uptime®

april/may13

the magazine for maintenance reliability professionals

Delayed Retribution

The Demise of Skilled Trades Apprenticeship Programs

CMMS

How Do You Justify the Purchase of a New System?

Is Your Asset Management Program Built on a

House of Cards?

uptimemagazine.com

Problem Solved

24/7 RELIABLE LUBRICATION

The Flex offers quick, tool-free activation. Set the discharge period by turning the rotary switch, then screw the device into the lube point. You can turn off and reactivate the Flex if needed.

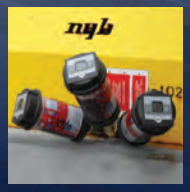
Problem: It is difficult and time-consuming for busy operators to deliver the right lubricant, in the right amount, at the right time to all lube points, while keeping the equipment free of dirt, water and airborne contaminants. This leads to costly downtime and shortened equipment life.

Solution: The Perma® Flex lubricator – filled with LE's high-performance, wear-reducing grease – provides reliable 24/7 lubrication, while keeping out contaminants. The Flex makes preventive maintenance easier, safer and more cost-effective in all types of equipment, particularly pumps, fans and blowers.

The Flex is ideal for:

Extremely moist or dirty areas

Hot & cold conditions



Small, tight spaces

Seeing is believing. Drop by www.LElubricants.com/uptime3.html today and fill out a form to receive a complimentary Flex lubricator filled with LE's premium industrial grease. While you're online, be sure to browse our site to learn more about LE's industrial lubricants and reliability products.

www.LElubricants.com • 800-537-7683 • info@LE-inc.com

300 Bailey Avenue • Fort Worth, TX 76107 • Fax: 800-228-1142

LE operates under an ISO 9001 Certified Quality System.

LUBRICATION ENGINEERS, Inc.

The Lubrication Reliability Source™

Contents april/may2013

Features

4 **Editorial**

7 **In the News**

9 **Is Your Asset Management Program Built on a House of Cards?**
The Importance of Creating a Solid Foundation

34 **Did You Get the Memo?**
A tongue-in-cheek look at the vicious cycle of corporate insanity

62 **Q&A**
Uptime magazine recently caught up with Anthony "Mac" Smith

64 **Book Review**
Maintenance Storerooms and MRO Made Simple

9

38

House of Card design incorporates the Uptime Elements - see pg 17

Elements

Leadership for Reliability – Int – integrity

14 **Are You a Reliability Linchpin?**

Asset Condition Management – Ab – alignment and balancing

18 **Best Practices:** Machinery Alignment Shimming

Leadership for Reliability – Cbl – competency based learning

22 **Start Executing! Success Doesn't Stop at Training**

Asset Condition Management – Vib – vibration analysis

26 **Measuring Vibration Analysis Program Effectiveness**
A Different Kind of Yardstick

ACM Asset Condition Management

28 **The Evolution of Success**
Arizona Public Service

Asset Condition Management – Ir – infrared thermal imaging

36 **Hazardous Environment**
Focus on the Area of Use for Device Selection

Leadership for Reliability – Hcm – human capital management

38 **Delayed Retribution**
The Demise of Skilled Trades Apprenticeship Programs

Leadership for Reliability – Pam – physical asset management

43 **Why Drive Change?**

Leadership for Reliability – Opx – operational excellence

44 **Engagement**
A Maintenance Story

Asset Condition Management – Aci – asset condition information

46 **Business Analytics**

Asset Condition Management – Lu – machinery lubrication

50 **Reliability Milestones Reached by Plant-Wide Oil Mist Systems**

Reliability Engineering for Maintenance – Ca – criticality analysis

52 **Missing Link in Work Management**

Work Execution Management – cMms – computerized maintenance management system

55 **CMMS Cost Justification**
How Do You Justify the Purchase of a New CMMS System?

Asset Condition Management – Ut – ultrasound testing

58 **ULTRASOUND**
The Final Frontier… Or, Is It?

Editor's note: Part 3 of the Precision Gear Lubrication article can be found at: http://uptime4.me/pgl3

28

Editorial

Integrity:

Without It Reliability Does Not Work

It is an honor to lead the team that creates each issue of Uptime magazine. There is a great deal of research, effort, recruiting, planning, writing, proofing, editing, more editing, graphic design, artistic layout, deadlines, digitizing and the final setting of ink to paper that goes into each issue.

The team creates much of its result through integrity - keeping its word and honoring its word by cleaning up any mess when it cannot keep its word. In a world of deadlines and creativity - giving your word with responsibility is a BIG factor for success.

I have been fortunate to be part of this extraordinary Uptime team and they continue to teach me by creating a powerful change in the world through their inspired work. The team also creates result by working with a laser-like focus on our mission and vision.

You may be surprised to learn that the mission we work to has nothing to do with magazines or web sites or conferences. Our mission is to make the people we serve safer and more successful.

Everyone on the Uptime team understands the mission and everyone works toward its fulfillment. The mission establishes our focus and our goals. It aims to answer the "what about me" and the "why" of our company and the work we do. The mission is aimed at being inclusive for everyone the organization touches in one way or another, even our competitors.

Our vision is to deliver ideas that make a difference in the areas of maintenance reliability and asset management.

This vision is an open invitation for all the people on our team, our contributors, our readers, our partners, our sponsors, our contractors and our suppliers to create ideas and events that correlate and support its framework.

Speaking our vision out loud creates a possibility to transform. From the moment it is spoken, the "real world" becomes "possibility" and barriers to the realization of the vision dissolve. When you speak the vision that ideas can make a difference in maintenance reliability and asset management – they do!

Our vision articulates the possibilities for us and we hope it will for you as well. It does not intend to aim at a point in the future or the past. It is available now. Our vision includes you. In fact, we invite you to "borrow" our vision.

It is also an honor to serve the audience that reads Uptime magazine and attend Reliabilityweb.com conferences, especially when they share stories of how they have used what they learn to make improvements. That is one of our highest purposes.

If you already have a great mission statement or a great vision, will you please share it with me? (tohanlon@reliabilityweb.com) I would love to learn and be inspired by you! You are invited to read this issue of Uptime cover to cover to let us know if we lived up to our mission and if you share our vision as well.

Warmest regards,

Terrence O'Hanlon, CMRP
CEO/Publisher
Linkedin.com/reliabilityweb

PS: Do you want to learn to view your program in a more holistic way? Begin that process by applying for the Uptime Awards before April 21st at ***www.uptimeawards.com***

uptime®

PUBLISHER/EDITOR
Terrence O'Hanlon
tohanlon@reliabilityweb.com

CO-PUBLISHER
Kelly Rigg O'Hanlon

EDITOR
Jenny Brunson

CONTRIBUTING WRITERS
Arizona Public Service, Brian Baldwin, Nancy Ball, Bill Barto, Paul Berberian, Heinz P. Bloch, Don Ehlert, Ron Garner, Will Goetz, Jim Hall, Tony Holliday, Shon Isenhour, Krishna Kumar, Joel Leonard, Alan Luedeking, Ron Moore, Doug Plucknette, John Reeves, Anthony "Mac" Smith, Jeff Smith, Darrin Wikoff

VP OF SALES AND PUBLISHING
Bill Partipilo
bill@reliabilityweb.com

DIRECTOR OF PUBLISHING
Michelle Hudson

ART DIRECTOR
Nicola Behr

DESIGNERS
Justine Lavoie
Sara Soto

PRODUCTION COORDINATOR
Matthew Kordonowy

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

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

Uptime Magazine
PO Box 60075, Ft. Myers, FL 33906
1-888-575-1245 • 239-333-2500 • Fax: 309-423-7234
www.uptimemagazine.com

Uptime Magazine is a founding member of AMP

Uptime® (ISSN 1557-0193) is published bimonthly by Reliabilityweb.com, PO Box 60075, Ft. Myers, FL 33906, 888-575-1245. In the U.S., Uptime is a registered trademark of Reliabilityweb.com. No part of Uptime may be reproduced in any form by any means without prior written consent from Reliabilityweb.com. Uptime is an independently produced publication of Reliabilityweb.com. The opinions expressed herein are not necessarily those of Reliabilityweb.com.

POSTMASTER: Send address changes to:
Uptime Magazine, PO Box 60075, Ft. Myers, FL 33906

LIFE CYCLE® INSTITUTE

CHANGING BEHAVIOR TO PRODUCE RESULTS℠

TRAINING SCHEDULE: APRIL 2013 - DECEMBER 2013

COURSE	WHO SHOULD ATTEND	YOU WILL LEARN HOW TO	DATES & LOCATION	DAYS/CEUs	COST
Lean Maintenance DELIVERED BY JOEL LEVITT Based on Joel Levitt's book 	Managers, Directors, Supervisors and Team Leads in Maintenance, Asset Management, Shutdowns and Turnarounds, Plant/Project Management, Engineering or Reliability.	Use tools and processes to create a Lean organization. Identify and eliminate waste, reduce operating and maintenance costs, increase uptime, gain top management support and learn to plan and schedule maintenance jobs for Lean execution.	Aug 27-29, 2013 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Materials Management	Materials Managers, Storeroom Managers, Planner/Schedulers, Maintenance Managers and Operations Managers	Apply sound storeroom operations principles. Manage inventory to optimize investment. Understand the role of purchasing. Implement effective work control processes.	Apr 9-11, 2013 (CHS) Oct 22-24, 2013 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Maintenance Planning and Scheduling	Planner/Schedulers, Maintenance Supervisors, Maintenance Managers, Operations Coordinators, Storeroom Managers and Purchasing Managers	Apply preventive and predictive maintenance practices. Calculate work measurement. Schedule and coordinate work. Handle common maintenance problems, delays and inefficiencies.	May 13-17, 2013 (CHS) Aug 5-9, 2013 (CHS) Sep 23-27, 2013 (HOU) Nov 4-8, 2013 (CHS)	5 consecutive days 3.2 CEUs	$2,495
Planning for Shutdowns, Turnarounds and Outages DELIVERED BY JOEL LEVITT	Members of the shutdown or outage teams, planners, plant engineers, maintenance engineers	Save time and money on your next shutdown by learning how to effectively plan for and manage such large projects. Learn processes and strategies for optimal resource allocation.	May 21-23, 2013 (CHS) Oct 1-3, 2013 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Predictive Maintenance Technologies	Plant engineers and managers, Maintenance, Industrial and Manufacturing Engineers, Maintenance Supervisors and Managers	Collect and analyze data to assess the actual operating condition. Use vibration monitoring, thermography and tribology to optimize plant operations.	Oct 8-10, 2013 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Prosci® Change Management Programs	Executives and Senior Leaders; Managers and Supervisors; Project Teams; HR and Training Groups; Employees	Build internal competency in change management. Deploy change management throughout your organization. Become licensed to use Prosci's change management 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 and Operations Excellence DELIVERED BY RON MOORE	Operations Directors, Site Managers, Change Managers, Operations and Maintenance Managers, First Line Supervisors, Reliability Leaders	Apply operations excellence and reliability principles. Learn to deliver competitive advantage through asset productivity, defect elimination and workforce engagement.	Sep 24-25, 2013 (CHS)	2 consecutive days 1.4 CEUs	$1,750
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.	Apr 23-25, 2013 (CHS) Sep 24-26, 2013 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Reliability Excellence Fundamentals	Personnel involved in applying or are impacted by Reliability Excellence, and people who influence business process improvement.	Experience the fundamental concepts of Reliability Excellence in order to drive performance improvement efforts within your organization.	May 21-23, 2013 (HOU) Sep 10-12, 2013 (CHS)	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.	SESSION 1 DATES: May 7-9, 2013 (CHS) Aug 13-15, 2013 (CHS) Oct 8-10, 2013 (CHS)	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.	Aug 13-15 2013 (CHS)	3 consecutive days 2.1 CEUs	$1,495
Root Cause Analysis	Anyone responsible for problem solving and process improvement	Eliminate latent roots and stop recurring failures once and for all. Learn a process to establish a culture of continuous improvement and create a proactive environment. Manage and be able to effectively use eight RCA tools.	Apr 16-18, 2013 (HOU) Oct 22-24, 2013 (CHS)	3 consecutive days 2.1 CEUs	$1,495

*LOCATION CODES: (CHS) = Charleston, SC | (HOU) = Houston, TX | Visit www.LCE.com for all Institute Location Addresses

REGISTER NOW!

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

UT-RMC R&M Certificate

Select courses approved for credit toward the University of Tennessee's Reliability & Maintainability Certificate.

LCE LIFE CYCLE® ENGINEERING

IN THE NEWS

Are You a Winner?

Find out if your maintenance reliability program is a winner by entering the Uptime Awards before April 21st. More details at **uptimeawards.com.**

A Battle We Can All Fight....

Meet Mike Seiter, a valued author for *Uptime* magazine and other publications in addition to being a polished presenter at several major Reliabilityweb.com conferences over the years. Mike has helped Reliabilityweb.com create one of the most significant maintenance reliability bodies of knowledge available. This picture of Mike was taken at a fundraiser for a fallen deputy. The next day, Mike had a seizure (June 3rd, 2012). He was diagnosed with Hydrocephalus - "water on the brain" and stage 4 brain cancer. He is currently being treated at the James Cancer Hospital in Columbus, OH. We are all praying for Mike to pull through and beat this ugly thing we call cancer. Grey bracelets, the color for brain cancer, are being sold for $5 with Mike's name on them. Monies raised will be donated to the James Cancer Hospital in Mike's name.

To order a bracelet or make a donation, visit **FightForMike.org.**

Out of This World

Eastern Processing Center reliability team leaders, Frank Saukel and Gary Pell, hosted a plant tour for *Uptime* magazine and Reliabilityweb.com team members Bill and Becky Partpilo with Terrence and Kelly O'Hanlon. The team met to preview the results of a Design For Reliability program that led to winning an Uptime Award in 2012. *Uptime* magazine is proud to have contributed to this critical National Security mission.

Asset Management Certification

Reliabilityweb.com CEO Terrence O'Hanlon was selected by ANSI to represent the United States as an expert for ISO Working Group 39, which developed a draft for ISO/IEC 17021-5 requirements for auditing and certification of asset management systems. The meeting took place Feb. 25 through March 1 at the ISO Central Secretariat in Geneva. Countries represented included France, Belgium, the Netherlands, Japan, Australia and the USA. More details online at **iso.org.**

Next Gen Reliability Leaders

Terrence O'Hanlon was invited to present the Uptime Elements to the Fort Myers Institute of Technology Turbine Generator Maintenance class. According to O'Hanlon, these enthusiastic young professionals were quick to grasp the business advantage of asset performance management and future cooperation is under way. More information about the class is online at **fortmyerstech.edu.**

House

Is Your Asset Management Program Built on a of Cards?

The Importance of Creating a Solid Foundation

Will Goetz

The June/July 2012 *Uptime* article, "Bridging the Gap Between Construction and Operations for New Capital Assets" (Robert DiStefano, et al, 2012), illustrates the business value of preparing new assets to operate beginning in the design phase. Bruno Storino expanded on DiStefano 2012 with "Capital Projects Operational Readiness and Business Risks: Maximizing Returns on New Assets" (Storino 2012), which provides an overview of a comprehensive program that optimizes the transition from engineering to operations for new assets.

This article adds to that body of work by illustrating *how* to manage the handover of asset data—the linchpin of operational readiness for large-scale projects.

With asset intensive industries planning to invest more than one trillion dollars per year (IDC, 2012) and potential savings from readying assets exceeding one percent of lifecycle costs (*Uptime*, 2012), it is not surprising that operational readiness is receiving a great deal of attention. Moreover, with ISO 55000 slated for release in 2014, companies are likely to see increasing pressure from regulators, customers and analysts to have seamless control of asset data throughout the lifecycle.

As demonstrated in Storino 2012, managing the handover of asset data is only one of many necessary activities, but it rises to the level of a critical success factor because the business of operating complex, large-scale assets depends on the support of software systems. Today,

no one who works in a plant with thousands of pieces of equipment will argue to the contrary. Indeed, preliminary drafts of ISO 55000 explicitly recognize the importance of software systems in managing assets across the lifecycle. Nevertheless, most plants still begin operations with sparse asset data in the enterprise asset management (EAM) system and rich asset detail locked up inside of engineering documents.

In the early days of operations, the lack of detailed asset data and the corresponding lack of documented maintenance strategies inhibited the efficient allocation of plant resources. With business pressure high to generate positive cash flow, personnel are assigned to making assets run, so requests for the additional resources needed to catch up on asset data are often denied. Once a plant is operating, the cold hard reality is that the profit and loss statement rules resource decision making. Poor quality asset data, reactive maintenance and poor profit performance create a self-perpetuating cycle that is difficult to break.

ments include: what data fields must be provided, the format it must be provided in and the values permissible for each required data field. With a solid specification in place, data is created during the design phase following these requirements and minimizing rework to build an efficient EAM data structure to support the operate phase.

The data required to deliver a fully functional EAM system on commission and start up are those asset data needed to create and maintain maintenance strategies throughout the balance of the lifecycle. The following data fields are generally considered essential:

Tag ID: naming and numbering conventions and field mask that enable the unique identification of equipment.

Location ID: the end nodes of the asset hierarchy to which maintainable equipment records will be attached. The appropriate number of parent hierarchy levels should be set by the owner's asset data standards with input from finance and accounting on reporting requirements. All levels of the hierarchy down to the location ID must be provided. ISO 14224 provides good guidelines for the development of a hierarchy standard.

Classification (Class, Subclass): between 1,000 and 2,000 equipment classifications. These fields are used to provide the richness and detail needed to categorize equipment objects, to associate supporting templates and to support statistical analysis of equipment reliability.

Attributes (service, material, duty rating, power, etc.): the additional details associated to classifications that help in identifying equipment characteristics, developing maintenance strategies, planning of work orders and analyzing reliability statistics.

Manufacturer: a listing of standardized manufacturer and vendor names. A large project may require more than 50,000 names.

