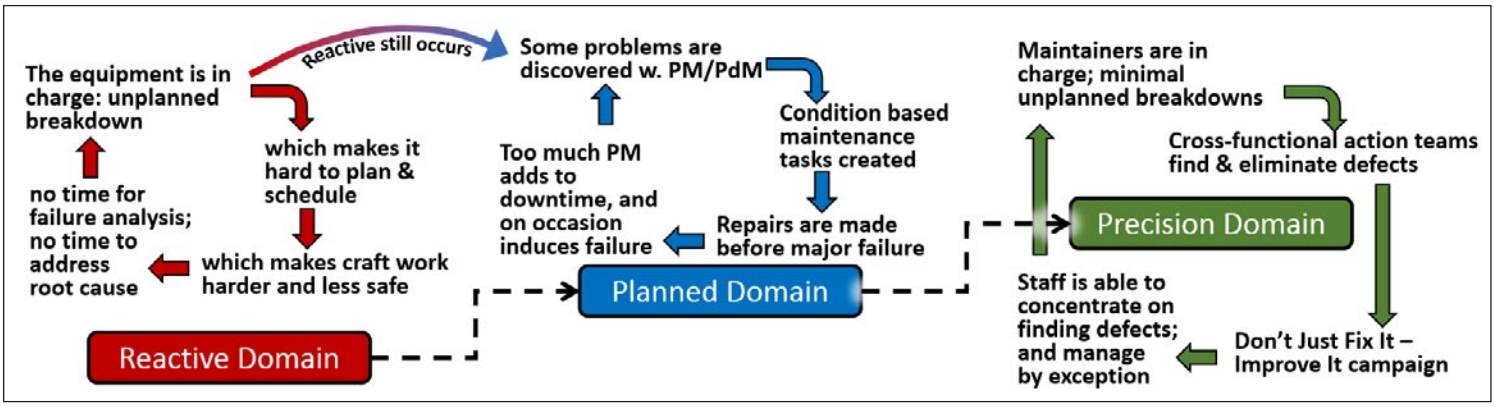
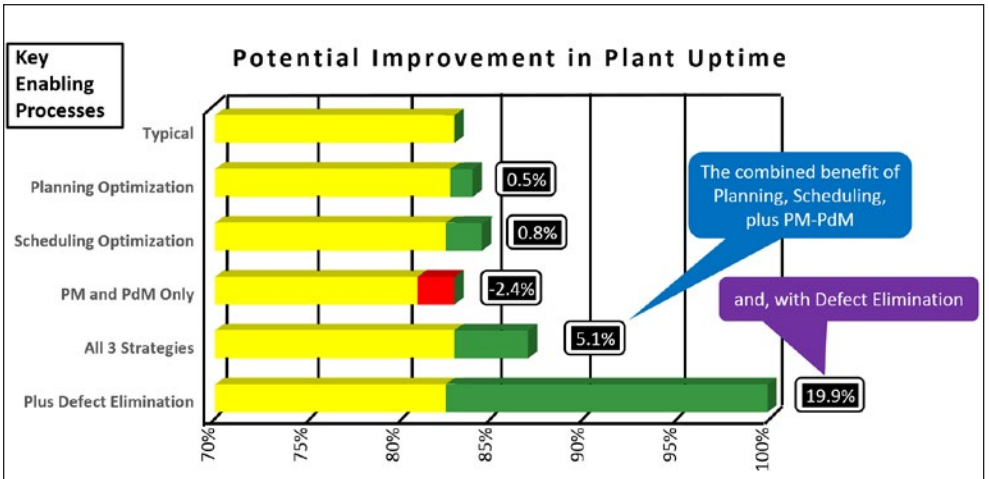


Figure 3: All three domains



Winston Ledet and Professor Mark Paich studied the synergies of planning, scheduling and PM-PdM (and also in isolation) and noted with a combined approach the largest improvement can be achieved.

Figure 4: Potential improvement in plant uptime

Requirements for Success

- ✓ **Leadership** needs to make sure the focus is on defect identification, detection and prevention, and that staff is allowed time to eliminate defects in action teams.
- ✓ Asset systems might be assigned to a system proprietor who is closely involved.
- ✓ The O&M staff should have training as to what a failure mode is.
- ✓ The reliability team should leverage failure data from the CMMS to identify worst offenders and begin focusing on these areas.
- ✓ Define the complete defect elimination process, including end of shift and weekly meetings.
  - Identify the defect tracking screen. Prioritize these defects based on impact and those that could be eliminated in the next four hours. (Charge this time to overhead.)
  - Once work is selected, then convert to a work order.

What Should the Action Team Look For?

Any equipment that is operated over time will accumulate defects through normal wear. Plus, there can be defects from design, including ergonomic, safety, or maintainability issues. But sometimes, the O&M staff introduces defects. Reasons for this are:

- Operating equipment outside of allowed boundaries;
- Incorrect operational procedures or poorly written procedures;
- Lack of knowledge, as in precision maintenance;
- Failure to follow maintenance procedures;
- Incorrect maintenance procedures or poorly written work plans;
- PM/PdM strategy may be incorrect.