Model: model naming conventions and field lengths must be provided. Small differences in model numbers and names can make a very large difference in equipment characteristics.

Serial Number: unique identifier of a physical piece of equipment. Some equipment manufacturers embed intelligence into the serial number related to characteristics of the equipment (e.g., metallurgy and material of construction, size, etc.).

Materials Data: classifications, attributes, manufacturer/vendor, and part number are the key fields that must be captured to organize the data and prevent duplicate catalog entries and purchases. Materials' master records will be used to build bills of materials and optimize stock levels.

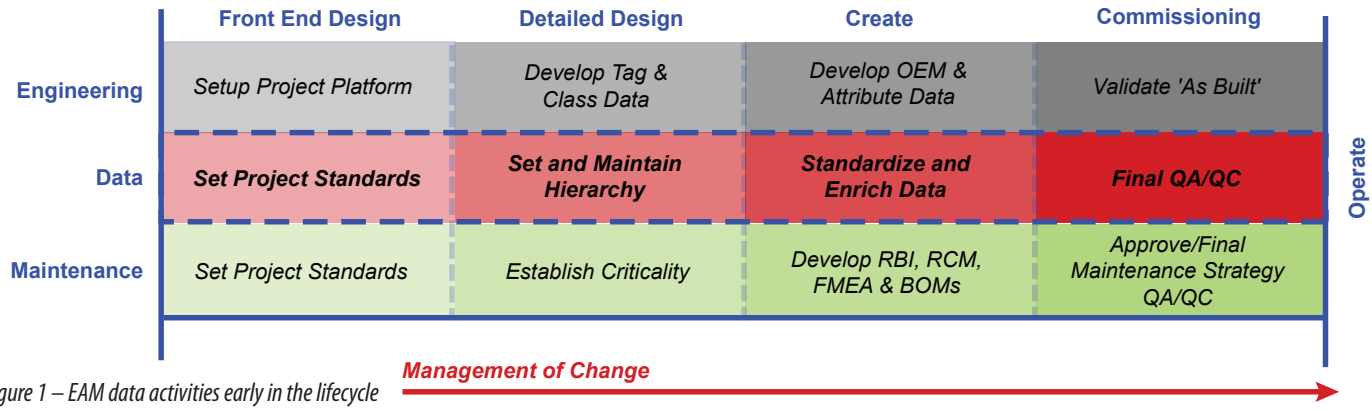


Figure 1 – EAM data activities early in the lifecycle

THE IDEAL SOLUTION

Progress is being made in software technologies to facilitate the exchange of data between document-based and database representations of assets (engineering platforms and EAM systems, respectively). The asset data required by operators can be stored as metadata attached to engineering drawings. Several engineering platforms are capable of extracting metadata and organizing it in database format. In turn, the database of asset data can be loaded into the EAM system. Metadata contained in the engineering documents originates from *many* engineering contractors and equipment manufacturers. The data quality challenge is to limit the values engineering contractors may enter into their documents to the values, field lengths and data masks permitted by the EAM system. This means the owner must specify data quality requirements very early in the contracting process and prepare the project's engineering platform to support them. Data quality requirements

THE ASSET DATA REQUIRED BY OPERATORS CAN BE STORED AS METADATA ATTACHED TO ENGINEERING DRAWINGS.

Specifications for each of these categories must be included in the project handover requirements. This list does not include maintenance strategy data elements (e.g., criticality, bills of materials, task lists, schedule, etc.) because these can be separated from data required of engineering contractors. As depicted in Figure 1, development of these data types is part of the maintenance work stream.

Figure 1 illustrates an EAM system's preparation activities from the earliest phases of an engineering project, describing how data standards introduced early in the process support development in each subsequent phase.

Phases progress from left to right, beginning with front end design and activities are divided among engineering, data and maintenance work streams. Generally, data originates in the engineering stream and flows downward within a phase. The exception is in the front end design phase where project standards are established in the data work stream and used to set up the project platform and organize the project standards. Within the maintenance stream, project standards for criticality ranking, failure analysis, maintenance strategy documentation and project organization are all key components of standards that need to be developed prior to the end of the front end design phase.

MAINTENANCE STANDARDS DEFINE THE DEGREE TO WHICH THE MAINTENANCE PROGRAM WILL UTILIZE PREDICTIVE TECHNOLOGIES AND CONDITION MONITORING.

Maintenance standards define the degree to which the maintenance program will utilize predictive technologies and condition monitoring. At a minimum, they need to define which technologies will be used on which equipment, which equipment will receive traditional time-based preventive maintenance (PM) and which equipment will be allowed to run to failure. The maintenance strategy standards should include detailed specification on how maintenance plans will be put into the EAM system, how procedures will be broken down into steps, how procedures will be combined into plans, how plans will be rolled up into schedules and what craft skills are expected to be utilized. These details are vital to ensuring that the operations team will actually be able to execute the program once the plant is turned over to their custody. Additionally, standards for potential failure identification methods should include reliability centered maintenance analysis techniques, failure modes and effects analysis, and root cause failure analysis. Each of these standards should include a description of how the analysis is conducted, what the deliverables are and where completed analyses will be stored for reuse or improvement.

Corporate standards for criticality ranking of assets and potential failure identification methods are also important to guide the development of the program early in the asset lifecycle. Criticality helps to guide the application of resources both for analyzing potential failures and subsequently in planning the application of resources to mitigate potential failures (e.g., condition monitoring). Criticality standards may include criteria, such as the impact of an asset failure on production, maintenance cost, safety, product quality and the environment.

During detailed design, the associations between the asset hierarchy and equipment objects are initiated. Within the master equipment list, functional locations are differentiated from equipment objects because functional locations are permanent reference points and equipment objects may change. For example, within a given system, a pump may provide an essential function to the overall system for a period of time, but a serialized asset may perform that function at a point in time. If a repair is required, the asset may be removed from service at the functional location and moved to another location both physically and within the EAM system. Throughout these moves, the costs and maintenance history should follow the equipment and also be traceable to the functional location.

The classification data standards loaded into the platform are, in effect, specification templates for each asset type, providing structure for the capture of asset class data and enabling association of the class data to a specific tag. From an engineering process perspective, the classification data may be entered directly into engineering drawings or into associated data sheets. Also given an asset hierarchy, criticality ranking can proceed in the maintenance stream. During this and subsequent phases, the design and physical configuration of assets is fluid, necessitating a robust management of change process to ensure the design, hierarchy, data and maintenance strategies remain internally consistent.

In the detailed design phase and following on into the create phase, asset data will begin to be specified. This is when the majority of information will be transferred and developed. Figure 2

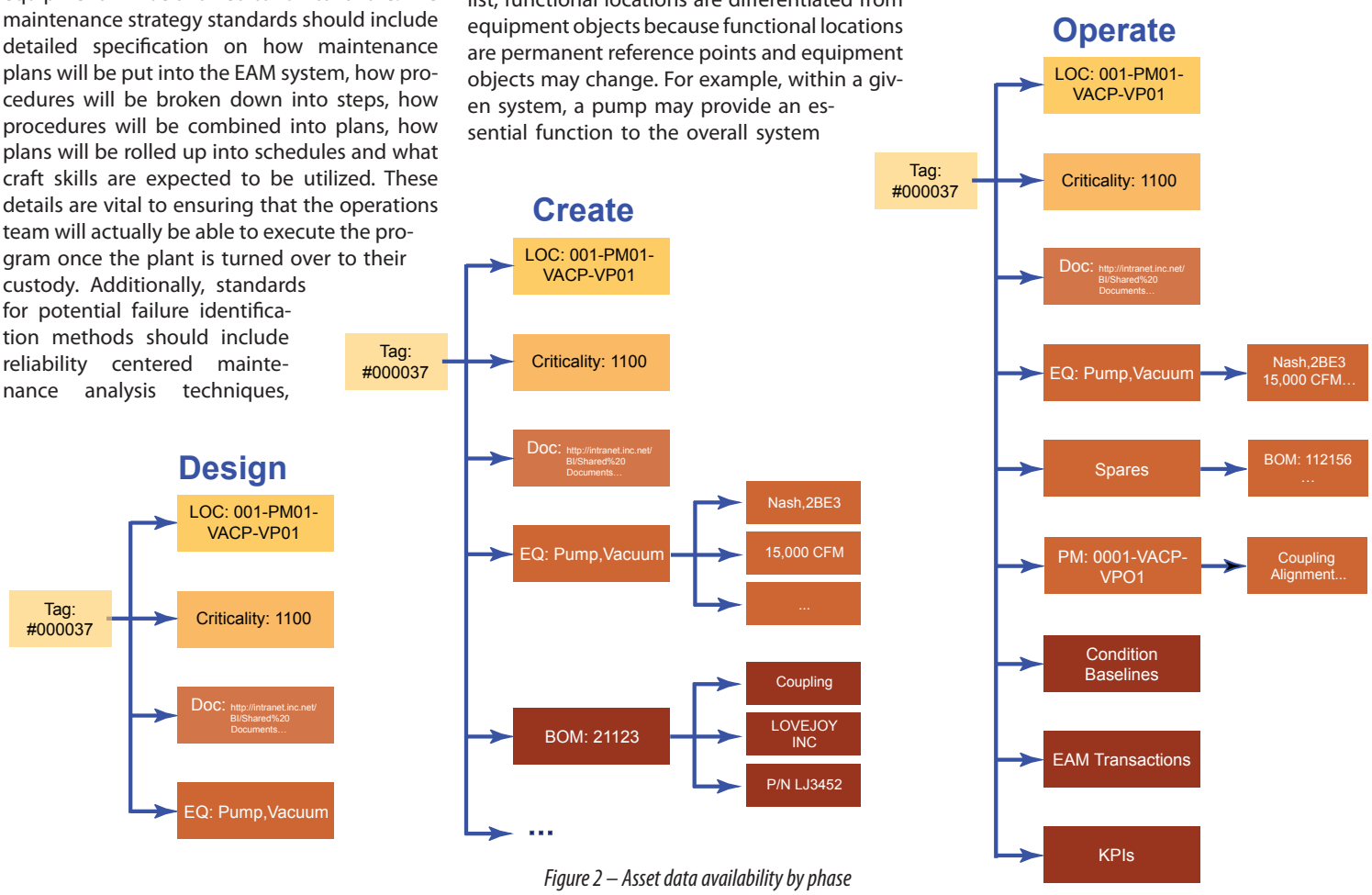


Figure 2 – Asset data availability by phase

illustrates the progression of data availability. Asset data from data sheets should be recorded as equipment records, using equipment standards to populate all values. The file name and version number of the data sheet should be tracked in the equipment record as the original source of the information and a notification should be issued if any changes are made to the data sheet, allowing appropriate follow-through editing in the equipment record. Quality review of the mechanical data sheets is a critical component and depends on the management of change process (see Figure 1). Errors or ambiguities need to be routed back to the engineering and design team and reconciled before the team has moved on to other tasks or projects and the ability to make corrections is lost.

It is also important to note that both Figures 1 and 2 depict the create phase as having a distinct break from the design phase simultaneously for all assets. In reality, this is not likely to be the case. As the design of systems is completed, work packages will be issued for construction and the design documents should be provided in parallel to the data and maintenance development teams.

The create phase (see Figure 1) is the time for intensive data work stream activities. Standardization and enrichment are broad terms for activities directed at ensuring consistency within asset data, efficiency in populating data fields and completeness of values within every asset record. With many parties involved and tens of thousands of data records to be managed, setting up the engineering platform is not enough to ensure successful delivery of quality EAM system data. Even the most robust set of data standards will require "other" or "new" categories for unanticipated manufacturers and classifications. Such categories are notorious sources of data quality problems. Success depends on timely and continuous review of asset data and feedback to engineering contractors regarding inconsistent values and incomplete data.

Enrichment is a parallel activity to standardization and uses standardized values to populate records efficiently. By matching standard values entered in classification, manufacturer, model and attribute fields to preexisting records, data fields that may be missing from records in the engineering data set can be augmented efficiently. As the project progresses and the catalog of detailed records grows, the need to reference OEM information diminishes and automation of enrichment increases. Additionally, the degree to which standardization and enrichment can be leveraged to reduce engineering data requirements should be fully explored and documented within the project. Data enrichment activities should be substituted for original data entry into engineering documents where possible because they are likely to be more efficient.

THE CREATE PHASE IS THE TIME FOR INTENSIVE DATA WORK STREAM ACTIVITIES.

Failure analyses, maintenance strategies and bills of materials also can be prepared during the create phase. Since this program may fold new assets into a current enterprise program, existing asset-class-specific failure analyses and maintenance strategies should be leveraged as much as possible. For example, an existing program is likely to have failure analyses already developed for common equipment like AC motors or centrifugal pumps, which should be applied to these asset types. Similarly, for the existing asset base, application of predictive technologies and use of condition monitoring, maintenance task lists and bills of materials are likely available for some equipment types and possibly even for the exact make and model. Standardizing the detailed asset data greatly simplifies the standardization of maintenance practices, which has the eventual additional benefit of providing a richer sampling of the effectiveness of the strategies across the enterprise. Coupled with a continuous improvement approach to defect elimination, standardization has a powerful impact on improving asset performance and lowering implementation costs.

The EAM system's master data framework needs to be functional prior to the commissioning phase to enable the capture of important startup information. As illustrated in the create phase of Figure 2, when assets begin to become operational, it is very important to establish the predictive maintenance (PdM) baselines for comparison to future operating conditions. These baselines provide the basis for identifying early failures that can be corrected prior to final commissioning. The paper, "MSDGC's Reliability-Centered New Asset Turnover Process" (Janzen, et al, Management Resources Group, 2011), documents a good example of how early catches can be made. PdM routes should be conducted periodically before the assets are fully turned over to operations. This will enable the identification of any rework that may be needed prior to releasing the responsible parties in the create and commission phases.

Validating EAM system data during the commission phase is a vital last step in data quality assurance. As the engineering documentation is reviewed in the field to finalize as-built condition, the corresponding EAM representation of the asset data also should be field validated. Mobile technologies enable efficient comparison of EAM data and engineering documents and allow modification or approval as needed, ensuring the EAM system, physical equipment and engineering documentation begin operations in lock step.

WHEN THE IDEAL IS OUT OF REACH

Setting asset data standards for projects before they begin is by far the most efficient approach for transitioning to the operations phase of the lifecycle. In contrast, the least efficient, highest cost approach is always developing the asset data during the operate phase. While many large companies have instituted project requirements that support the most efficient approach, many of the companies developing projects today have a range of obstacles preventing them from attaining the ideal. Projects may take five to 10 years to develop and may have progressed too far to have standards interjected at the ideal phase. Operating organizations may be established specifically for a project and may have no preexisting infrastructure of standards to deploy. Contractor handover requirements may be set already and may not be able to be modified without considerable expense. Even in situations where project realities prevent the ideal, steps can still be taken to lower the risk and expense of delaying develop-

ment of EAM system data. Practical steps that operators can take to develop their asset data include: adding data standards to the contracting platform as reference information instead of using them to validate fields; purchasing standards from third-party vendors; and adding data work stream activities independently of engineering activities.

STANDARDIZATION, ENRICHMENT AND VALIDATION ARE KEY TO DATA QUALITY

The purpose of building data standards into the engineering design platform is to reduce standardization, enrichment and validation in the project, not to eliminate them. If the metaphorical "horse has left the barn" occurs and the project has begun without standards in place, the validation and standardization benefits of the engineering platform will be missed and more data work will be required to attain the same level of data quality. While this approach is less efficient than the ideal, it will still enable the plant to attain design production levels more rapidly than the alternative of delaying data and maintenance development until the operate phase.

MAINTENANCE STRATEGIES ARE DESIGNED TO OPTIMIZE ASSET AVAILABILITY GIVEN A BROAD SET OF CONSTRAINTS.

IT'S NEVER TOO LATE FOR STANDARDS

Indeed, for many organizations that have not yet adopted the full set of standards discussed here, putting them in place and applying them to new assets, capital projects and acquisitions is a good way to establish them. However, care should be exercised to avoid creating any conflicts with existing asset data structures in the EAM system. For example, a complete redesign of the hierarchy structure will not be possible in SAP (systems, applications, products in data processing) without also modifying the mask, structure and transaction history for existing assets. Similarly, modifications to classifications and characteristics may require mapping of existing asset records to the new standard. While these details need careful attention, implementing standards can be accomplished progressively by beginning with new assets and then successively applying them in the management of change process and as part of future shutdowns, outages and turnarounds.

MAINTENANCE PLAN DEVELOPMENT IS CRITICAL

Lastly, robust EAM system master data are essential, but only because they are put in place to enable development and management of the set of activities needed to manage and mitigate the consequences of failure. Maintenance strategies are designed to optimize asset availability given a broad set of constraints and, as a result, create savings benefits that drive the business case for preparing the EAM system.

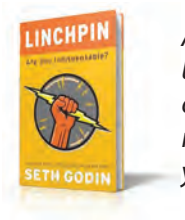
The preceding overview of the technical approach to managing asset master data through the early phases of the asset lifecycle is, of course, only part of the answer to how to manage the process. As described in DiStefano 2012, a gap exists in most companies between those responsible for capital construction and those responsible for operating. To address this gap, companies must bring together leadership from construction management and operations to ensure that gaps are adequately covered, in that construction phase deliverables meet operations phase requirements and money is allocated specifically to support these deliverables. Additionally, a parallel gap exists in the financial treatment of assets with the transition from a capital project budget to an operating plant balance sheet and profit and loss. Project budgets need to increase to bridge this gap and accommodate the cost of managing asset data and building maintenance strategies. The business rationale is solid: since readiness investments deliver returns throughout the asset lifecycle, they should be treated as a capital expense. By amortizing them across the lifecycle, the asset will deliver a higher cash flow throughout its operating life.

Technical capability and asset complexity continue to advance, driving the potential and need for changes in early asset lifecycle phases. There is a strong business case for increased investment in support of these changes. ISO 55000 will drive broad adoption of complete lifecycle approaches to asset management. We are on the cusp of a broad transformation in the way asset lifecycles begin.

Will Goetz, CMRP, is the Chief Marketing Officer of Management Resources Group, Inc. He has developed expertise in maintenance management and information systems by focusing on the value of solutions, working with good people and listening actively. *The author would like to thank Rick Janz, Bruno Storino and Bob DiStefano for their input to this article. www.mrgsolutions.com*

Are You a Reliability Linchpin?

Bill Barto



Author's Note: I want to acknowledge that the general premise for this article is the book by Seth Godin titled, "Linchpin: Are You Indispensable?" This book is a game changer. After I read it, I was compelled to include it in all aspects of my life, including my career as a reliability engineer. If this article resonates with you, I strongly suggest you get a copy of the book and read it cover to cover.

There is no lack of good information available for improving reliability in your organization. It usually comes in the form of tools to learn and tasks to complete. Learning the proper way to critically rank your assets or create a fault tree is important, but only the start to making a real difference in your company. The hard work is finding ways to exceed expectations and make significant and meaningful cultural changes.

Merriam-Webster defines linchpin as "one that serves to hold together parts or elements that exist or function as a unit." If your company is typical, it needs a reliability linchpin – someone who is prepared to break new ground, challenge the status quo and forget the rules that tell him or her to just show up and get a paycheck. You already possess the ability to become a reliability linchpin, everyone does. The journey starts with recognizing that the working world has changed from what it was years ago.

A hundred or so years ago, the heads of companies needed workers who would show up for work, follow a set of instructions and repeat this day after day for their entire career. These factory jobs were plentiful and functioned like cogs in a machine. The men in charge had the ability to remove and replace workers at will. They were also successful in reorganizing our society to allow them to keep the positions filled. They created a universal educational system (that is still in use today) that promoted the training of millions of factory workers. This model has worked so well that those who operate outside this way of thinking (linchpins) look odd and invite criticism. Obviously, we do not want to find ourselves in this situation.

Have you ever met a linchpin? You probably have encountered one in your daily life and failed to notice. When I am not traveling for work, I am usually sitting in a coffee shop a few miles from my house. Why do I visit this particular coffee shop when there are other places that serve coffee closer to my house? I do so because a linchpin opened this particular shop. Everyone that works behind the counter knows the proper preparation of coffee and can do it repeatedly. They destroy the coffee-making status quo by not simply switching on an automatic brewer and pouring cups of coffee. As far as I am concerned, whoever started this coffee shop is a coffee linchpin.

Just like the coffee linchpin recognized in the example above, a reliability linchpin needs to acknowledge that most limitations are self-imposed and only serve to reinforce the status

quo. If your organization is typical, reliability engineering responsibilities are new and unclear. As a result, they do not always provide a clear map for successfully completing tasks. This creates the perfect opportunity for you to get educated on current reliability and maintainability practices and spread the knowledge through your company. Instead of throwing up their hands at the inability of their company to provide the plan for them, reliability linchpins welcome the freedom from this lack of structure and plot the course themselves.

Let me be clear, this is not an excuse to go off on your own, create your own personal practices and not share them with the rest of your company. Going back to the coffee shop example, I do not worry about which employee makes my coffee. What I do worry about is that the coffee linchpin will leave because he was the one that ignored the perception that people only want plain coffee and created coffee preparation procedures, trained the employees, purchased the right equipment and has not allowed the quality to decline in the years that I have been coming here. He wanted to make the place indispensable to me – the only place that I will go to get a cup of coffee.

Table 1: Typical actions		
Reliability Engineering Functions	**Status Quo**	**Reliability Linchpin**
Preventive Maintenance	Suggest conservative time spans based on OEM recommendations	Convert time-based tasks into predictive ones using condition monitoring techniques
Failure Mode and Effects Analysis	Analyze 1-2 of the most frequent failure modes based on historical information	Expand to analyze the most hazardous failure modes based on risk factors or criticality
Root Cause Analysis	Reveal the first or most anticipated root cause	Determine ALL root causes and implement corrective action to eliminate the possibility of reoccurrence

To create the environment where others recognize and value your contributions, you must resist the temptation to go after short-term praises for completing a few tasks successfully and instead look for the long-term honors of blazing the trails that others in your company will follow. Your recognition as an individual who exceeds the status quo will come quickly and provide you with new and greater opportunities. Table 1 lists a few examples of ways to exceed the status quo for typical reliability engineering functions.

Along with getting educated and plotting the course for exceeding expectations, another quality of the reliability linchpin is the ability to complete tasks. This may seem overly simplified, but we all know of situations where the reliability exercise (e.g., FMEA, RCM and RCA) failed to deliver results because the team never implemented the final recommendations. In his book, Godin refers to two major challenges to the completion of projects and tasks: thrashing and coordination. The reliability linchpin will anticipate these challenges and do everything in his or her power to avoid them.

Thrashing is the tweaking and modifying that occurs during the project. Some tweaking is necessary, but the problem occurs when major thrashing takes place late in the project. Thrashing late in the game will seriously delay results and cause poor decision making in order to deliver on time. Thrashing is a natural occurrence. That's why careful planning must happen at the beginning of a project when things are more fluid. A reliability linchpin will not be afraid to force answers to the difficult questions early in the planning. Coming to an early resolution on project variables will allow the work to continue without grey areas that invite thrashing.

THRASHING IS THE TWEAKING AND MODIFYING THAT OCCURS DURING THE PROJECT.

The larger the company for which you work, the more problematic coordination becomes. Maintenance and reliability projects are typically very important to the organization. As a result, many individuals will want to become involved because they are either afraid of poor decision making or desire sharing in the accolades when the project is successful. Unfortunately, projects become exponentially more difficult to manage when additional people are involved. The reliability linchpin will ensure that the team is limited to the minimum number of people necessary. The best way to limit the number of people is to develop clear requirements at the beginning of the project for being involved. This way there is no question when someone wants to get involved later on. Another way of ensuring the team limit is to run the project yourself. By leading the team (not co-leading or part of a leading committee), the reliability linchpin can ensure that no one is thrashing and only necessary individuals are involved.

All of the obstacles aimed at preventing you from becoming a reliability linchpin emanate from something Godin calls the resistance. In short, the resistance is the most basic part of your brain that does whatever it can to keep you safe and away from risky behavior. Unfortunately, that means it wants you to fly below the radar and just sit down and do your job. It is imperative to be able to recognize when the resistance is getting involved. Unfortunately, defeating the resistance involves occasionally putting yourself in uncomfortable situations. The reliability linchpin will look for opportunities to make improvements that the company has been afraid or unwilling to make simply because it has never done it that way before.

If you are ready to step up and become a reliability linchpin, all it takes is the decision to start right now. You do not have to leave your current position, demand a new title, or even change where you sit. You are the only barrier that is keeping this from happening. Ignore the resistance and decide today that you are going to throw away the map (if there is one) and start blazing the trail. You cannot afford to be average anymore. Create new and exceptional procedures for completing your daily tasks, coordinate the work without thrashing, avoid the internal and external resistance, and enjoy the honors that come from being a reliability linchpin.

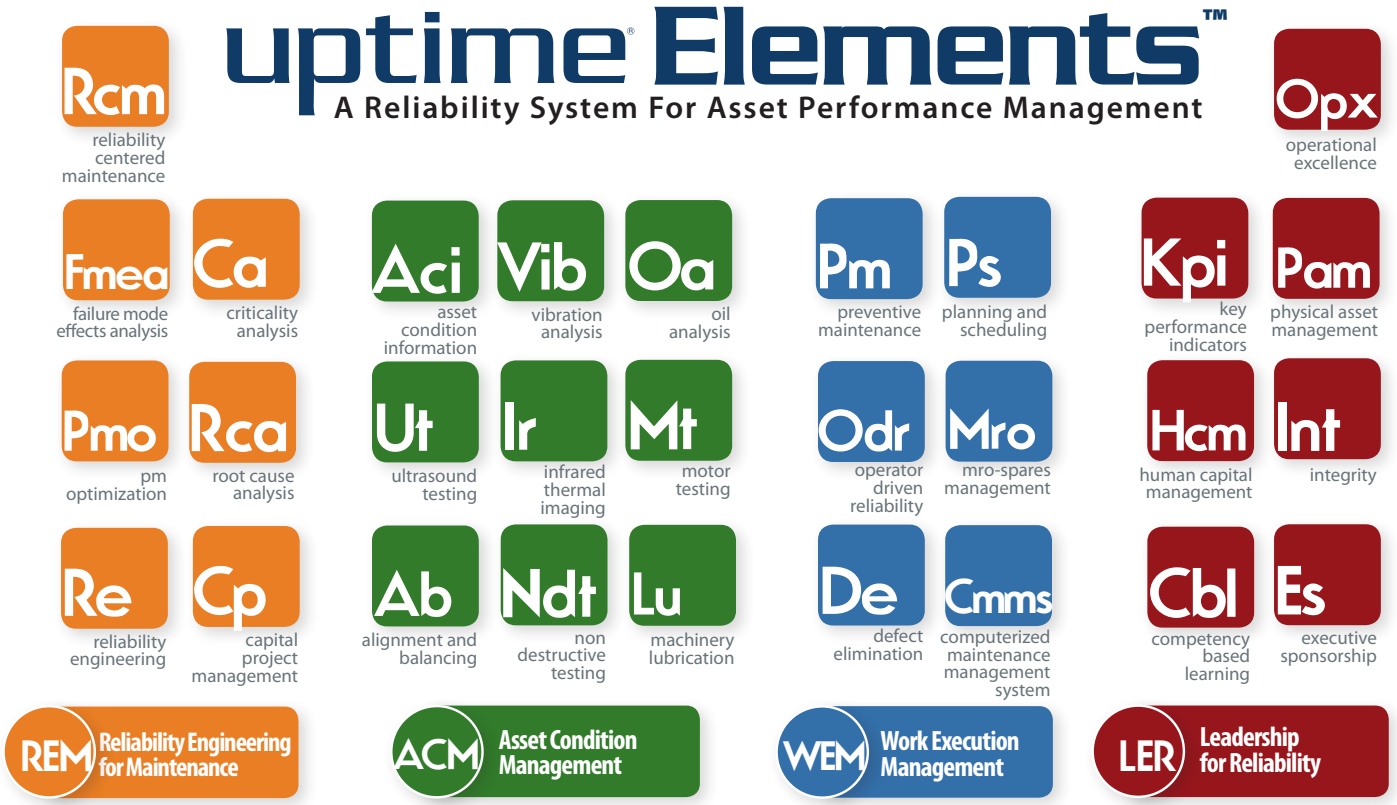
References:

Godin, Seth. Linchpin: Are You Indispensable? New York: Penguin Group, 2010.

Bill Barto, ASQ CRE, CMRP, is a Reliability Engineering Subject Matter Expert with Life Cycle Engineering (LCE). Bill has more than 17 years experience as a quality engineer, project engineer and maintenance engineer. In addition to earning a BS degree in Mechanical Engineering and a MS degree in Maintainability Engineering, Bill is a Certified Maintenance and Reliability Professional (CMRP) and an ASQ Certified Reliability Engineer. www.lce.com

Reliabilityweb.com® and Uptime® Magazine Mission:
To make the people we serve safer and more successful.

One way we support this mission is to suggest a reliability system for asset performance management as pictured below. Our use of the Uptime Elements is designed to assist you in categorizing and organizing your own Body of Knowledge (BoK) whether it be through training, articles, books or webinars.



Reliabilityweb.com's Asset Management Timeline

Awareness Training - Get your managers and team members to see the big picture

Schedule Uptime Elements Awareness Training live at your location to begin your reliability transformation.
Email: **crm@reliabilityweb.com** or call **(239) 333-2500 ext 125**

RELIABILITY® 2.0
Las Vegas

Reliabilityweb.com and Uptime Magazine thank these World-Class Solution Providers for supporting RELIABILITY 2.0 in Las Vegas.

PRESENTED BY RELIABILITY WEB.COM

April 8-12, 2013

GOLD SPONSORS

DES-CASE™

ARMS RELIABILITY

Allied INSPIRED.RELIABLE.GLOBAL

SQi SpectraQuest, Inc.

Bentley®

SDT Ultrasound Solutions
What Industry listens to

SILVER SPONSORS

LUDECA Keep it running.

MOBIUS INSTITUTE

SKF®

JMS SOFTWARE

The Manufacturing Game®

mainnovation

People and Processes

PHILADELPHIA MIXING SOLUTIONS, Ltd.

ue SYSTEMS INC The ultrasound approach

CASCADE MACHINERY VIBRATION SOLUTIONS

LINDSAY ENGINEERING

emaint

Best Practices:

Machinery Alignment Shimming

Alan Luedeking

There is much more to proper shimming of machines for alignment than meets the eye. There are a number of things you should consider and look out for when selecting and using shims.

First and foremost, you should be using high quality, precut slotted stainless steel shims. Cutting your own shims by hand out of cheaper rolls of carbon steel or brass shim stock may save you money in materials, but will prove far more expensive overall for several reasons. For one thing, you will be able to cut only the thinner thicknesses with scissors or shears, whereas thicker thicknesses (over 0.004") will require using an acetylene torch or a saw, which is labor intensive and presents several safety concerns. After you have cut your shims by hand, it is essential to deburr them carefully with a ball peen hammer and file. All of this will cost you the most valuable commodity of all: time. Moreover, the end result will be fewer available shim thicknesses than you would otherwise have with precut stainless steel shims, resulting in less precise alignments. In addition, if you are cutting shims by hand, there is a far higher risk of minor cuts, requiring a visit to the nurse for a bandage, with the attendant's loss of time and safety-reporting paperwork this would entail.

It is important to select your brand of precut stainless steel shims carefully, as they vary widely in quality and tolerances. It is extremely important that the shim be of consistent quality, completely even in its thickness throughout, accurate in its thickness, flat and burr free. Also, it should have no hazardous sharp edges. The metallurgy of the shim is also important to guarantee its hardness and corrosion resistance. Only the best quality precut stainless steel shims offer all these features. An excellent shim will always save you time and money in the long run. Let's see why:

YOU MAY THINK THAT LIMITING YOUR SHIMMING TO JUST THREE SHIMS UNDER A MACHINE FOOT IS UNREALISTIC AND UNREASONABLE, HOWEVER, IT IS NOT.

ADVANTAGES OF PRECUT STAINLESS STEEL SHIMS

Precut stainless steel shims are:

- **Precut**: You don't have to hand cut them, saving you much time.
- **Burr free**: This means greater precision in the thickness.
- **Accurate** in their thickness (up to 0.025").
- **Even** thickness throughout.
- **Flat** and undistorted.
- **Convenient**: Steel carrying cases make transporting shims easy and help to keep them neat and organized.
- **Versatile**: More thicknesses and sizes to choose from means you will use fewer shims to achieve the desired thickness, thereby saving both time and money in materials.
- **Safe**: The safety tab allows for safe manipulation of each shim. Never allow your fingers to get under a machine foot!

Some of these points require further attention, as they have a direct impact on your best practices regime. Let's examine a few of these.

NUMBER OF SHIMS

You should try to never use more than three (or four at most) precut shims under one machine foot, except in exceptional circumstances. The reason for this is too many shims under a machine foot leads to increased risk of exceeding your permissible soft foot tolerance. You can calculate approximately from a quarter to half a thousandths of an inch (0.00025-0.0005") movement from compression for each air space under the foot. If you have three shims, you will have four air spaces as follows: Between the underside of the foot and the first shim; between the first and second shim; between the second and third shim; and between the third shim and mounting surface. This means three shims will inevitably produce about 1 mil (0.001") worth of movement every time you tighten or loosen the anchor bolt.

This effect is usually due to a slight lack of coplanarity between the machine's feet and base, and in some cases, slight bowing of the shims. If you add to this the effect of surface contaminants present on both faces

of each shim (finger oils, dust, grease, etc.), the movement can be greater. This is why a tolerance of 2 mils for soft foot is considered standard. In addition, stainless steel can be expected to compress about half a percent of its overall thickness under load, so you can expect a 100 mil shim stack to yield another half thousandths under load. (Contrast this with some brass alloys that can yield as much as six percent!)

You may think that limiting your shimming to just three shims under a machine foot is unrealistic and unreasonable, however, it is not. Good machine installation practices dictate that a good rough alignment between the machines should not necessitate ever having more than 100 mils worth of shims under any machine foot to achieve final alignment within tolerance. Good quality, precut stainless steel shims come in 13 thicknesses, ranging from 1 mil to 120 mils. These are: 0.001", 0.002", 0.003", 0.004", 0.005", 0.010", 0.015", 0.020", 0.025", 0.050", 0.075", 0.100" and 0.120". With these 13 thicknesses, you can achieve <u>any</u> desired shim thickness, from 1 to 150 thousandths, with never more than three shims.

Examples:

24 = 20 + 4

69 = 50 + 15 + 4

97 = 75 + 20 + 2

149 = 120 + 25 + 4

These examples show that you will save money with precut shims because the greater variety in available thicknesses means you almost never need to use more than two, or at the most three, shims under one machine foot. Over time, this adds up to a lot of saved shims. As part of this best practice, it is imperative that you always maintain your shim cases fully stocked with all thicknesses, otherwise shim consumption may balloon. For instance, if you run out of fifteens, you will find yourself using a ten and a five, or three fives, which quickly escalates your shim costs and increases the risk of violating the rule of using no more than three shims under a foot.