In addition, the action team should look for existing failure modes, such as loose gearbox bolts due to vibration. In other instances, they are looking for opportunities to mistake proof. And at the end of shift, the team should conduct a brainstorming session to discuss potential issues and get feedback from others.

Here is a list of mistake proofing:

- Identify potential safety and ergonomic issues.
- Clarify work instructions and present a checklist that requires the user to check the box using pen on paper or updating a mobile device.
- Improve work instructions to make them informative, consistent and concise. (**Note:** This is best done by involving the technicians in the feedback. If they won't come to you, then the planner should schedule end of week sessions.) It should be possible to apply color-coding to hazardous job steps, with keywords in color, such as **WARNING:**.
- Ask if a step is serious enough to warrant job step sign off by a quality representative.
- Consider technology, such as an ultrasonic grease gun, which is designed to help lube technicians know when to stop adding grease.

The Defect Management Process

The assumption is that the action teams have been properly trained in defect elimination, such as with The Manufacturing Game®, an experiential learning simulation.

Once defects are discovered, team members would enter them in the CMMS using a special application called defect tracking. From this growing list, they would decide what is important. When a decision is made to act, an official work order record is made. These meetings might be held at end of shift each day and also in a weekly session. The time spent in meetings reviewing and discussing defects goes to a blanket work order.

Figure 5 is a slightly modified flowchart by George Mahoney, Reliability Excellence Lead at Merck pharmaceutical.

Set Up Defect Tracking Screen Inside the CMMS

Once the process is understood, the defect tracking screen can be incorporated (see Figure 6). All known defects would go here. Some/most would get converted to work orders.

Be Sure to Eliminate the Defect

Standards promote consistency, which, in turn, provide a strong foundation. (**Note:** Merely