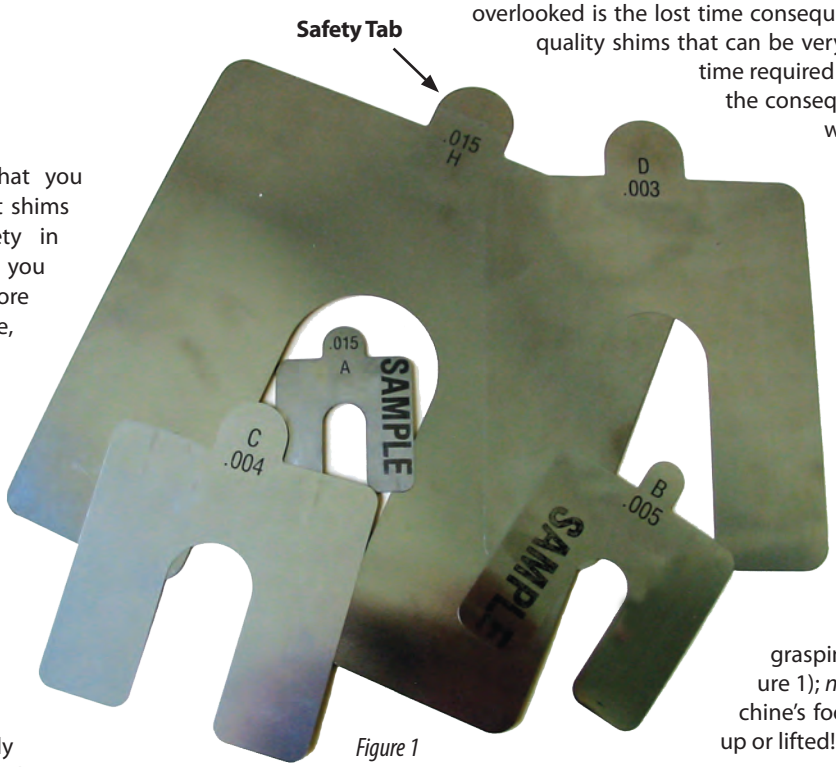


Figure 1

If you absolutely must shim your machine up by more than 150 thousandths, then go ahead and use four shims; however, if you must shim up 0.250" or more, then have your machine shop make you a chock (a chock is a shim that is 250 mils or more in thickness) and make sure this chock is carefully milled flat and coplanar on both faces. Then use three or fewer shims, normally on top of the chock, to complete the alignment.

ASCERTAINING PRECISION OF SHIMS

Always measure the thickness of any shim 0.050" or thicker with a micrometer. While certain brands of shims are of excellent quality and evenness in their thickness throughout, like all commercial precut shims, they are only guaranteed accurate in their marked thicknesses from 0.001" to 0.025". Thicker thicknesses are always nominal (just as the steel mill rolled the sheet) and therefore, should be always miked. For instance 0.075" shims may mike out at 0.078" and 0.100" shims may actually measure 0.104" thick. *This does not matter*, so long as you <u>know</u> it! Thus, make sure a 1" micrometer is a standard part of your alignment toolkit.

MARKING AND QUALITY OF SHIMS

Always look for precut stainless steel 304 shims whose thickness and size are indelibly etched upon them. This is a sign of a best quality shim. Avoid using cheaper brands that only ink their shims, or worse yet, punch stamp them with the thickness marking. Punch stamped shims is a sign that they are not flat, resulting in a leaf spring effect under the machine's feet that contributes to a "squishy foot" soft foot.

Some lesser quality shims usually have raised knife edges (burrs) along their edges because they are not tumbled after being stamped out of the sheet and the dies used to stamp them out are not sharpened often enough. This also results in a shim of inaccurate thickness, which will contribute to or even cause a squishy soft foot; it also constitutes a significant safety hazard for the millwright who is not using safety gloves.

In the end, cheaper shims always end up costing you much more than good quality shims, given the increased labor costs resulting from the necessity of making repeated adjustments of the machine's position and the greater downtime that results from the shims' inaccuracies. Not to be overlooked is the lost time consequences of minor cuts caused by poor quality shims that can be very significant not just in terms of the time required to treat the injuries, but also from all the consequent paperwork required to comply with your internal safety incident reporting requirements.

SHIMMING TECHNIQUE

Always sandwich your thinner shims between thicker ones to protect them. In fact, if you have to shim 26 thousandths, choose to use a 20 and two 3s, rather than a 25 and a 1 alone.

Always insert your shims until you feel them touch and then withdraw them slightly. This way you know for sure that you are not letting the slot of the shim get caught in the threads of the anchor bolt.

Always handle your shims by grasping them by the safety tab (see Figure 1); *never* let your fingers get under a machine's foot while the machine is being pried up or lifted!

SHIM SIZES

Precut stainless steel shims come in several standard industry sizes, as pioneered by Lawton Industries many years ago: These are:

- Size A: 2" × 2" with a 5/8" slot
- Size B: 3" × 3" with a 13/16" slot
- Size C: 4" × 4" with a 1 1/4" slot
- Size D: 6" × 5" with a 1 5/8" slot
- Size G: 7" × 7" with a 1 3/4" slot
- Size H: 8" × 8" with a 2 1/4" slot

Lawton has published a chart of horsepower ranges and motor frame numbers associated with the different sizes of shims. See Tables 1 and 2 (next page).

Alternatively, choose your shim size more by the slot size than by the foot's surface area. It is a myth that you have to support the entire surface area of the machine foot with the shim. You only need to support the load zone around the anchor bolt. See Figure 2 for an illustration of the load zone and the area that should be supported by the shims. Most machine feet are made much larger in surface area than what is strictly necessary

Table 1 - Shim Sizes & Horsepower Ranges				
	SIZE A	SIZE B	SIZE C	SIZE D
Shim dimensions	2″ × 2″ × 5/8″	3″ × 3″ × 13/16″	4″ × 4″ × 1 1/4″	6″ × 5″ × 1 5/8″
H.P. Range, approx.	0.25 to 15	10 to 60	50 to 200	150 to 1,000

Table 2

NUMERICAL LISTING FOR CORRESPONDING MOTOR FRAME NUMBERS

2" x 2" x 5/8" SIZE A MOTOR FRAME NUMBER		3" x 3" x 13/16" SIZE B MOTOR FRAME NUMBER		4" x 4" x 1-1/4" SIZE C MOTOR FRAME NUMBER		6" x 5" x 1-5/8" SIZE D MOTOR FRAME NUMBER	
42	184	86*	325	203*	408	502	681
48	185	253	326	204*	409	503	682
56	186	254	327	224*	443	504	683
143	187	255	328	225*	444	505	684
145	188	256	329	363	445	506	685
162	189	257		364	446	507	686
163	1810	258		365	447	508	687
164	213	259		366	448	509	688
165	214	283		367	449	582	689
166	215	284		368	504*	583	
167	216	285		369	505*	584	
168	217	286		403	506*	585	
169	218	287		404	507*	586	
1610	219	288		405	508*	587	
182	2110	289		406	509*	588	
183		323		407		589	
		324					

** Denotes Old Frame Number*

to support the mass of the machine and its operational load stresses. So, if a machine foot is larger than a given size of a shim, but the shim adequately supports the load zone around the hole in the foot, you do not have to worry if the outer edges of the foot overhang the shim a bit— that is perfectly okay.

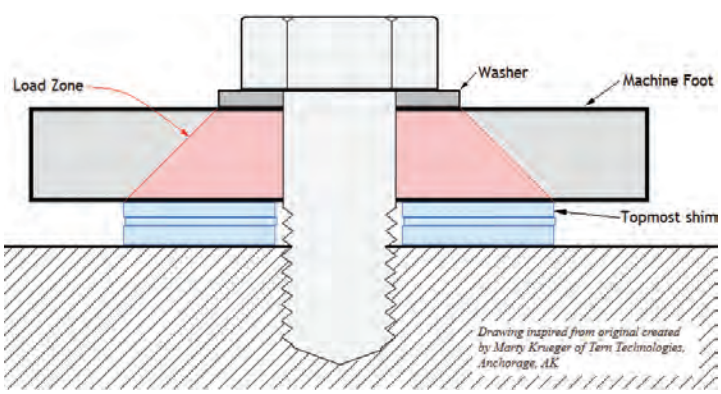


Figure 2: Load zone to be supported

The load zone (depicted in red) is defined as a cone approximately 45 degrees from the edge of the flat washer under the anchor bolt through the thickness of the machine foot. As long as your topmost shim supports the surface area defined by the cross-sectional cut of this cone under the foot, you are adequately supporting the load zone of the machine's foot and do not need to support any excess surface area under the foot.

Figure 3 shows an example of how *not* to shim a machine: Too many shims were used and the shims do not support the load zone of the machine's foot around the anchor bolt. Moreover, the Size 'A' shim used on top of the shim stack is too small for a motor of this size. When the anchor bolt of this foot is tightened, the foot will be stressed, distorting the machine's frame and altering the internal alignment of the bearing bores, as well as affecting the air gap between rotor and stator. Note too that the motor was painted *in situ*, covering the shims and jackscrews in paint and also allowing paint to go under the foot. These are all bad practices.

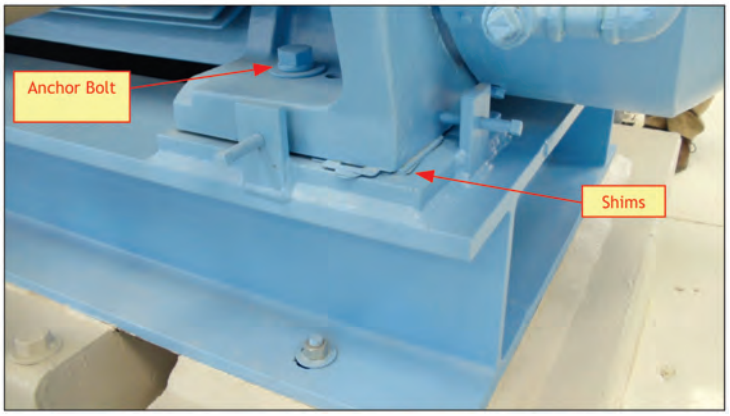


Figure 3: How not to shim a machine

If the existing standard shim sizes cannot properly fit the load zone of a given machine foot, or you cannot accommodate the anchor bolt(s), consider having custom shims manufactured in the exact shapes and sizes that you require. The best shim manufacturers offer this customization and can make you shims in any desired material (SS-304, Monel, etc.) at a lower cost and with higher precision than you usually will be able to have them made for in-house.

UNUSUAL CIRCUMSTANCES: STEP SHIMMING

Sometimes, a machine will have feet that are significantly angled with respect to the contact surface of the base plate or sole plate supporting them. This can be caused when the feet are accidentally bent, or when the machine is "rolled" to accommodate a horizontal misalignment problem (definitely *not* a best practice!) Tightening the anchor bolts under these conditions would force the feet flat to the base, thereby distorting the machine and increasing the radial load on the bearings. This affects air gap clearances between internal components and places undue stress on the feet or other machine parts. How do you solve this problem? The best way, of course, would be to re-machine the base plate, sole plate, or undersides of the machine feet in such a way as to eliminate the lack of coplanarity. However, this may not be practical or economical to do. This leaves us with the only other possible solution: *step shimming*.

Step shimming requires several thinner shims to be carefully inserted between the machine's foot and its support surface in such a way that they are offset from one another in step fashion. This fills the tapered gap between the underside of the foot and its support plane as evenly as possible, as illustrated in Figure 4. This may require you to use more than three shims overall, but as with everything, there is always an exception to the rule and here the benefits of doing this outweigh the disadvantages. Although not elegant, the step shimming solution is expedient, easy and economical, and will prevent a much more serious machine frame distortion problem, allowing your machines to run satisfactorily until your next

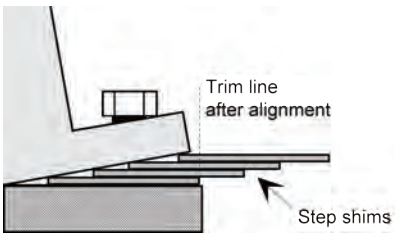


Figure 4: End view of step shimmed machine foot

major outage when you can schedule the time and resources to fix the problem properly in a more permanent manner. It goes without saying that if the time and resources are readily available, you should consider remachining the undersides of the feet or the contact surfaces of the base plate, or making a tapered "dutchman" shim for the foot. Keep in mind, too, that the "bent" foot may be symptomatic of a larger problem with the machine, such as internal damage if it resulted from the machine being dropped in transport or installation. If the angularity between the foot and the base is too large, consider replacing the entire machine or the base, as may be.

While we are on the topic of angled feet or irregular surfaces, let us address the topic of "soft" shims for a moment. Soft shims that mold themselves to the uneven opening under the feet are *not* recommended; they allow the machine's casing to distort when the feet are tightened before they set and harden, thereby resulting in an undesirable, strained condition of the machine's frame. In other words, you are creating a shim fitted to the distorted condition of the machine, rather than to its undistorted, stress-free configuration. Soft shims may seem like an expedient solution, but we strongly discourage their use.

CALCULATING A STEP SHIM

To step shim correctly, choose a shim thickness that will allow you to stack no more than four shims to fill the uneven air gap between the underside of the foot and its support surface. Place these shims between the underside of the foot and any shims already present for the alignment of the machine as evenly as possible. To calculate the ideal shim thickness, measure the largest air gap with an inside micrometer and divide this gap by five. This will reveal the ideal thickness of shim to use for the four steps. For instance, if you must fill a 20 thousandths tapered air gap, dividing this gap by five yields an ideal step shim thickness of 4 mils. Use four, 4 thousandths shims to fill the tapered air gap as evenly as possible.

Step shimming works well since the angles involved are sufficiently small enough to fall well within what is known as the 'swedge' angle for the coefficient of friction of the materials involved. This means as you tighten the anchor bolts and apply load to the shims, they will tend to remain in place rather than "squirt out" like watermelon seeds. Once the step shimming task is complete and the alignment of the machines has been rechecked with all anchor bolts tight, do not neglect to trim off the excess part of the shims protruding out from under the edge of the machine's foot to prevent possible injury.

In conclusion, best practices in shimming for machinery alignment and soft foot correction involve some care and attention to detail, the use of high quality, burr free, precut stainless steel shims and good shimming technique. Choose your shim supplier with care and keep your shim boxes fully stocked with all available thicknesses, in all the sizes needed to adequately support the load zones of the machines in your plant.

Alan Luedeking is Vice President of Ludeca, Inc. in Doral, FL. He has 30+ years experience in machinery shaft alignment and training and holds an ISO level I Vibration Analyst Certificate. Besides his work, Alan enjoys spending time with his family and numismatics. www.ludeca.com

Leadership for Reliability — Cbl competency based learning

Start Executing! Success Doesn't Stop at Training

Darrin Wikoff and Shon Isenhour

Are you buying new equipment? Are you implementing reliability improvement? Are you transitioning to a new enterprise asset management (EAM) system?

No matter what change is being made, if a site wants a truly sustainable performance increase, then it must have an education program that includes six key elements. Those elements include:

- A business case for education;
- Learning process;
- Leadership support and involvement;
- Content that is retainable and relatable;
- Trainee ownership and control of their experience;
- Reinforcement through direct application.

If the organization takes the time to execute each of these elements together, then return on education (ROE) becomes a reality.

LEARNING SHOULD HAVE A RETURN ON INVESTMENT

Training must be scrutinized just like any other capital investment. A company would not purchase a new piece of equipment without taking the time to understand both the cost of that equipment and the benefits that the new equipment will bring to the company. Unfortunately, many companies budget for training and either lose it in the first round of budget cuts or spend it haphazardly on whatever request the employees submit for the year. Both of these outcomes provide limited results and almost no return on investment.

TRAINING IS AN EVENT, BUT LEARNING IS A PROCESS.

The request for training should follow a process that identifies the problems the organization is having, the skills the organization lacks and the individuals who should be trained to provide those skills. The last step is a plan to use those skills within the facility after they are obtained. Once we have the problem statement, we can then identify the skills required and begin to quantify what those skills are worth in the form of documentable improvements. For example, if I know I need more volume on a line that has reliability issues, then I may need reliability engineering skills to meet that goal. The unreliability has a cost and if I can reduce it by some percentage, then I have created a return on my efforts. Now I can look for or create training that provides the skills required and the application needed for ensuring retention of the material and the returns expected. This means that the training should have a solid curriculum that meets your learning objectives and an application project in the target area to generate a payback. Later in this article, we will show you an example charter that meets all of these needs.

LEARNING IS A PROCESS

Training is an event, but learning is a process. The learning process begins with a clear understanding of expectations between both the training participant and his or her immediate supervisor. The learning process does not stop once new information has been presented, but instead provides a means for frequent reinforcement and encouragement to apply new concepts. The learning process ends when new skills are demonstrated and evaluated and new behaviors are institutionalized.

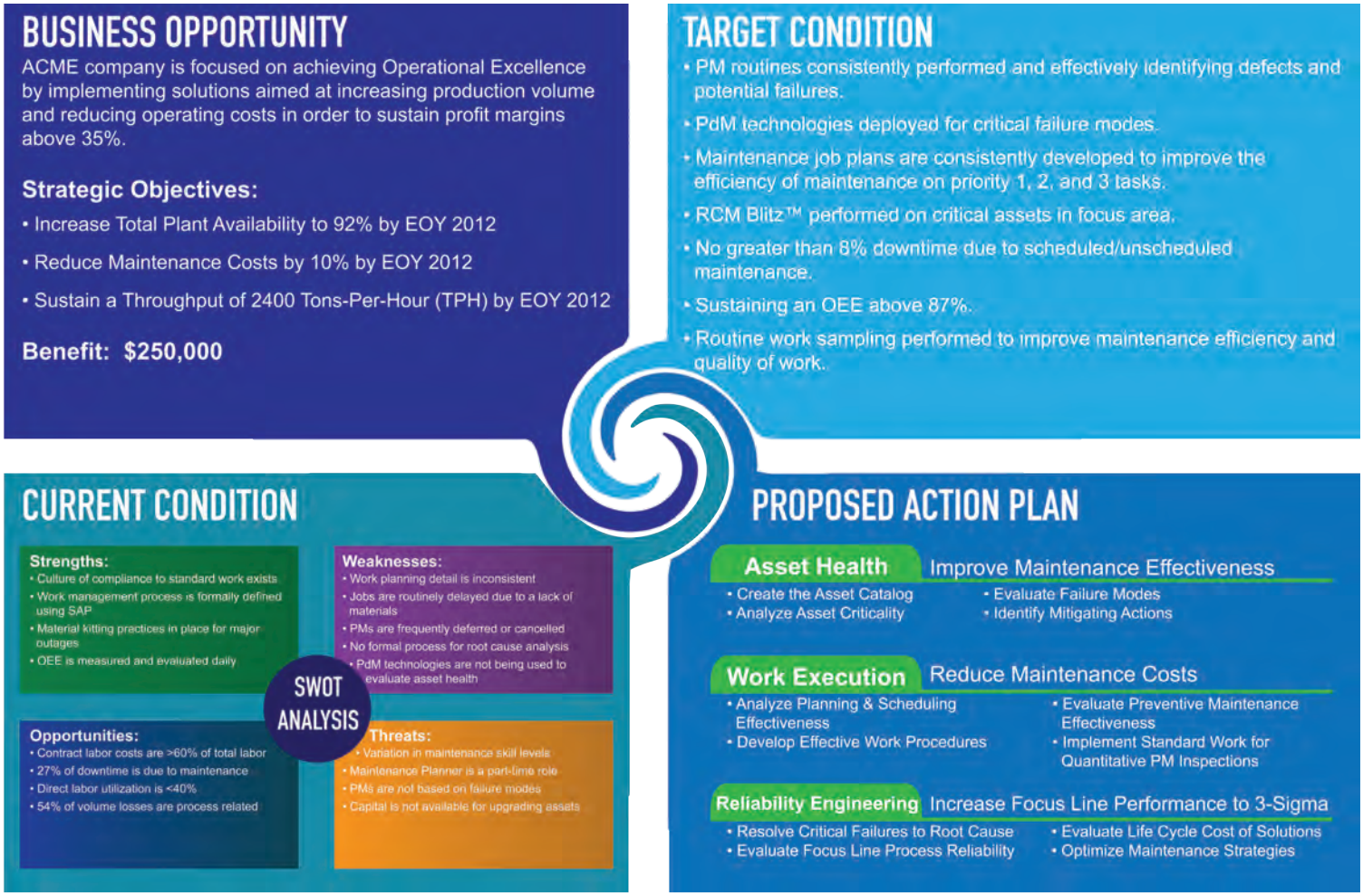


Figure 1: Learning Process Project Charter

Within a learning process, expectations of how the participant will apply new skills gained through the program and the performance improvement goals necessary for reinforced learning are facilitated by way of a "project charter" (Figure 1). The project charter serves as a learning contract between the participant and his or her supervisor and communicates why the training is necessary, how new concepts will be applied to the business, and what outcomes are expected to justify the expense and time invested in training the individual. The project charter helps the participant understand what is expected and what they need to learn before the training event, so they are able to engage more effectively and identify specific takeaways.

PARTICIPANTS WANT MORE THAN ONE MEDIUM FOR LEARNING

Each learning module within the learning solution should be designed to appeal to five types of learners. ***Verbal*** learners will key in to the narrative that supports the curriculum and become intrigued through reading assignments used to provide varying levels of detail behind each conceptual discussion. ***Visual*** learners enjoy an imaginative, animated learning environment, their senses heightened by puzzles, mazes and illustrative models on screen. ***Kinesthetic*** learners are drawn in when prompted to interact with images and animations on screen, moving objects, clicking buttons and simulating concepts using mockups or physical exercises. ***Social*** learners

Type of Learner	Likes To	Is Good At	Is Best At
Verbal Learner	Read, write, and tell stories	Memorization	Interpreting your message for others
Visual Learner	Draw pictures, design models and watch videos	Imagining	Creating models, templates and visual aids
Kinesthetic Learner	Move around frequently and interact with models	Physical activities	Simulating concepts
Social Learner	Talk with others and participate in group discussions	Communicating	Sharing personal examples that reinforce concepts
Individual Learner	Work alone and reflect on personal experiences	Setting goals	Completing individual projects

Table 1: Types of Learners

thrive on group discussions and will become engaged when given an opportunity to share their personal examples of each concept with others. ***Individual*** learners come alive when they have a task to complete. The project charter itself creates engagement for this type of learner and they become focused on making sure they can achieve the agreed upon expectations.

PARTICIPANTS WANT CONTROL OVER THE PACE OF LEARNING

Recognizing that participants have different learning needs based on their backgrounds and experience level, the learning solution should enable each participant to take control of the learning pace. Online learning modules in which participants are permitted to skip conceptual discussions if their current level of understanding is sufficient increase engagement and relevancy of the learning curriculum. If the conceptual portion of the learning module is skipped, activities should be designed within these online modules to test comprehension and understanding of core concepts before the participant can proceed. Quizzes, matching exercises, or fill-in-the-blank exercises are examples of ways to reinforce learning while providing a self-paced flow through the instructional material. This effectively maintains the integrity of the learning process while promoting a learner-centered approach. Instructor-led portions of the learning solution, in turn, should be reserved for opportunities to demonstrate and practice new skills that reinforce the core concepts. This format of instructional design ensures understanding of new concepts, regardless of each participant's prior knowledge or experience, and creates application-based learning at a pace that is consistent with each participant's learning needs.

TRAINING WITHOUT REINFORCEMENT IS NOT LEARNING, IT IS ONLY INSTRUCTION

The learning solution must provide constant reinforcement of application-based learning objectives. During the instructional design, define project solution task assignments that are relevant to the core concepts presented and the participant's project charter. For example, if the

What will I learn? (core concepts)	What am I expected to do with my training?	What competencies will I gain from this training?
Recognize the fundamentals of risk assessment and risk management	Prioritize engineering projects based on identified risks	Risk management tools, templates, and process
Describe RAM modeling and how it influences design	Perform reliability modeling in order to evaluate opportunities for improvement	A fundamental understanding of reliability, availability and maintainability calculations and modeling
List the five principles of Design for Reliability	Develop and implement a Design for Reliability checklist for all engineering projects	A fundamental understanding of Design for Reliability

Table 2: Learning Impact Map

learning solution teaches asset criticality analysis, then the participant should be expected to perform criticality analysis on a small subset of assets within their facility to demonstrate they understand the core concepts associated with criticality analysis and their ability to apply the skill effectively. It is also important to develop a means for sponsors to track participant progress on both learning module completion and task assignment completion to assess participant engagement and provide frequent encouragement. Tests or exams used to verify understanding of conceptual material are okay, but higher levels of retention and competency improvement require participants to apply what they have learned. A learning coach, therefore, should be identified to help participants apply each new skill relative to their project charter, and provide immediate evaluation of the skill application in order to advance the learning and ensure repeatability of the skill.

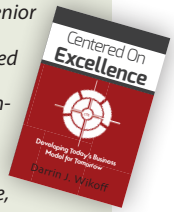
LEARNING IS DIFFERENT FROM TRAINING

"Excellence is an art won by training and habituation. We do not act rightly because we have virtue or excellence, but we rather have those because we have acted rightly. We are what we repeatedly do. Excellence, then, is not an act but a habit." ~Aristotle

LONG-TERM RESULTS OF EDUCATION ARE REALIZED IN THE APPLICATION OF NEW SKILLS, NOT AS A SINGLE ACT, BUT AS HABITS THAT FORM OVER TIME.

As a final thought, remember that long-term results of education are realized in the application of new skills, not as a single act, but as habits that form over time. Leadership's commitment to executing new skills is paramount for learning to take place. To train someone means to provide instruction or coaching in a mode of performance or behavior and refers to the acts of the "trainer." To learn, on the other hand, means that someone comprehends what is being taught, gains knowledge from it and applies that knowledge towards a skill or behavior. Both training and learning must be present in education for new habits to form and for the individual and the company to realize results now and into the future. Developing your learning solution with the ideals presented in this article will increase participation and execution of new skills, and ensure an immediate return on your investment.

Darrin Wikoff, CMRP, is a Senior Instructor/Change Management Professional with Allied Reliability Group. For the past 10 years, he has continued to coach and mentor many of the world's industrial leaders. www.gpallied.com - Darrin is the author of the book, Centered on Excellence, available at www.mro-zone.com



Shon Isenhour, CMRP, is Director of Education and Work Execution Management for GPAllied. Shon specializes in Business Process Management, Strategic Planning, Organizational Change Management and Reliability Engineering, and has lead improvement initiatives for industries. www.gpallied.com • Blog at www.reliabilitynow.com

Measuring Vibration Analysis Program Effectiveness

A Different Kind of Yardstick

One of the more common challenges for any predictive maintenance (PdM) program is to come up with definable and measurable parameters that tangibly identify the value of the program.

Brian Baldwin

During this pursuit for the ultimate yardstick, we as reliability practitioners sometimes lose sight of the ultimate goal, which is to improve equipment reliability and subsequently reduce operations and maintenance costs. Unfortunately, for the sake of justifying our programs, we commonly turn to the abstract measurement of "soft" dollar savings associated with cost avoidance.

For those of us who are intimately involved with a vibration analysis program, we objectively know there is great value in routinely monitoring and analyzing vibration data on our rotating equipment. However, we find it difficult to communicate this value in meaningful terms that our leadership can use to manage resources and justify maintenance expenses. The "What if…" cost avoidance approach mentioned above is difficult to defend when maintenance budgets are scrutinized and trimmed during the annual budget preparation cycle. This is especially true for an established vibration analysis program that has been successful at minimizing or eliminating the high profile, costly failures that were once commonplace, but are now merely a faint memory.

So how do we successfully communicate to our management team the value of our vibration analysis program? The approach described below is one that uses the functionality of a computerized maintenance management system (CMMS) to identify the impact our program has on the utilization of resources in a reactive maintenance mode. In order to accomplish this, we must ensure the work order and asset modules of our CMMS are properly configured with specific

THE "WHAT IF..." COST AVOIDANCE APPROACH MENTIONED IS DIFFICULT TO DEFEND WHEN MAINTENANCE BUDGETS ARE SCRUTINIZED AND TRIMMED.

attributes that can be queried to help identify assets included in the vibration analysis program, corrective work types, emergent/breakdown work, labor and material costs, and lost production costs. In doing so, our CMMS provides the ability to query all emergent work orders and filter on those assets that are monitored within the scope of the vibration analysis program for a given date range. Additionally, fault codes can be utilized within the CMMS to provide more granularity in the identification of vibration related anomalies as opposed to the more general blanket of emergent work cast over the assets within the program scope.

Query results displaying totals for labor hours on repair work orders are then used in the calculation that follows to determine the effectiveness of a vibration analysis program in reducing reactive maintenance activities.

$$\%EFF_V = \frac{\text{Vibration Program Labor Hrs}}{\text{Vibration Program Labor Hrs} + \text{Emergent WO Labor Hrs}_{\text{VIB ASSETS}}} \times 100$$

For example:

In the month of December, we spent a total of 80 man-hours on data collection, analysis and reporting. During that same time period, the plant experienced 10 anomalies out of the 250 machines we routinely monitor during the month that either resulted in a breakdown or emergent repairs. The 10 anomalies resulted in a total of 100 man-hours to reactively repair and restore affected equipment to normal operation. The vibration monitoring program's effectiveness based on labor utilization can be calculated as:

$$\%EFF_V = \frac{80 \text{ Hrs}}{80 \text{ Hrs} + 100 \text{ Hrs}} \times 100 = \textbf{44\% Effective}$$

Trending vibration program effectiveness on a monthly basis provides a focused performance measure that gives greater insight into the traditional ***percent reactive work*** key performance indicator (KPI) used to indicate the general mode of maintenance efforts. Deeper analysis of specific contributors to the effectiveness of the vibration analysis program can help identify areas for improvement and implement targeted corrective actions that will enhance existing maintenance strategies for our rotating equipment.

TRENDING VIBRATION PROGRAM EFFECTIVENESS ON A MONTHLY BASIS PROVIDES A FOCUSED PERFORMANCE MEASURE.

Another valuable performance measure that complements the labor-based effectiveness indicator described above is the monthly Pareto analysis of the ***total cost of failure*** for those same vibration related emergent/breakdown type of work orders. This includes all costs associated with labor, materials, contractors and lost production. Modifying or utilizing an existing user-defined field in the CMMS work order module to capture lost production/missed opportunity cost is an efficient way to tie equipment related financial losses to work orders and accurately document the total impact of equipment anomalies when reporting on the total cost of failure.

By leveraging the functionality of a CMMS to document and measure maintenance reliability performance, in this case vibration analysis, we have an efficient method to measure and communicate the tangible value of our program. Paramount to the success of any vibration analysis program, accurate root cause identification and effective corrective actions are necessary to drive improvements in rotating equipment performance. However, without a meaningful measurement that makes a compelling statement for the positive impact on equipment reliability, even the best vibration analysis programs will struggle to justify any further investment.

Brian Baldwin, CMRP, is a Maintenance and Reliability Specialist with Puffer-Sweiven. He has 25 years experience in development, implementation, management and optimization of reliability programs at both the plant and corporate levels, holding various engineering and management positions during that time.

The Evolution of Success

Arizona Public Service

ACM Asset Condition Management

Uptime Awards
Best Maintenance Reliability Programs

2012 WINNER
BEST ELECTRICAL MAINTENANCE RELIABILITY PROGRAM

What does 13 years of evolution in a public service utility's predictive maintenance (PdM) team look like? Let's start with one reliability coordinator, one infrared camera and a laptop.

Thirteen years ago, that is what Arizona Public Service (APS) initially invested in a PdM program. Today, the program has evolved into seven technicians, utilizing over 50 different non-destructive testing (NDT) pieces of equipment, in nine areas of the department. As the PdM team and the company simultaneously grew, effective work management systems, communication systems and structures were created.

APS is the largest electric utility company in the state of Arizona. APS provides service to over 1.1 million customers within 35,000 square miles in 11 of the 15 counties in the state. APS generates 6,400 net megawatts and owns over 35,000 miles of transmission and distribution lines. The company has been serving Arizona's energy needs for more than 126 years.

Scott Alford, the original reliability coordinator, now leads a team of seven technicians within the predictive maintenance department. The team focuses on overhead line reliability, underground equipment inspections, substation inspections, substation transformer surveys, radio frequency interference, pump vibration, Sf6 leak detection, corona detection and ground grid integrity testing.

Since inception, APS has seen over $20 million in cost avoidance benefits from predictive maintenance alone. Cost avoidance and improved reliability are some of the team's greatest accomplishments, but safety is always the number one priority. The group proudly has not had a recordable event since the department's beginning.

The team of technicians is a very diverse, yet focused group. As technicians are added, it is preferred that they have specific backgrounds in education or work experience. The technicians must have a proactive attitude, with an understanding of our industry and strong purpose as a PdM group. The ideal technician will frequently think outside the box and be self motivated to investigate abnormal equipment and situations related to the team's areas of focus. All technicians complete formal classes and obtain certifications in various areas, including thermography, vibration and airborne ultrasound among others.

The two-person overhead reliability team uses a custom fabricated, state-of-the-art PdM vehicle to scan overhead lines while traveling down the road. The 4WD vehicle is equipped with an infrared camera, a corona camera and a wide angle digital camera with zoom. The team also uti-

lizes a helicopter to fly over rural statewide transmission lines looking for anomalies. To date, the team has found in excess of 870 anomalies while patrolling over 7,700 miles of line throughout Arizona.

Underground equipment checks consist of thermal and visual inspections. Currently, these inspections are focused on APS's key customers. The team has collected data from anomalies found and preventable outages over the last 18 months. A future goal is to have a dedicated team to inspect all underground equipment.

The PdM team performs infrared substation inspections on over 400 substations statewide. All of the substations are tier rated and the frequency of annual inspections for each substation is based on that rating. There have been over 1,700 anomalies found in APS substations using infrared cameras. APS also performs corona inspections in many of its substations. A yearly corona scan is scheduled in each of the company's high voltage (115kv and above) substations. Any additional scans are based on "for cause."

A substation transformer survey consists of collecting acoustic emissions data; vibration readings on the main tank and pumps; sound level data; a dissolved gas analysis (DGA), as required; a visual inspection; and collecting other pieces of information. The transformers are baselined, but also surveyed for cause when necessary. The high voltage transformers are equipped with an online DGA monitoring system. APS also has an on-site laboratory staffed with two chemists for manual DGAs. The PdM team utilizes its own portable DGA unit for immediate on-site results.

The transformer pumps have a set route and frequency for vibration readings. The frequency in which a pump is tested is increased or decreased based on results from the data collector.

All of the company's radio frequency interference (RFI) complaints are also directed to the PdM department. The PdM team includes a dedicated RFI technician. This position focuses on external customer service. The PdM team's RFI technician has been successful in finding even the most unique and complicated sources of RFI, many of which are not generated by APS equipment.

Never being satisfied with mediocrity, APS's PdM team continuously seeks new and improved NDT equipment. In 2012, the team successfully launched a new ground grid integrity testing program. The new program has already identified several missing, corroded, or broken bonds within substations, therefore improving the safety of the substation crews and equipment. New predictive monitoring equipment was just purchased and allows the team to remotely monitor and record data in oil-filled equipment using 16 independent sensors.

The PdM department maintains an extensive database. This database is used to assist in cost avoidance, trending, planning and scheduling. The database is extremely organized. Even to the untrained eye, an employee would be able to access and view the information with a great deal of understanding almost immediately.

In order to maintain consistency and excellence, the PdM team has documented a procedure for each type of inspection or test. The group also

has developed technical application guides (TAGs) for a majority of these. The documents are readily available to be read, reviewed and updated by any of the department's PdM technicians.

For a long time, APS has used a computerized maintenance management system (CMMS) that plays a crucial roll in the PdM department. The software is used to schedule and issue work orders for planned maintenance (PM) inspections and testing. The team also utilizes it for condition-based maintenance tracking.