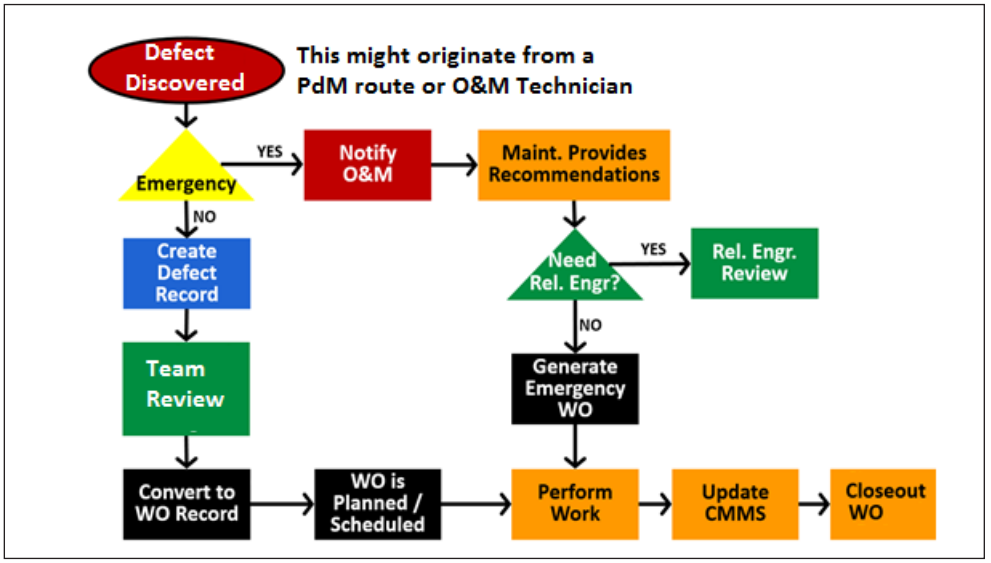


Figure 5: Possible flowchart for defect record processing

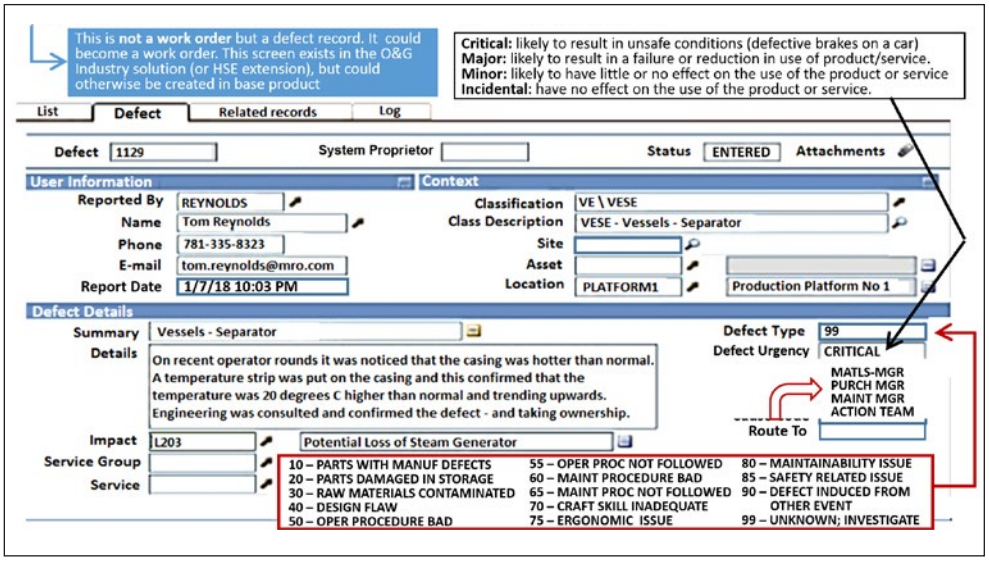


Figure 6: Example screenshot for defect tracking

issuing a standard is not a final step. It must be issued and reinforced. Practicing the steps ensures continuous improvement.) As Henry Ford said, "If you think 'standardization' as the best you know today, but which is to be improved tomorrow – you get somewhere."

Note: PdM technology does a good job of finding the defect, but it may not always focus on discovering the actual root cause, in which case, the defect will occur again.

Action Team Rules

The action teams select which defects they want to eliminate, regardless of criticality. However, management may apply some rules, such as:

1. Any identified defects need to come through a cross-functional team and copied to system proprietor. The action team, however, will set priority.
2. The defect must not violate any HSE policy.
3. Once converted to a work order, the target completion should be within 90 days.
4. If estimated costs requiring a purchase order exceed $5,000, then management approval is required.

Repeating Failures

The true root cause might have been misalignment; soft foot; pipe stress; lack of lubrication; improper lubrication; lubrication breakdown; undersized foundations; improper belt tension; over torqued electrical connections; dirt, dust, or moisture on connections; improper size wiring; improper torque; improper gaskets; improper design; poor start-up/shutdown; inadequate cleaning; or improper operation. If this root cause is not identified and eliminated, then the failure will likely repeat (Figure 7).

Steps to Initiate a Defect Elimination Program

Defect elimination, if successfully implemented, can result in a significant reduction in failures. This is achieved with: (a) staff training, (b) creation of cross-functional teams, and (c) operator involvement in basic PM (i.e., basic skill; no disassembly; no tools). The goal should be to engage the entire workforce in defect elimination by using action teams as a means of creating a culture that encourages equipment improvement as a normal part of the everyday job.

1. Conduct defect elimination training for all maintenance staff.
2. Create cross-functional action teams.
3. Identify asset system proprietors. Have the reliability engineer walk down the system with the proprietor.
4. Conduct operator training on failure mode identification.
5. Conduct maintenance staff training on precision maintenance.