APS has two additional pieces of software that work alongside the CMMS for any anomalies that the PdM team finds. PDIQ is a custom APS program that manages all aspects of a substation. This application is available to the entire organization, allowing critical information to be entered into the system. This allows APS to view the overall health status of any substation or asset. Additionally, APS has deployed a corrective action request (CAR) system. The company can track any unsatisfactory condition more efficiently at all levels. This system is also configured to trend more accurately and consistently. Along with the company's aggressive root cause analysis program, the CAR system is just one more tool in the arsenal.

IN ORDER TO MAINTAIN CONSISTENCY AND EXCELLENCE, THE PDM TEAM HAS DOCUMENTED A PROCEDURE FOR EACH TYPE OF INSPECTION OR TEST.

PdM members have received formal root cause analysis training. In addition to this, APS has developed a separate in-house root cause analysis certification program. All PdM team members either have attended the in-house program or are scheduled to attend.

The PdM department's annual goals are tracked using key performance indicators (KPIs). The team has a KPI for each month and year for the multiple NDT areas. The team is proud to report that 100% of the KPIs were completed in 2012.

The APS PdM team strongly believes that communication and customer satisfaction are the key factors of success. Besides utilizing CMMS, PDIQ and the CAR system, the team strives to maintain the highest level of customer satisfaction not only in communicating anomalies, but in giving and receiving feedback from various maintenance departments. When the unexpected request or emergency occurs, the technicians immediately respond, coordinate and work outside of their scheduled PM.

The PdM team has mission and vision statements in place, including an aggressive 10-year road map outlining future success. The group continually challenges itself to find new ways to improve safety, reliability and customer service for the company. This positive attitude has allowed the department to achieve the Infrared Program of the Year Award in 2010 and the Best Electrical Maintenance Reliability Program of the Year Award in 2012. The APS PdM department strives in looking forward, always searching for ways to grow in this ever-changing environment.

Do you have an award winning program? Let us know - www.uptimeawards.com


OilSafe RED
OilSafe MID GREEN
OilSafe BLUE
OilSafe YELLOW
UL LISTED
NO. MH47936
PROUDLY MADE IN THE USA

Did You Get the Memo?

Ron Moore, CMRP, Managing Partner of The RM Group, Inc.

A tongue-in-cheek look at the vicious cycle of corporate insanity by IMC leader Ron Moore, the Author of *Making Common Sense Common Practice* and *What Tool? When?*
(available at www.mro-zone.com)

We hope you NEVER find yourself on the receiving end of this type of corporate memo, but if you have been or will be — perhaps this can remove some of the sting.

Beta International Corporation
The Supplier of Choice

Date: January 1, 2013
To: Neely Dunn, Manager, Reliability Engineering
From: Otto Kraetic, VP of Operations
Subject: Downsizing of Reliability Engineering

As you know, the company is currently experiencing serious difficulty:

The market is soft – sales are down 5%-10%, depending on the products and markets served, mostly due to price pressures from our customers.

Costs are up – the cost of energy, raw material supplies and equipment are up 5% or more, depending on the cost element.

Labor costs are up 6% over the past two years.

While we are confident that the strategy of our new CEO, Stan Backenwatch, will return us to a strong and profitable market position, we have some immediate problems. Our share price is declining, along with our profits and market share. We have quarterly forecasts that we must meet, something we've failed to do the past two quarters, much to the displeasure of Mr. Backenwatch. Never mind that the long-term forecast for our products is bright, particularly in developing countries, we must meet our quarterly numbers.

The Reliability Engineering Group has performed admirably over the past five years and has been instrumental in reducing our maintenance costs by 30%, cutting our unplanned downtime by 75%, increasing our availability from 90% to 98%, improving our OEE from 70% to 85% and giving greater focus to operational practices that have been the root cause of many maintenance issues. The list goes on, but suffices to demonstrate the performance of the group.

Unfortunately, company performance dictates that we must further reduce our costs in all functional areas. As a result, it is with great reluctance that we must reduce the size of the group by some 50% over the next few months, the plan to be developed for this. We have good reliability now, so it seems that we no longer need as many reliability engineers in the group; the condition monitoring group is now finding only about 25% of the defects that it found in the beginning of the program, so it seems we don't need as many people in that program; the shop floor craftspeople have all been trained in precision practices, so the need for the proactive elements of the group aren't likely as necessary as they were, suggesting the need for fewer people; the PM program is much more robust for avoiding and detecting defects, so the PM optimization function is needed less. I could go on here, but the point has been made – we simply don't need as many people in the Reliability Group as we once did – Mission Accomplished! Congratulations and best wishes for your future.

Beta International Corporation

The Supplier of Choice

Date: January 8, 2013
To: Otto Kraetic, VP of Operations
From: Neely Dunn, Manager, Reliability Engineering
Subject: Downsizing of Reliability Engineering

Yes, we're aware the company is currently experiencing difficulty, as outlined in your memo of January 1. I also note that while profits are down about 30%, we're still far more profitable than our competitors, perhaps because of all the good work you mentioned in your memo. All of us in the Reliability Group have a really keen sense for the obvious. We just hope your decisions don't make the situation worse. So, the purpose of this memo is to respond to try to help you avoid that. I'll be retiring from the company next month, thus contributing to your desire to downsize the group and minimizing the impact on at least one person. And given my forthcoming retirement, I feel free, and even compelled, to be totally honest, even blunt, in my comments. These comments are offered not to offend, but rather to inform, so that better decisions can be made.

As I hope you know, as our reliability has improved, our safety performance has also improved. Injuries are down by 66% since the program began. We have data from numerous other companies that demonstrate this principle – a reliable plant is a safe plant is a cost effective plant. Surely, you've seen this over the past few years. The fewer breakdowns and disruptions we have, the fewer injuries we have. Your logic would suggest that we should reduce the safety department and resources by 66%. Are you going to do that? That would be (being politically correct here and not saying what I really want to say) ill-advised, wouldn't it?

You stated that we now have good reliability, so we don't need as many reliability engineers. Is there really logic in that statement? Who will sustain the reliability we already have? Who will work on the improvements, particularly on the operating practices that we still need? Who will provide input into future capital projects for assuring reliability in our new equipment and sustaining our good practices on future designs? Who will interface with procurement to make sure they consider total cost of ownership, not just price? Reliability does not happen through magical forces. It takes a tremendous effort to achieve good reliability, and then at least as much to sustain what has been accomplished, and improve even more.

You're right that we only find about 25% of the defects that we once found. By your logic, we could reduce the condition monitoring by 75% and get the same results. It's not a linear system. We still have to monitor the machinery and equipment to find the defects, and the number of machines has **not** changed. What machines would you like us to stop monitoring? We now monitor 50% more equipment than we did two years ago and twice as much as we did when we first started, all with essentially the same resources. It's taken us years to find and eliminate the defects, restore the equipment and put in place the good practices that avoid the defects being introduced into the equipment in the first place. If we reduce the resources, then system performance will, in all likelihood, decline. There's an old adage, one that you perhaps hadn't heard: If you remove resources from the system without changing its fundamental system design, system performance will deteriorate. Think about it – you're a smart man. It takes years to build something, but only a few months to destroy it. Your plan will destroy what's been created.

As you stated, our proactive practices for assuring precision maintenance are much better. Alignment and balancing are routinely done to a high standard; precision installation of machinery is now routine; precision installation of piping and pipe flanges is now quite good – remember all the leaks we used to have, but don't now? Yes, it's all good! But, who will keep it that way? We have new people coming in as the older folks, like me, retire. Who will make sure the practices are sustained? The tooth fairy? Pardon my sarcasm and bluntness, but you're just not thinking about the system as a whole and how it gets sustained. More importantly, and as noted above, who is going to interface with projects, purchasing, stores and operations to make sure improvements are ongoing there? As you know, or should, we demonstrated that most of the defects come from upstream of maintenance, in projects, purchasing, startup and operations. We have a long way to go to have excellence in those practices to avoid the defects coming into the systems. Resources are needed to do that.

As you stated, our PM practices are much better. About 40% have been reviewed for so-called optimization. And we improved them dramatically. We eliminated about 20% of the 40%, or 8% total; they weren't adding any value, didn't have enough detail to allow for defect detection, or were being done at the wrong frequency, among other things. Who's going to do the other 60% and save even more money?

The company has been on a path to world-class performance now over the past five years, making the dramatic improvements you articulated. However, it is not world-class yet. In fact, in my estimation, we have another five years to go, along with the commensurate improvements in performance – lower costs, better safety, and better capability to address the markets with quality product, in full and on time. We are not nearly done.

Cutting the Reliability Group in half will likely reduce reliability and increase costs, something that you seem determined to avoid, but bound to achieve. Do you really want higher costs because we've stopped doing the things we've been doing? Or greater risk of injury because of the lack of reliability? I genuinely believe not.

Someone once said that ignorance is bliss, so you must be fairly happy. I'm sure this memo has taken away some of that happiness, but made you better informed. I'd be happy to discuss these points at your leisure, or mine, if you have the courage.

HAZARDOUS ENVIRONMENT

Focus on the Area of Use for Device Selection

Tony Holliday

The phrase "intrinsically safe" is often used generically to describe products destined for hazardous (explosive) areas, when in fact, the term is actually one of a number of methods for enabling a product to be used within a hazardous (explosive) environment. This kind of term is referred to as a protection concept.

Further examples of protection concepts are:

- Explosion-proof,
- Purge and Pressurized,
- Encapsulated.

Unfortunately, the use of the term *intrinsically safe* as a catch-all term is used frequently, if incorrectly. For example, when searching for a camera designed for hazardous areas, the norm would be to search for "intrinsically safe camera," where in fact there are cameras that use intrinsically safe, explosion-proof and purge and pressurized protection concepts.

This generalization causes problems at some levels. Users can be fixated on obtaining an "intrinsically safe" device, when in fact the means or protection may actually be irrelevant; it is the environment in which the device is required to safely operate within that is important.

For example, the explosion-proof protection concept enables a device to be safely used within a Class I, Division 1 environment. However, intrinsically safe devices have a number of safety levels, meaning a device that is certified as intrinsically safe may not be acceptable in the same areas as one certified as explosion proof.

Basically, the area determines the device selection, not the protection concept. More on this later.

Protection Concepts

If we address a few of the more common protection concepts, we can see they differ in the method used to create a device that is deemed safe for use within a potentially hazardous (explosive) area.

Explosion-proof

This was the first method of creating a "safe" device. Explosion-proof, referred to in Europe as flameproof, is a means by which a device with higher power ratings is encased within an enclosure. The enclosure itself does not prevent explosive gas from entering, nor does it prevent a spark from occurring within.

The enclosure is designed to:

a. contain the initial overpressure caused by an internal ignition, and
b. allow the expanding gas to escape in a controlled manner by means of carefully designed and calculated gaps known as flame paths.

Flame paths are not proprietary information. They are defined in the explosion-proof standards and have been calculated over the years as the minimum safe gap allowed for a specified volume and intended target location.

Figure 1: Typical explosion-proof digital camera

The purpose of flame paths is to allow the expanding hot gas to exit the enclosure via a series of gaps. As the gas expands into the outside world via these gaps, it cools to the extent where it no longer has sufficient energy to cause an explosion outside of the enclosure, hence rendering the facility safe. The downside is the equipment itself is generally heavy due to the strength required to contain any explosion. As such, the creation of portable explosion-proof equipment is generally not undertaken.

Typical examples of flameproof devices are motors and switchgear, whose energy is far above that required to ignite the area into which they must operate.

Purge and Pressurized

Purge and pressurized is a protection concept intended to effectively create a safe area within an enclosure into which uncertified equipment is installed within "safe-area" equipment. In this method, an inert gas, such as nitrogen or argon, is flooded into an enclosure creating a non-incendiary environment.

Purge and pressurized specifics change from location to location, however in some instances, a control system is required to monitor the gas pressure. If a leak in the inert gas is detected by way of a pressure drop, the control system automatically shuts down power to the enclosure, de-energizing internal components rendering them safe until gas is refilled.

The use of the term "purge" in this protection concept is of particular interest here. Once gas pressure is lost and the enclosure is ready to be refilled, it must be purged with inert gas for a predetermined period in order to reduce the residual oxygen to safe levels. In many purge and pressurized systems, there are pockets that cannot be adequately purged by a single tapping, therefore a gallery made from a tube or a series of tubes may be used to "chase" out oxygen collecting in hard to reach areas.

While purge and pressurized may seem like an obvious route for lighter product design (no need to contain an explosion), the sealing requirements and the need for some local codes for purging make it more prevalent in fixed equipment.

Typical examples of the purge and pressurized protection concept would be control panels, although some cameras have been manufactured and certified using this method.

The upside of purge and pressurized is a much lighter enclosure design. The downside is the inert gas is a consumable, so portable equipment using this concept requires recharging and repurging.

Encapsulation

Encapsulation effectively attempts to perform a similar function to purge and pressurized in that the explosive atmosphere is prevented from reaching critical components or equipment by means of hard setting encapsulant.

However, this encapsulant must be of a particular type, which itself must be tested to withstand significant environmental stresses intended to simulate a lifetime of field use. These tests are by no means simple and an entire design can be failed based solely on the material used to encapsulate it.

Additionally, accessibility to the circuit (in the context of an electronic product) is sacrificed as the protection concept is based totally on coverage by the encapsulant. On the positive side, there are minimal circuit restrictions once the encapsulant has been tested.

Encapsulation is not accepted in North America as a protection concept.

Intrinsically Safe

Intrinsically safe as a protection concept is defined as devices using low voltage and power. It is sometimes assumed, albeit incorrectly, that this refers only to voltage and current limitations.

In reality, electronic circuits are not only severely limited on voltage and current, but also on inductance and capacitance coupled with strict physical requirements to prevent short circuiting of safety components and/or individual components exceeding the intended auto-ignition temperature of the target environment under a fault condition.

Figure 2: Typical intrinsically safe thermal imager

With an intrinsically safe circuit, the battery itself must be tested separately. The use of higher voltage Lithium Ion batteries is rare since they can explode under a fault condition. More commonly implemented secondary (rechargeable) cells use NiMH chemistry which is less volatile.

Many intrinsically safe devices use primary (non-rechargeable) cells. This is more of an advantage as in recent years the chargers themselves must be deemed "associated" devices and be certified as part of the entire product. There is a certain logic here; if a standard battery charger is used on a certified battery and causes damage, how can we be sure the battery remains safe? The answer is we can't be sure, therefore, the charger itself must now be tested and certified.

More Restrictions!

Over the years, I have heard many highly intelligent, educated people refer to intrinsically safe as a "wrapper" for a non-intrinsically safe device.

If only this were true!

To illustrate, let's just say we have jumped through the hoops and now have an electronics design that complies with the standards and is intrinsically safe. It would be simple to assume that because the electronics are now safe, the packaging is irrelevant.

Unfortunately, that is not enough. Another significant source of energy is static electricity. If a polymer case is used in the design of an intrinsically safe device, then the plastics themselves must be tested to be anti-static. This process involves conditioning - again - and then a surface conductivity test to confirm that a charge cannot be created.

Even if all these challenges are successfully met, the unit must still pass what is called an ingress protection or IP test and a drop test.

The drop testing requirements for an intrinsically safe device are severe. In the case of the camera shown in Figure 2, the entire device is frozen to -10 degrees C for an extended period. Then the device is dropped multiple times onto concrete.

If the drop test does not result in noticeable damage, the IP testing is subsequently performed ON THE SAME TEST SAMPLE.

Figure 3 shows the final result of the IP5X testing, after the drop test.

Figure 3: Pre and post IP5X testing

INTRINSICALLY SAFE AS A PROTECTION CONCEPT IS DEFINED AS DEVICES USING LOW VOLTAGE AND POWER.

Quality Control

Now that we have established the design parameters, created a product and had it certified, we can start selling it, right?

Unfortunately, not!

Quality control is a major challenge with the creation of any explosive area device. As a safety-related device, the control and repeatability of manufacture is paramount. In Europe, ATEX certified equipment requires a separate Quality Assurance Notification (QAN) for the device to be legally sold. This is different from a standard ISO 9001:2000 quality management system and far more stringent with respect to inspection, testing and acceptance. For Nationally Recognized Testing Laboratories (NRTL) certified devices, additional quality control is needed, as are additional audits. This is the case even if the manufacturer already manufactures ATEX equipment and vice versa.

As a manufacturer adds certification marks to the device, the requirement for additional quality control and subsequent third-party audits also increases.

Typically, for devices certified for use in the United States or Canada, these audit frequencies are once per quarter. For European ATEX certified products, the audit is generally on an annual basis.

Conclusion

Whether the device uses intrinsic safe, explosion-proof, purge and pressurized, or any other protection concept, the aim is the same: To create a device or system that is safe to use in the environment for which it is intended.

Typically, hazardous area devices are more expensive than those intended for use in safe areas and it is easy to see why.

The challenges and risks associated with certification mean that design cost and time are dramatically increased. Once a device is certified, the cost to manufacture is also far higher than for a non-certified unit. Special material and processes, increased quality control and multiple audit costs result in a higher cost to the end user.

However, this price is insignificant when compared with the time required to raise permits for non-certified devices, not to mention the potential cost of fines and litigation should a non-certified device cause harm by virtue of its use.

Mr. Tony Holliday currently serves as Managing Director at CorDEX Instruments Ltd. Tony served as IR Windows General Manager at Fluke Electronics Corporation until April 2011. A trained engineer and published author, Tony has been responsible for improving worker safety and reducing plant operational costs by developing new and innovative products and has presented electrical safety papers at key safety conferences across the United States. www.irwindows.com

Delayed

The Demise of Skilled Trades Apprenticeship Programs

Doug Plucknette

We are performing a reliability centered maintenance (RCM) analysis on a critical piece of rotating equipment and discussing the mitigating tasks for misalignment. I ask the team if the maintenance group has a laser alignment tool to facilitate precision alignment each time the unit is uncoupled and recoupled.

Team: "No, we have looked at a few, but haven't been given money to purchase one."

Me: "Can you perform the precision alignment with reverse dial indicators? You can achieve precision alignment this way as well."

Team: "I don't think we have anyone in our shop who knows how to do that and if we did, I'm not sure operations would give us the time to do it."

Me: "You haven't been trained on how to perform precision alignment with dial indicators?

WORLD-CLASS EQUIPMENT RELIABILITY REQUIRES A SOUND DESIGN THAT IS ENSURED AT THE TIME OF INSTALLATION USING PRECISION MAINTENANCE TECHNIQUES

Retribution

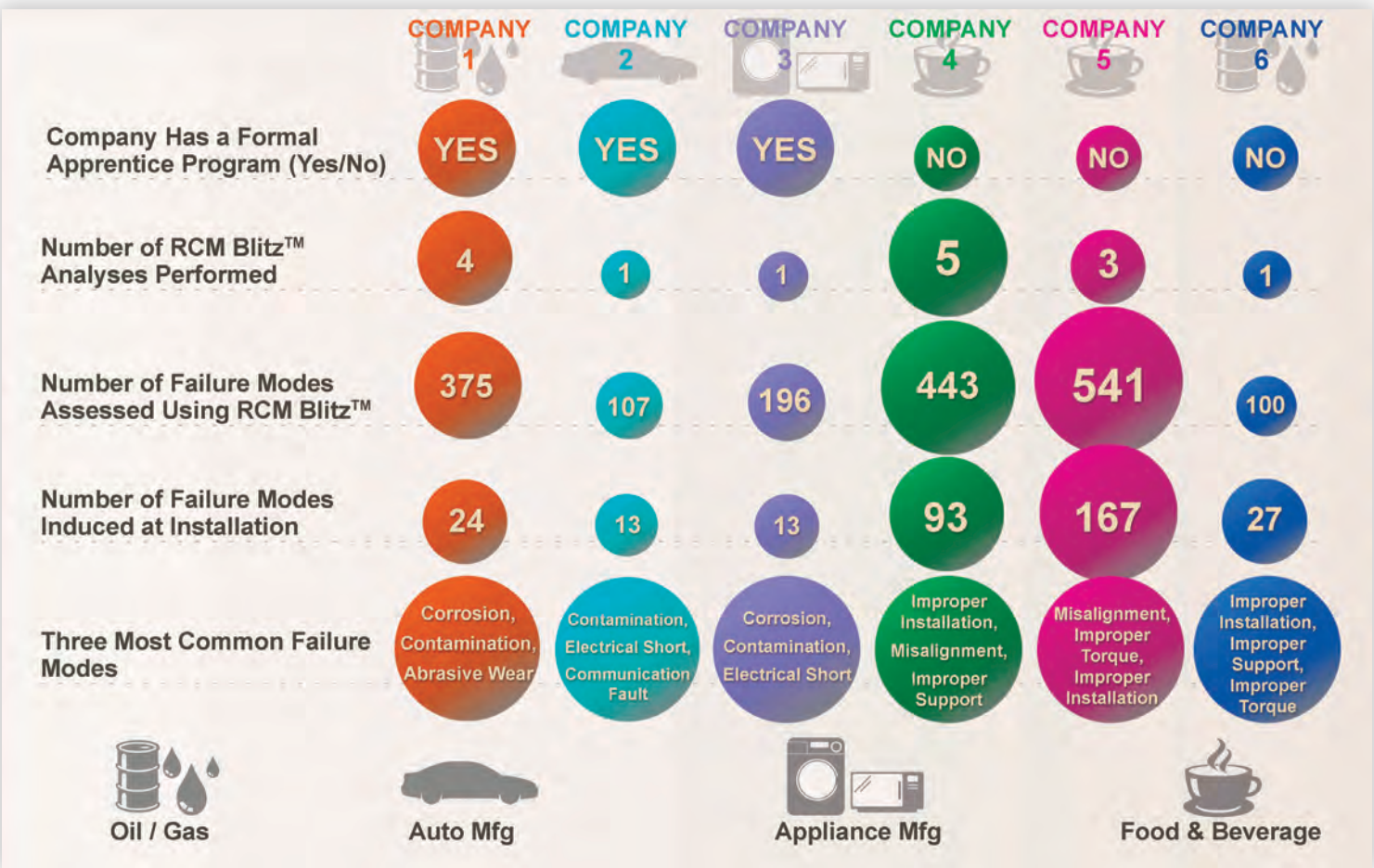


Figure 1

I take it your company doesn't have a formal apprenticeship program?"

Team: "No, they stopped the program over 20 years ago and it doesn't look like we will ever get another one."

This is the same story for an alarmingly increasing number of manufacturing plants in the United States today. Formal skilled trades apprenticeship programs have nearly become extinct and as a result, fewer and fewer tradespeople have the knowledge and capability to perform critical precision maintenance tasks. At the same time, the people who manage these companies are seeking the assistance of consultants like me to help improve the reliability of their critical assets.

I guess we are in a classic catch-22 once again. World-class equipment reliability requires a sound design that is ensured at the time of installation using precision maintenance techniques. This is followed up with a proactive maintenance strategy based on failure modes that include the corresponding condition-based or preventive maintenance tasks. If we do not have the equipment and/or the capabilities to perform precision maintenance, the expectation of world-class reliability can never be achieved.

Even more importantly, as predictive maintenance technologies improve, our maintenance technicians now have the capability to detect, identify and mitigate failure modes **if** (and this is a BIG if) they understand precision

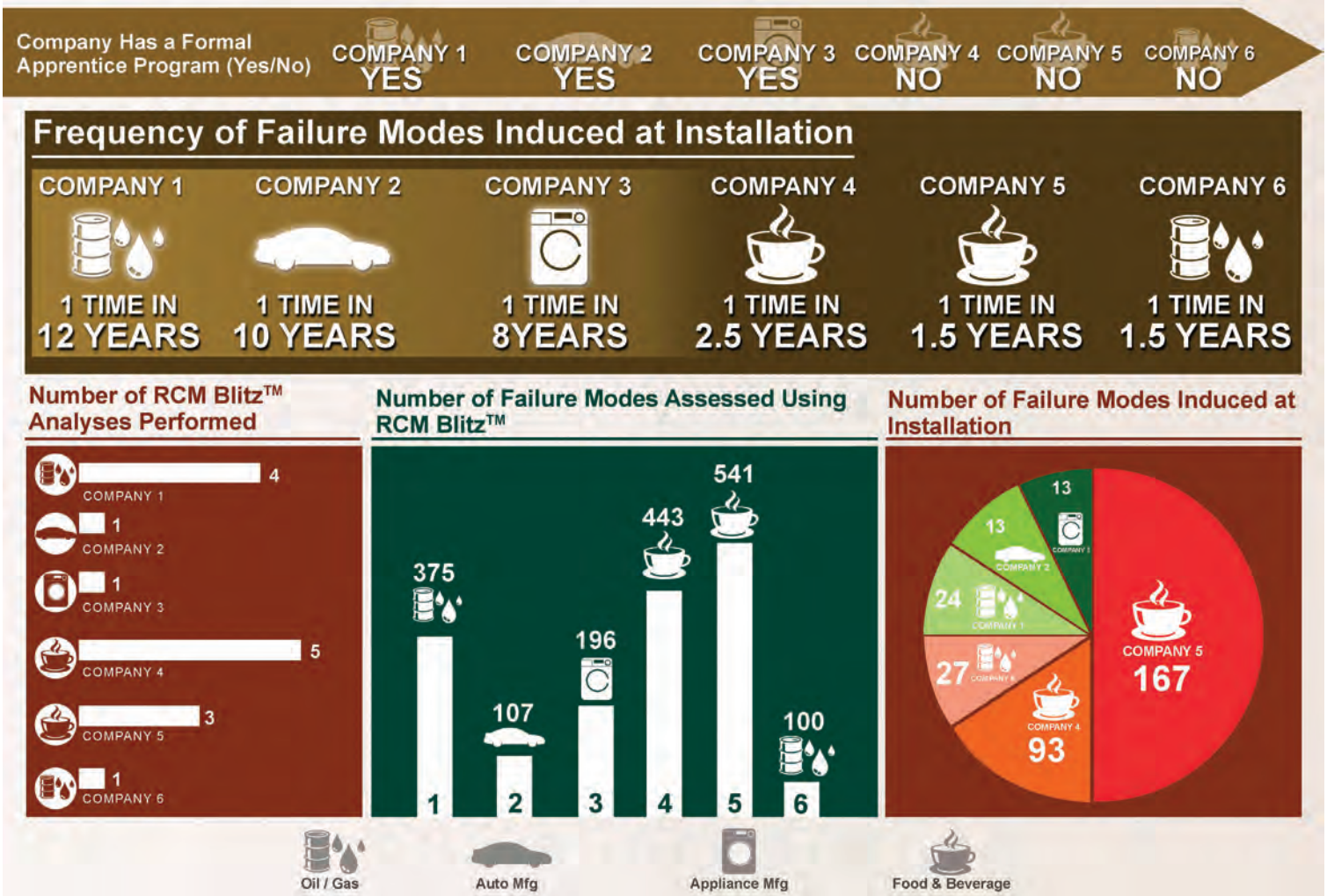


Figure 2

maintenance techniques and have the ability to identify failure modes. From my point of view, having worked with thousands of maintenance craftspeople at hundreds of companies around the world, those who have not been properly trained in maintenance techniques are far less likely to grasp and retain these critical concepts.

So, how did we get here? How is it that over the last 40 years apprentice programs across the United States have almost completely disappeared from manufacturing companies large and small to a point where some of the younger managers have no idea what I am referring to when I ask if they have an apprenticeship program?

Even more importantly, how do we reverse this trend and get today's corporate executives to understand the importance of formal skilled trades apprenticeship programs?

HOW DO WE REVERSE THIS TREND AND GET TODAY'S CORPORATE EXECUTIVES TO UNDERSTAND THE IMPORTANCE OF FORMAL SKILLED TRADES APPRENTICESHIP PROGRAMS?

When attempting to drive change, I believe in leaving my emotions at home and showing up to the challenge with data!

Thus began the painful task of looking back through the last few years of RCM analyses that were performed for companies around the globe either by myself or one of our certified facilitators. While we had hundreds of analyses I could look at, the criteria was simple: I needed to select a few companies that I know had formal apprenticeship programs and another handful that I was certain did not provide formal skilled trades training (Figure 1). I was interested in looking for a few things to see if I could identify the impact that formal skilled trades training has with regards to the failure modes we analyze.

1. Do the companies that invest in skilled trades apprenticeship programs have significantly less failure modes associated with improper installation, misalignment, improper torque, improper balance, or improper lubrication?
2. Do companies who believe that experienced skilled tradespeople are as common as buttons on a shirt and require no special training or education suffer or benefit from this belief?

While this is just a quick sample (Figure 1), it is quite clear that companies that do not have or require formal apprenticeship training programs are more than 3.6 times more likely to suffer from failure modes where the defect is caused at the time of installation than companies who do offer formal skilled trades training. The most common failure modes for these companies occur at the time of installation or replacement and have a direct impact on the life of the equipment. With the understanding that if we do not provide formal skills training

for maintenance technicians, it will result in increased failures induced at the time of installation, we should now look at the impact that training has on the overall life of the affected components.

To do this, I reviewed the same data and looked at the frequency of failures for each component where the failure modes of improper installation were addressed in the RCM analyses (Figure 2).

THE MOST COMMON FAILURE MODES OCCUR AT THE TIME OF INSTALLATION OR REPLACEMENT.

Looking at this data, we can see that companies that have formal apprenticeship programs still do, on occasion, suffer from failure modes induced at the time of installation, but the frequency of these failures is at a much lower rate. We can conclude this by developing an overall frequency for the three companies that have formal training and comparing it to the frequency for the companies that do not offer training.

The frequency of failure modes induced at installation for companies that have apprenticeship training programs (1, 2 and 3) is one time in 10.44 years.

The frequency of failure modes induced at installation for companies that do not offer formal training (4, 5 and 6) is 1.88 years.

From this, we can conclude that if your company is not offering formal skilled trades apprenticeship programs, or is not hiring technicians who have completed such a program, it will not only suffer from an increased number of individual failure modes induced at installation (3.6 times), but also the mean time between failure (MTBF) of each component will be greatly reduced (1.88 years vs. 10.44 years). Based on this knowledge, how can you expect to achieve world-class reliability if you do not have a way of training your people?

Doug Plucknette is the worldwide RCM Discipline leader for GPAllied, creator of the RCM Blitz Methodology, author of the book Reliability Centered Maintenance using the RCM Blitz Method, *and Co-Author of the book* Clean, Green & Reliable. *www.rcmblitz.com. Purchase at www.mro-zone.com*

Give Work a Chance!

Joel Leonard

Joel Leonard is a tireless champion for increasing and improving U.S. manufacturing and has brought more attention to the maintenance skills crisis than any other individual we know. Reliabilityweb.com and Joel Leonard have created an alliance to drive even more awareness and, more importantly, more action through the new Give Work A Chance initiative. We hope you will join us in thanking Joel for his past work and supporting his future efforts through the Reliabilityweb.com Network.

Super maintenance problems are finally getting super attention and resources. After the 34 minute delay at this year's Super Bowl and the recent stranded cruise ship fiasco in the Gulf, the maintenance crisis is now becoming regular satire content on Saturday Night Live.

With the passing of ISO 55000 and future regulations, more impetus will be focused in the boardrooms to fully understand the challenges and issues confronting their maintenance needs. In addition, more sensitivity will be felt to develop stronger skilled internal resources and build solid pipelines of skilled talent in regions around the world.

Now that the general public, rather than only engineering and maintenance professionals, better understand our challenges, more resources and support to address and mitigate the maintenance and skills crises that inhibit economic prosperity and put everyone at risk will be forthcoming.

That is why we are excited to announce the alliance between SkillTV and Reliabilityweb.com. Together, we are going to help regions across the U.S. and abroad implement proven strategies and strive to pilot new approaches to expand the number of skilled workers, tap into retiring workers' resources, and help incumbent workers with breakthrough training techniques to generate more productivity, reduce costs and increase safety levels. We will be sharing new videos and more profiles of innovative people, companies, or organizations so more companies can take advantage and emulate these approaches. Later this year, we will be launching a series of books called "GIVE WORK A CHANCE" to inspire more approaches, develop solid pipelines, increase reliability performance and help mitigate the skills and maintenance crises.

We also will be supporting workforce development and economic development efforts to upgrade and develop more skilled workers. In the future we hope to create short courses to be added to community colleges' continuing education departments to help develop the electromechanical, troubleshooting and predictive skills necessary for the new generation of quality technicians to address the current and increasingly sophisticated future technical requirements.

In addition, we will be supporting the virtual members of the Association of Maintenance Professions (AMP) by creating new online information, services, tools and resources to help advance the maintenance profession with the latest technologies. We also will be working in the trenches by consulting with groups around the world and providing additional support to generate more funding, resources and attention to their challenges so more solutions are implemented.

Each time a major disaster occurs, it further validates our mission and generates more to our movement to upgrade maintenance reliability efforts. Already, the NFL is requiring additional maintenance reliability planning for future Super Bowls and that has spread to other major events to implement safeguards as well. The whole cruise ship industry will be implementing future measures to avoid similar disasters during the peak cruise season.

During his State of the Union address, President Obama rolled out a program to investigate and prioritize fixes for infrastructure challenges. So now we are no longer working in isolation with minimal support, as more are learning that without strong maintenance reliability efforts, economic growth stagnates and people are at peril.

So join us and help us all GIVE WORK A CHANCE! Tune in to future columns as we will be outlining new steps and measures underway. Feel free to contact Joel@SKILLTV.net.

MORE THAN 10,000 VIBRATION ANALYSTS TRAINED*

*Since 2005, MOBIUS INSTITUTE has provided classroom training to over 10,000 vibration analysts. We train more analysts than any other training organization throughout the world. In addition to our classroom training in vibration analysis, we have trained thousands more through our DISTANCE LEARNING (via the web), and our iLearnVIBRATION software. MOBIUS INSTITUTE also provides classroom and distance learning training in FIELD BALANCING, SHAFT ALIGNMENT, and CONDITION MONITORING PRACTICES.

We are ISO/IEC 17024 accredited and provide vibration analysis training and certification per ISO 18436. Visit our website to find out how you can join the largest and most capable community of VIBRATION ANALYSTS that have been taught by MOBIUS INSTITUTE.

MOBIUS INSTITUTE

www.mobiusinstitute.com

Call us in the USA & Canada at (877) 550-3400 or international at +1 (615) 216-4811 or email us at learn@mobiusinstitute.com

Why Drive Change?

Jeff Smith

Be The Change at www.maintenance.org

"There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success than to take the lead in the introduction of a new order of things." - Niccolo Machiavelli

What drives us to change existing habits? Why not just join the masses and accept our fate and mediocrity?

The fact that you are reading this leads me to believe you have some concept of the effort involved in changing culture, after all, it is Uptime. In the reliability world, change is our normal state. Whether we are dealing with a bad actor or instilling a new business process, we are trying to change something. To understand what makes a change agent, I look back on my start in the reliability world.

I started my career in the railway doing track maintenance work. The equipment fascinated me, intergraded electronics automating advanced hydraulic systems. Track liners, tie inserter cranes, all types of equipment working in harmony! This metal ballet was a thing of beauty to watch. Then with a rainbow invoking spray of hydraulic oil, the show abruptly ended. I watched as the machine helper pulled out a chunk of -12 hydraulic hose and quickly spun on some, somewhat clean, fittings. I remember a passing thought that if the hose and fittings were cleaner, and if the helper had fit the hose so it would not rub, it might last longer (mean time between failures). I also entered a suggestion that the hoses and fittings should be contained in a sealed box with one end done on each size roll (mean time to repair). At this point, I became obsessed with finding better ways to maintain equipment; I did not realize there was a reliability industry, but hey, who did in 1980.