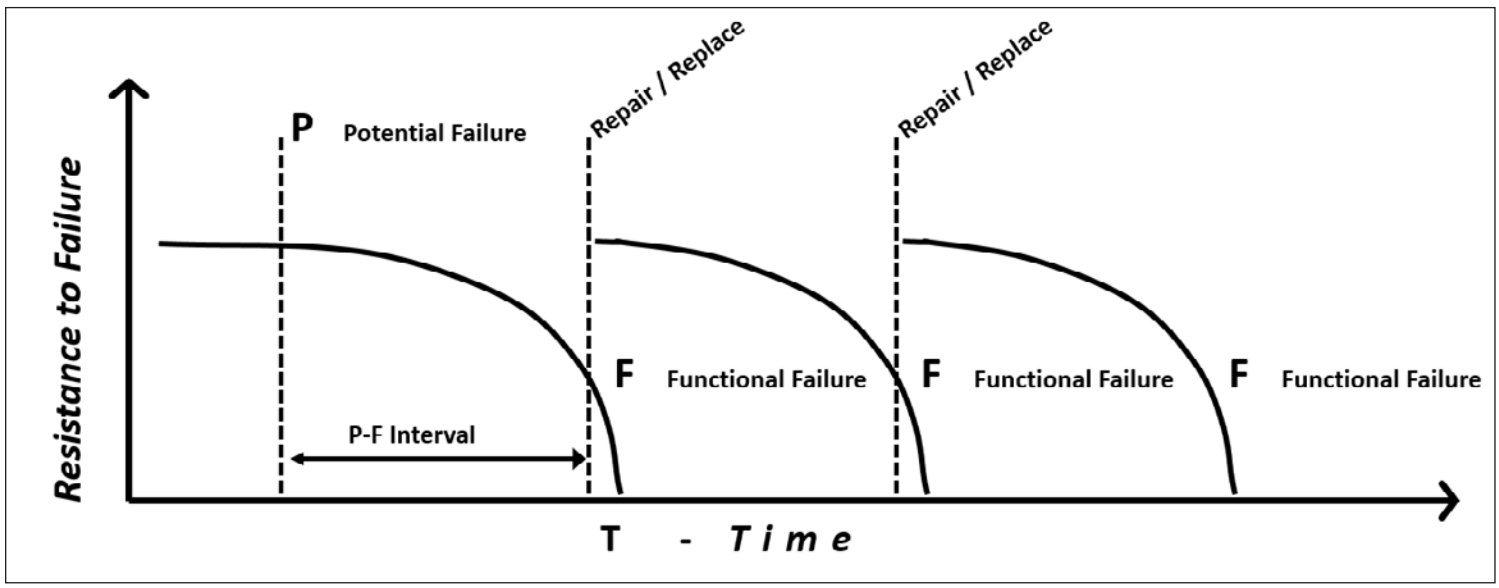


Figure 7: Repeating failure

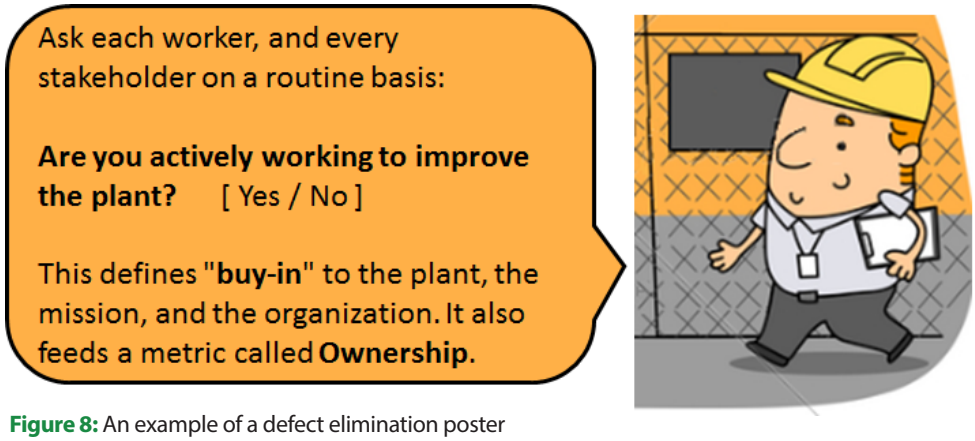


Figure 8: An example of a defect elimination poster

6. Extract asset worst offenders from the CMMS using Pareto style failure analytics. Use this report to tell the staff where to focus.
7. As a way to set the importance for this initiative, management might "turn off the CMMS," except for emergency work and regulatory required PM tasks, and instruct the entire O&M staff to focus on defect identification and elimination. This interval might be for one week.
8. Tracking results: Leadership should track plant availability, production improvement, ownership buy-in, and defects identified and eliminated monthly. Also, calculate and record avoidance cost.
9. Create a defect elimination poster, as shown in Figure 8. The message of this poster should emphasize to employees to:
   a. Do everything possible to avoid defects from being introduced.
   b. Emphasize precision maintenance, pride in work and extending the life of assets.
   c. Enhance job planning, optimize procedures by adding clarity and use the right procedures with the right skills and the right materials with the right lubricants.
   d. Mistake proof systems and assets (e.g., poka-yoke).
   e. Schedule brainstorming sessions and use quality circles to solicit new ideas.
   f. Make sure proper evidence gathering is performed when repairing assets.
   g. Avoid operator misapplication of assets and ensure operating procedures are correct.
   h. Support management goals to promote staff education, for example, precision maintenance training and ability to recognize problems/hazards.

Training Methods

Training teaches O&M staff members how to use their senses to examine plant equipment and identify when it is not running right. Training methods might include:

1. Teaching in a classroom setting what to look for, as it is unlikely that all the staff has the relevant experience to identify failure modes.
2. Performing detailed walk downs of the plant, system and area with a reliability expert to recognize defects, take pictures and utilize monitoring tools. Such monitoring tools may include:
   a. Automotive stethoscope to listen for noises;
   b. Handheld temperature probe;
   c. Laser thermometer to measure temperature;
   d. Vibration pen to monitor vibration.
3. Utilizing inspection checklists to tell staff members where to look and what to look for.

Final Tips on Defect Elimination

To achieve world-class reliability, organizations should develop a defect elimination culture that relentlessly pursues and prevents the introduction of defects and errors at all stages of the equipment lifecycle.

Not everything can be fixed in 90 days. Sometimes, the CMMS needs to be improved with regard to failure data capture. Or, the engineering staff may benefit from outside assistance and knowledge transfer as to defect identification. The staff may even need more training on CMMS utilization or correcting missing master data.

These tips were extracted from Winston Ledet's books on defect elimination:

1. All maintenance staff should attend defect elimination workshops.
2. Establish action teams with cross-functional representation, along with a system proprietor. You need corrective actions, not just recommendations.
3. Capture successes and share and document findings in a continuous improvement forum.
4. Establish a goal for every one of 100 repair actions and create a work order titled, "Don't Just Fix It, Improve It."

Using automation tools within the CMMS, the administrator can make every 100th repair work order print out with a special header requesting improvement.

For every 1 out of 100 put it back in service better.	
After	Will Disappear
1 year	57%
3 years	83%

5. If beneficial, make use of external change agents to transfer critical knowledge.
6. Consider turning off the CMMS during the rollout of the defect elimination program.
7. Utilize Pareto style outputs to identify worst offenders and drill down into failure modes to find the true cause. The failure analytic can sort out total downtime costs, as calculated by: Total Repair Costs + Lost Production Costs.

Lastly, create a mission statement:

" We will eliminate defects base maintenance on condition and maximize safety through reliability improvement."

And, follow that mission statement daily.

John Reeve *is the Senior Business Consultant at Total Resource Management. Mr. Reeve is a seasoned professional and consultant with over 25 years of diverse industry experience, with expertise in work, asset and reliability management system design. Mr. Reeve obtained a United States Patent for maintenance scheduling.* *www.trmnet.com*

John R. Murphy
Principal, Gallatin Management Services
Senior IIoT Leader, Reliabilityweb.com

Mr. John R. Murphy started Gallatin Management Services following his retirement in 2016 from CSX, a leading freight transportation company headquartered in Jacksonville, Florida, with over 29,000 employees and $11 billion in annual revenues. Originally from Montana, John holds degrees in Management and Marketing, and an MBA with post-graduate work in Transportation. For the last seven years, he has been an international quality judge and routinely speaks or writes on the subjects of continuous improvement, change, asset management, predictive analytics/IOT, and reliability.

Employed with CSX for 34 years, he held a number of positions in the areas of terminal management, rail car management, operations planning, economic analysis, budget planning & reporting, and led the creation of CSX's Six Sigma, Lean Engineering, Project Management, and Process Excellence programs. In the course of his own continuous improvement journey, Mr. Murphy completed CSX's Blackbelt and Master Blackbelt certification programs.

John retired as CSX Chief Mechanical Officer – Engineering and Strategy. In his CMO role, John was responsible for development of locomotive and railcar business intelligence systems, physical infrastructure modernization, creation of asset management and workforce planning strategies, and led the Mechanical, Electrical, and Industrial Engineering maintenance functions.

He founded Gallatin with the objective of helping businesses, agencies, and the military by providing comprehensive solutions optimizing the reliability, availability, and cost management of their physical assets. As part of his support in driving those leading asset management practices, John recently joined Reliabilityweb.com as Senior IIoT Leader.

Q: What Industrial Internet of Things (IIoT) ideas are adopted the easiest; what makes them easy to swallow?

For most companies, establishing an asset management platform seems to be the logical first step. Many infrastructure-heavy asset companies created homegrown systems back in the 1980s that are in need of renewal and replacement. So, for many, it is an organizational necessity and, fortunately, there are a lot of supplier options today and companies can tailor their needs to the right platform.

Probably the other is sensor platforms. Organizationally, everyone seems to understand the value of sensor health data, but, in the past, the challenge was the data architecture to support the analysis of the data being delivered. It was clunky and expensive. Remember those server farms you had to pay for? Companies tended to create many vertical lines of information that did not connect or correlate easily. The power of big data/IIoT is taking all the sensor type data feeds into a cloud environment and then running through analytic platforms to see a more end to end view of the business.

Q: What do you see as the biggest problem in adopting IIoT solutions?

Creating the business case for change. Heavy asset companies are generally hesitant to release or retire the asset (i.e., the rainy day syndrome). The reality of a successful enterprise asset management (EAM)/IIoT platform is that reliability will improve and, as a result, asset utilization will improve, meaning fewer assets are needed. The improved reliability and fewer assets to maintain are the key earning drivers to justify investment.

It's really a case of effective change management throughout the asset management project and selling the key stakeholders on the fact that the improvements (i.e., cause and effect relationship) are real and meaningful. The problem is most maintenance organizations are challenged when it comes to the financial investment justification process within their organization. Part of the EAM/IIoT maintenance leader's journey is creating new relationships within the organization, such as with the supply chain and financial professionals. Together, they can tackle adoption of IIoT solutions more effectively.

Q: The railroads were early adopters of technology as far back as the 1980s to locate cars and detect hot boxes. Is IIoT a direct outgrowth of this, seeking solutions to big issues, or is it new or somewhere in the middle?

I think somewhere in the middle is right on target. Monitoring of wheel/rail interaction has been the "big deal" in the rail safety arena for many years and it has been incredibly successful. Derailments caused by track/wheel are down DRAMATICALLY (see the Association of American Railroads website for the facts). But, it took a lot of trackside hardware, communication systems and software analytic technology investments to get this result. Given the technology of the day, this was a remarkable feat by the industry and it takes a healthy amount of human engagement to sustain the performance.

Today, big data and IIoT make replicating this approach vastly simpler, less expensive and the analytical platforms exist versus having to be built from scratch. Additionally, other variables can be now added into the analyt-

ics. Imagine looking not just at the wheel/rail interface, but the locomotive health data, operator performance, as well as track and signal functionality, all simultaneously while the freight or commuter train operates during the route. It's a near real-time health monitoring system with minimal human interface to attack all the reasons trains have unplanned stoppages.

Q: What killer app or technology was the breakthrough one in the last five years for the railroads? What about in the next five years?

I'm much impressed with machine learning predictive capabilities. Several vendors are in this space, but my preference is with those that have point-and-click learning capabilities. Cloud friendly, able to handle huge amounts of trending data, machine learning predictive tools have clearly demonstrated their ability to jump past condition or time based monitoring practices and move up the P-F curve to catch deteriorating operating factors much earlier than traditional monitoring techniques. Plus, you can hook machine learning alerts into your asset management platform to automatically generate work orders or actions based on the criticality of the alert. You can find more potential failures, eliminate them and extend asset reliability and, therefore, availability. Machine learning offers a great business case.

Q: Is there anything not quite on everyone's radar that is really exciting?

Yes, cognitive computing in the IIoT/asset management space. It's receiving a lot a hype right now and it's fair to say the industrial technology application is in its infancy, but certainly Watson has demonstrated the power in several of the consumer spaces, for example, medical.

It's just a matter of time before interconnected assets become smart enough to self-diagnose, self-repair, or develop solutions to deal with reliability and availability problems. Basic capabilities have existed for some years, but we're talking scalability differences versus today's functionality.

GE® seems to be taking a lead in this space with mobile assets and its edge computing capabilities on its new locomotives. Basic decision rule engines are on the "smart" computing capability of the locomotive, so not all data has to be transmitted in near real time to a remote back shop. Rather, only important data, determined using basic statistical parameters, is sent as alerts to the operator or the back shop engineering organizations. This reduces significant communication costs and provides more timely responses to critical operating situations.

Uptime invites you to The RELIABILITY Conference, April 24-28, 2017, where John Murphy will be presenting: *Why You Need to Understand IIoT* and *IoCM 101: The Internet of Condition Monitoring Basics*. For more information and to view the agenda, visit: **www.reliabilityconference.com**.

Rethinking Bhopal:

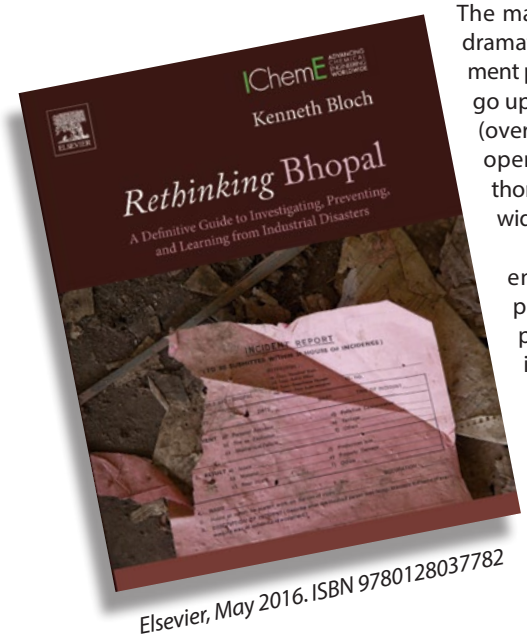
A Definitive Guide to Investigating, Preventing and Learning from Industrial Disasters

Written by Kenneth Bloch • Reviewed by Joel Levitt

This is a massive work (over 500 pages) that is really two books in one binding. It is a discussion about process safety with some excellent charts and background for those who are not engineers. It is also the story of the worst industrial accident in the world. The 1984 Bhopal gas tragedy killed 10,000 people and disabled hundreds of thousands more. (Due to reporting in India at the time, exact numbers are not known.)

The accident itself is a barrage of mistakes, bad procedures, miscommunication, poor design, unclear passage of critical operational knowledge, poor operation, inadequate training, lazy management and (in some ways, the worst) interference by politicians. In other words, almost everything went wrong that could have! There is plenty of blame. One of the best aspects of *Rethinking Bhopal* is the author's refusal to blame anyone. Bloch is clearly in the camp that mistakes were made, but they were done in a context of defective business systems.

Most people agree this incident put Union Carbide out of business. One could argue this is an unfair assessment since, by the time of the accident, the company was not directly involved in the operation of the plant. Even then, the overall design was changed in the U.S. plant, so large amounts of dangerous chemicals were not stored. The magnitude of the accident was dramatically exacerbated by government policy allowing a shantytown to go up right at the fence of the plant (over management's protests). The operators delayed calling the authorities, making the disaster more widespread.



Elsevier, May 2016. ISBN 9780128037782

Mr. Bloch is a senior health, environment and safety (HES) professional who specializes in petrochemical industry incident investigations and failure analysis, and it shows in his writing. He leaves no stone unturned. He has written articles about Bhopal before, as well as other investigations, so the topic has been percolating awhile.

He based the book's narrative on both traditional sources and documents recently unsealed by the Indian courts. By adding his deep knowledge of process safety, the reader gets a more complete picture of the situation.

When almost any level of root cause analysis for a large event is done, you generally find dozens, or even hundreds, of causes. Each contributes to the outcome. The book shows causes in all five defect domains, including:

- Raw material problems;
- Sloppy operations;
- Sloppy maintenance;
- Defective design;
- Inadequate spare parts.

This is an enormously useful and educational book. For me, it was a hard book to get into; I found the first 75 pages heavy going. But, as I got deeper into the story of Bhopal, I was more and more eager to keep reading. By the middle, it was quite a page turner.

In conclusion, this is a worthwhile book and recommended reading for anyone concerned about process safety, incident reporting, or Bhopal.

***Kenneth Bloch** is a senior HES professional who specializes in petrochemical industry incident investigation and failure analysis. His experience includes 30 years of downstream service in maintenance, PSM, technical, and operations roles. He speaks regularly at AFPM, API, and AIChE process safety symposiums about experiences that help prevent recurring process safety failures throughout the manufacturing industry.*

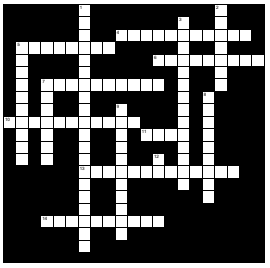
***Joel Levitt,** CRL, CPMM, is the Director of Reliability Projects for Reliabilityweb.com. He previously worked for Life Cycle Engineering. Mr. Levitt has 30 years of experience in many facets of maintenance including process control design, source equipment inspector, electrician, field service technician, maritime operations and property management. He is a leading trainer of maintenance professionals and has trained more than 17,000 maintenance leaders from 3000 organizations in 25 countries in over 500 sessions.*

Dear Crossword Puzzle Enthusiast,

We hope you have been enjoying the Uptime® Elements™ Crossword Puzzle created by PuzzleMaster, Ramesh Gulati, author of *The Uptime Elements Dictionary for Reliability and Asset Managers.*

We are excited to announce a new way to interact and show off your intellectual skills at the same time. Beginning with this issue, we will not be publishing the crossword puzzle's answers in the same issue as it appears. Answers will be published on-line 6 weeks after the issue's release, and in this case, March 10th. That gives you a month to solve the puzzle and share it with us.

Two winners will be drawn from all submissions with the correct answers.



First prize: Autographed Uptime cartoon (see below) by artist, Tom Fishburne.

Second prize: Autographed copy of *The Uptime Elements Dictionary for Reliability and Asset Managers* by Ramesh Gulati.

How to enter (void where prohibited):

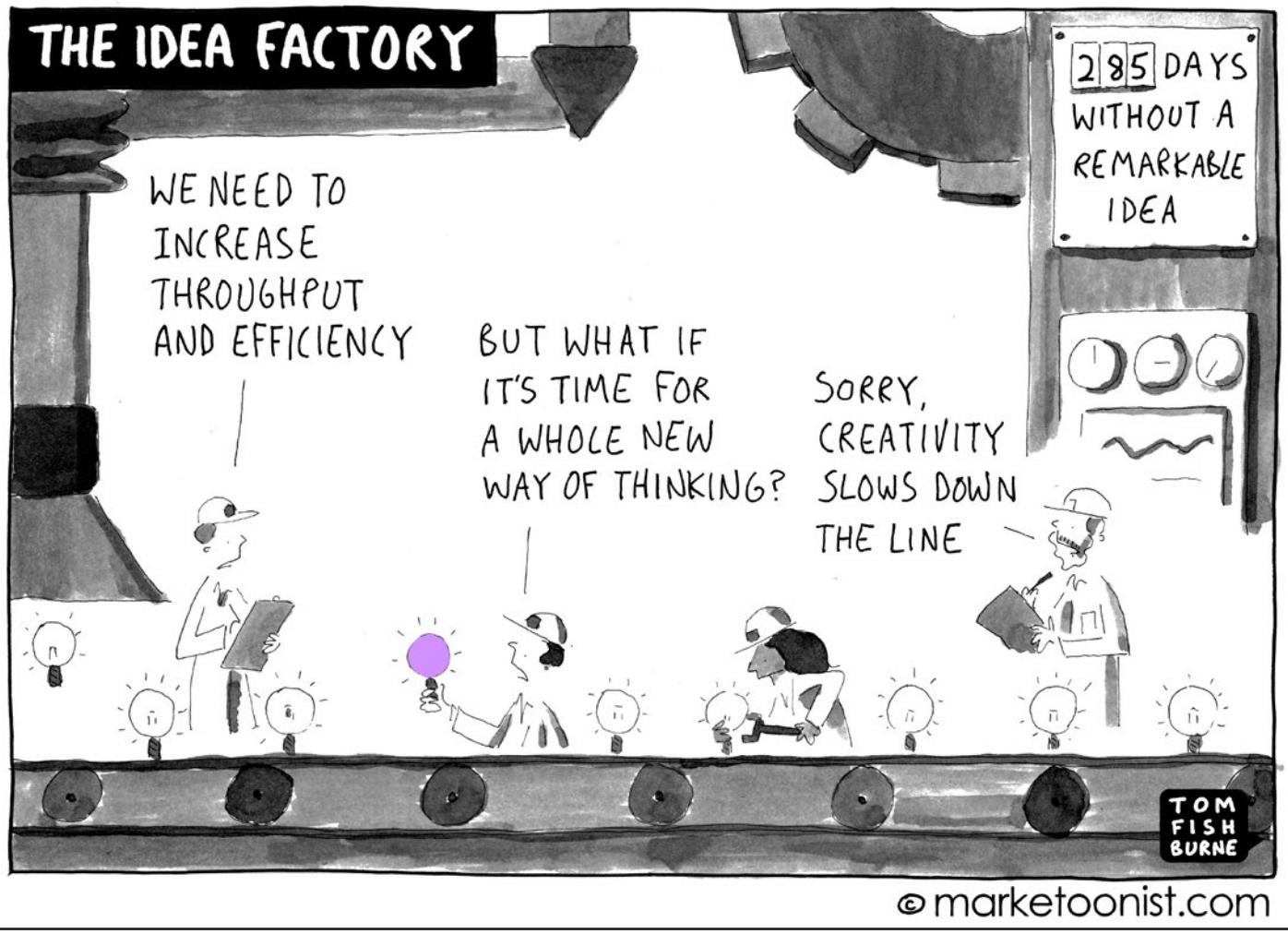
1. Solve the crossword puzzle
2. Scan it and email to puzzlemaster@reliabilityweb.com
3. Or mail it to PuzzleMaster c/o Reliabilityweb.com, 8991 Daniels Center Suite 105, Fort Myers, FL 33912 (must be postmarked by Feb 28, 2017)
4. Include contact details in your email or letter (for winning notification)

The winners will be drawn on March 10th and announced in the April/May issue of *Uptime* magazine along with the answer key.

Featured Uptime® Cartoon

Tom Fishburne, Marketoonist

Be sure to look for future cartoons from Tom in upcoming issues, and don't miss his Keynote at The RELIABILITY Conference where he uses cartoons, case studies, and his marketing career to tell a story visually. It is sure to be both humorous and insightful!



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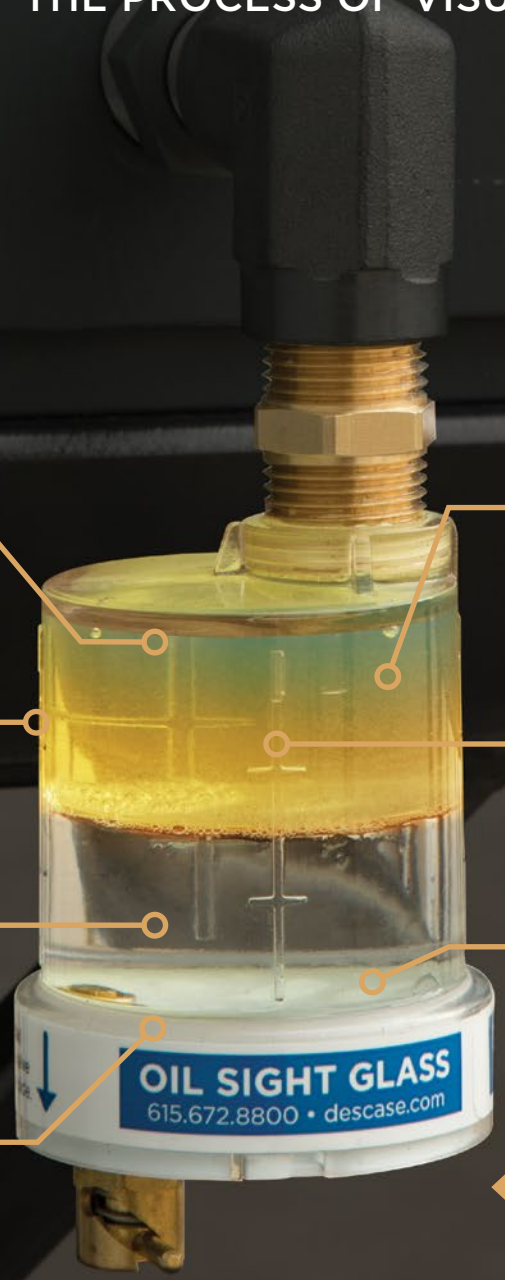

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