Throughout my carrier, I felt a compulsive need to improve on things as most reliability practitioners do; we want things to be optimized. Many of us feel this provides benefits beyond the simple monetary gains. We feel this approach will produce more efficient companies, which will affect the health, safety, environmental impact, energy utilization, sustainability and profitability of industry. I personally feel this is for the greater good of people and the environment. It is my faith in this concept that enables me to chip away at naysayers, plant seeds of best practices and challenge the realities of status quo.

The underlying vision of the Association for Maintenance Professionals (AMP) is to provide value to practitioners, to enable global communication for sharing learnings and to harvest knowledge from the amazing group of reliability pioneers that created this world. Those of you who are struggling with a business case, a complex process problem, a nagging bad actor, or just learning your way, we are here to help! The reliability world is an amazing place full of like-minded people from all industries, countries and backgrounds. I am proud to be a student of the reliability world and a servant to the next generation of practitioners!

Why drive change? Because it's for the greater Good!

Jeff Smith, CMRP, is the Senior Advisor for AMP, Global Development and the technical editor of Uptime magazine. He is a career reliability professional and change agent with the insight, vision and enthusiasm necessary to inspire teams and garner impressive results. His work has spanned a cross section of industries, including mining, pulp and paper, packaging, petrochemical, marine, brewing, transportation and synfuels.

AMP

Engagement

A Maintenance Story

Ron Garner

Portola Packaging, headquartered in Naperville, Illinois, has been on a lean manufacturing journey for the past three years.

Lean manufacturing depends on real-time data to provide fact-based, methodical evaluation of operations and processes. Portola deploys organizational learning and innovation management techniques to sustain and improve production and support assets. We also use key performance indicators (KPIs) and our interlocking X-Matrix to achieve integration throughout Portola's three U.S. manufacturing facilities. (X-Matrix is a software program that visually aligns annual fiscal goals to monthly expectations.)

The objective is to create alignment with the company's mission, vision and values. We wanted to transition from a "firefighting" problem solving mentality to a preventive and predictive maintenance approach. However, this cannot be achieved without getting everyone in the facility engaged. But what does "engaged" look like and how can you get there?

MAINTENANCE GO TEAMS HELP DRIVE MOMENTUM

In Portola's case, it started with the creation of maintenance department get organized (GO) teams to help drive performance. Each GO team is comprised of a process engineer and a mechanic who are dedicated to a specific product line. Following the 80/20 rule, we created four teams that cover 80 percent of Portola's products.

These teams are responsible for planning, executing, evaluating, sustaining and improving the company's maintenance processes on the assets to which they are assigned. By continuing to emphasize the importance of the preventive maintenance (PM) process and ensuring this is communicated clearly to all involved personnel, the philosophy began to take hold.

THE OBJECTIVE IS TO CREATE ALIGNMENT WITH THE COMPANY'S MISSION, VISION AND VALUES.

The idea behind the GO team process is similar to that of a racing pit stop. Everything is pre-staged. All plans have been finalized so when the PM starts, there are no distractions involving missing parts or tools and the time is spent actually working on the asset. Because the focus is on performing the work, this allows for a much more efficient use of PM time. When the PM is completed and the asset is returned to service, it is ready to run as designed.

GIVING OUR INTERNAL CUSTOMERS A VOICE

Even though we're talking about a maintenance initiative, our efforts have focused on the "voice of the internal customer." In Portola's case, it's primarily our production team members.

This is the second "engagement" key. The production team members have as much of a stake, if not more than the maintenance department, in the proper operation, care and maintenance of the equipment. By listening to the internal customer, maintenance is focused on creating value for the production team members. This is a critical factor in increasing the efficiency and effectiveness of Portola's processes and operations, which, in turn, help achieve organizational success.

We developed a total productive maintenance (TPM) tag system to assist with overall communications between all the separate groups. These are simple T-card tags with two sections. Once an issue is identified, one part of the tag, which describes the problem, is tied onto the equipment. The other part goes into the maintenance shop rack, organized by the GO team.

Willingness to use these TPM tags has increased as more operators have gained an understanding of their purpose and are more willing to participate in the program. Portola is currently averaging a monthly completion of more than 50 percent of these items and they are numbering in the hundreds. The remaining tags are put in queue in our computerized maintenance management system and prioritized for completion during the next scheduled maintenance event.

As the program evolved, we also added to the tag the name of the production team member who originally reported the issue. Although the typical school of thought is anonymity breeds honesty, identifying the person enables us to turn this into a communication and engagement tool.

When we fix an item, we can now ensure it was done to the person's satisfaction. Feedback provided to the operators has been key to the success of identifying the problem. People now have proof that their voice is heard and it has had a positive impact on performance.

DATA DRIVES OUR EFFORTS

Data drives our efforts. We evaluate results against our KPIs for PM completion, asset up-

time, scrap percentage and number of late shipments. We have daily routine tiered meetings that allow issues to be addressed and communicated through the chain of command.

We created a Tier I meeting schedule where the oncoming shift reviews the previous shift's KPIs. They look for major off-standard data points to better understand what drove the issue. Charts are posted weekly for each unit to provide results, promote feedback and identify opportunities to improve.

Results are communicated to upper management and corporate levels through the Dploy/X-Matrix reporting system for KPIs and facility objectives. Weekly conference calls with all plants and corporate staff are used to discuss each plant's performance and issues/concerns for the past week. The intent is to share best demonstrated practices and learn from each other, rather than having multiple resources trying to solve the same issues.

Before the creation of the GO teams, we were mired in downtime in excess of 15 percent, with overall equipment effectiveness (OEE) in the 60 percent range. Scheduling was a nightmare because we were guessing what a good planning rate for a given injection molder should be. Our scrap was driving costs up and the concern was not the same in all departments because certain items were seen as "production problems" or "shipping issues."

IMPROVEMENTS IN CULTURE, PERFORMANCE

This is where the greatest improvement in culture and performance has occurred. We have created critical and creative thinkers who have replaced the "take the marching orders and do the work" approach. We encourage and expect continuous improvement. We focus on what can be done better, smarter, easier and cheaper.

Over the last two years, PM compliance has emerged as the driving force behind uptime improvement. Preventive/predictive maintenance is not viewed as an event, but as part of a process improvement continuum. We are using a multitude of tools and teams to detect problems earlier, eliminate the root causes for failure and use data to improve uptime within our GO team framework.

Two years ago, the compliance number was in the 50 and 60 percentiles, now it is regularly in the 90 percent range, with PM completion (some accomplished outside of the scheduled window) hitting 100 percent during several weeks. We were saddled with 15 percent downtime, poor OEE and a large number of late/split shipments. During our last fiscal year, downtime was reduced by more than 30 percent, OEE is approaching 85 to 90 percent (previously under 60 percent) and in the last year, we reduced late shipments from more than 300 to less than 100.

MAINTENANCE METRICS

The end result has been eight consecutive months with uptime beating the 90 percent target. Downtime has been in the single digits, with a low of 5.6 percent in January 2012. Moving a major PM more than 24 hours requires approval from our vice president of operations. Portola considers performing PMs as scheduled very important.

Our shipping performance has been a major benefactor of the improvement in uptime and overall production efficiency as we went from an on-time performance of 92 percent in 2011 to right at our target of 98 percent in 2012. We accomplished this while increasing the total number of shipments and boosting production by more than 20 percent per month.

Due to increased uptime, scrap generated by starting and stopping has been greatly reduced. This has allowed us to beat an aggressive 10 percent reduction from the previous year by almost .5 percent. With a target of 3.35 percent, we are seeing numbers on a shift basis below three percent in many cases. Year-to-date, they have averaged right at three percent.

CONCLUSION

We believe in educating and training our people so they become scientific thinkers. We want to promote their involvement in problem-solving discussions within a structured approach. We also have to be able to prove that our efforts and results directly impact the company's profitability.

Our lean journey has come a long way, but we aren't done improving. Getting people engaged in the workplace can have an amazing effect on change. As people start to see that they can help bring about change, that their voice is heard and that cooperation brings change that is right the first time, the effects snowball. Team members start looking for additional ways to improve or change the workplace. This engagement is key in keeping a workforce moving your company in the right direction.

***ABOUT PORTOLA PACKAGING** - Portola Packaging, Inc., is a leading manufacturer of stock and custom tamper-evident plastic closures and containers for dairy, juice and other food segments. The company is known for its superior product integrity, technical capability, global manufacturing footprint and speed-to-market. www.portpack.com*

Ron Garner, maintenance manager, joined Portola Packaging's Kingsport, Tennessee facility in 2011. He is a retired U.S. Navy Senior Chief Petty Officer and has worked in the automotive, food and beverage industries in various maintenance capacities.

Business Analytics

Paul Berberian

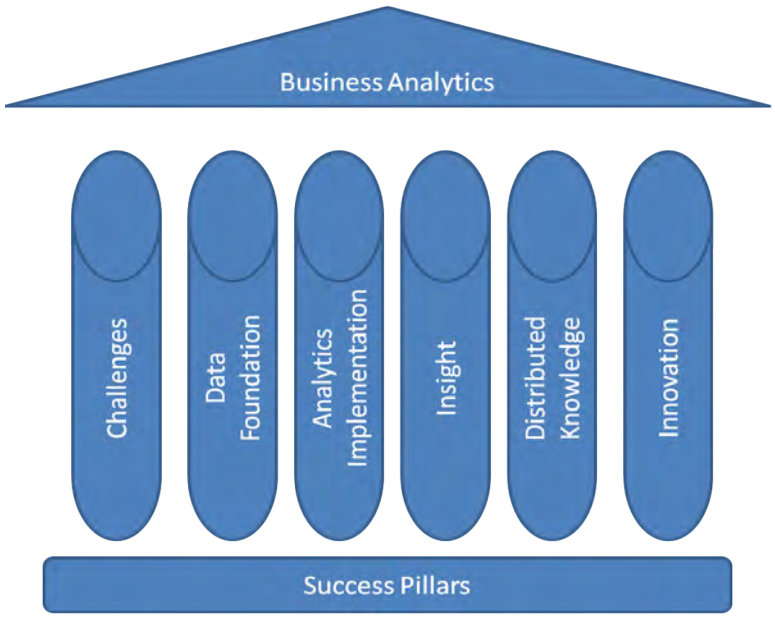


Figure 1

"...companies who do not adopt a Business Intelligence strategy in the next five years will be at a competitive disadvantage in the marketplace."

- per Gartner Inc.

Recent trends show that more and more manufacturers are looking to expand in the U.S. or move capacity back from overseas. To do this, companies will have to look for new, smarter ways to improve performance, increase machine reliability, maximize workforce effectiveness and increase uptime.

Business analytics (BA) will be a key factor in reaching these goals. Informed decisions must be made at every level – production, maintenance, purchasing, engineering and IT –enabling the management team to take decisive action and predict the future.

STRATEGIES FOR BUSINESS ANALYTICS ARE VERY SIMILAR TO MAINTENANCE STRATEGIES.

Strategies for business analytics are very similar to maintenance strategies. One approach is the "what happened" strategy. The business plan is: "Let's look at the data we have and find out what bad thing just happened and why." This is very similar to a run-to-failure strategy in maintenance. Something went wrong, now let's try to find out why. Here we are focusing on making business and maintenance decisions using historical data.

Another strategy focuses on performance to plan. This is a decision making or performance management strategy. Decisions become more real time, in the moment. This business strategy is comparative to using preventative maintenance strategies.

The final strategy is predictive insight. This is when we start to ask what will happen next and how can we influence a positive outcome. We can now use business analytics as predictive tools to anticipate future events and avoid them or take advantage of them. This is when a maintenance program can start moving toward reliability centered maintenance (RCM).

So why is it important to compare business analytic strategies to maintenance strategies? Because in the end, they are all connected. Sales and marketing are using business analytics to predict market trends and opportunities. Production has to be prepared to adapt to these changes. Purchasing has to have materials and parts in the pipeline to support the production schedule. And maintenance has to provide the uptime and capacity. All of these different groups within the organization have to work together to take advantage of opportunities in the market and create a new future.

ENTERPRISE ASSET MANAGEMENT

To accomplish these goals, many companies are using enterprise asset management (EAM) systems. An EAM solution manages the entire optimal life of physical assets to maximize value. Enterprise refers to the entire operation of a company and the management of assets across departments, locations, facilities and even business units. The goal of an EAM solution is to improve utilization and performance, reduce costs, extend asset life and improve return on assets (ROA).

An effective EAM implementation includes whole life planning, lifecycle costing and planned maintenance that leads to industry best practices. Companies can now see the impact and relationships between operations, engineering, maintenance, personnel and lifecycle costs.

Without high quality and consistent data delivered on an established schedule, the return on investment of the EAM is lessened. The furnished data must be provided automatically from SCADA systems, a PLC network, a distributed control system (DCS), on-line condition monitoring networks and/or other types of control systems that can consistently feed machine health data to an EAM or computerized maintenance management system (CMMS). Real time or near real time data is essential to the monitoring of machine health.

THE FINAL STRATEGY IS PREDICTIVE INSIGHT.

DATA FOR ANALYTICS

> *"More simply, the more you raise the quality of the data your organization interacts with, the higher the statistical probability your organization will make a better decision."*
>
> - R. Taggs, P. Sage, M. Osana, D. Tepora, J. Mark de Asis, TEAM Global, The Maximo Manager's Guide to Business Performance Management
> *www.mro-zone.com*

Step one is to set goals for the machinery health monitoring program and determine what machine condition data needs to be in the maintenance software for optimal decision making. The data required can vary depending on the type of machine. Pressure, flow, temperature, ultrasound, oil analysis and vibration data and/or a combination of all these or other inputs can provide the data required to assess machine health.

Step two is to figure out how the data will be collected and how often. Depending on the criticality of the machine to your production, you might want to collect data more often. High speed, critical machines (e.g., steam or gas turbines) with fast failure modes may need to be monitored continuously.

On-line data provides the most consistent and ubiquitous information as it can be automatically fed to the EAM or CMMS. Manually collected data is, by nature, collected less often and the task of manually moving the data to an EAM or CMMS is time consuming and expensive.

There is significant value to having good data in the reliability maintenance software. Dave Bertolini of People and Processes, Inc., writes, *"Perhaps it will surprise you to learn that 90% of Computerized Maintenance Management Systems contain little data worth trying to utilize for sound maintenance management decision making."* In other words, it's not bad software – it's incomplete or irrelevant data.

- Good data increases production uptime.
- Good data protects against environmental issues and regulatory fines.
- Good data allows the reliability maintenance team to work more efficiently.
- Good data reduces spare parts inventory while ensuring that parts that are required are on hand.

High quality and consistent asset condition data is needed to effectively transition from a reactive to a predictive maintenance culture. To date, the asset management revolution is focused on high-end assets. Online integrated condition monitoring solutions have traditionally been too expensive to deploy on hundreds of assets and could not be justified.

The costs of technical tools (e.g., smart phones, laptops, tablet computers) are coming down and those economies of scale are allowing providers to offer affordable solutions for condition monitoring. Modern networks allow the owner to outsource data analysis in real time and "expert" software programs have improved over the years.

THE COSTS OF TECHNICAL TOOLS ARE COMING DOWN.

Wireless technology and advanced networks that are being adopted as industry standards in other business models (probably within your company) are being applied as reliability maintenance solutions, eliminating the old, expensive, hardware-intensive solutions of the past. New systems are now scalable to enterprise and deliver ubiquitous data.

Today's condition-based maintenance (CBM) software allows machine faults to be readily identified and prioritized from machines that do not currently have problems. Trends can be built faster with on-line monitoring than with route-based programs. These new solutions are also scalable – from one machine to an enterprise level – on a single platform.

The combination of a well-implemented reliability maintenance software package and high quality, consistent data can help any maintenance program that is on the reliability path to achieve world-class reliability centered maintenance status.

Are you and others in your organization getting the data you need to make good decisions? Start today to find ways to add high quality, consistent machine health data to your reliability maintenance software program.

Paul Berberian is a Condition-Based Monitoring Specialist for SDT International. He has more than 12 years of experience related to condition-based maintenance in the reliability maintenance industry. www.sdthearmore.com

IDCON INC

For on-site training please call
1-800-849-2041

Training





Reliability and maintenance training for the manufacturing and process industry.

We don't sell engineering services, parts, tools, equipment or software...our independence translates into objective and credible advice and training.

IDCON's Best Practice Seminar Schedule for 2013

Results Oriented Reliability and Maintenance Management *(For Operations and Maintenance Management)*	October 22, 2013	Seattle, WA
Preventive Maintenance/Essential Care and Condition Monitoring	June 20-21, 2013	Raleigh, NC
Planning and Scheduling of Maintenance	June 17-19, 2013	Raleigh, NC
Root Cause Problem Elimination Training™	May 7-9, 2013 October 8-10, 2013	Raleigh, NC Raleigh, NC
Reliability & Maintenance Management *(Processes & Precision Skill Sets)*	April 22-26, 2013 November 4-8, 2013	Raleigh, NC Raleigh, NC

www.idcon.com 1-800-849-2041

Reliability Milestones Reached by Plant-Wide Oil Mist Systems

Don Ehlert and Heinz P. Bloch

Oil mist lubrication is basically a mixture of clean, compressed air carrying with it a relatively small amount of atomized lubricating oil.

Typically called oil mist or oil fog, plant-wide systems were first developed in Europe in the 1930s for high speed spindle bearings in the textile industry. The technology migrated to the U.S. in 1948 where it was used in the steel industry. During the mid 1960s, plant-wide oil mist systems were introduced to the hydrocarbon processing industry (HPI) in Venezuela. Chevron and Exxon began using these systems in the U.S. in the late 1960s and early 1970s.

The early systems did not work flawlessly and to this day there are still large refiners that refuse to use oil mist technology because of its initial shortcomings. It is a fact that many early systems were installed and commissioned only to be shut down and even dismantled before much time had elapsed. We know several refiners in the U.S. and Europe that have completely removed systems from service because of their perceived lack of reliability. However, the reliability issues were largely attributable to improper installations of the piping system and could not be blamed on either the oil mist generator or the technology basis.

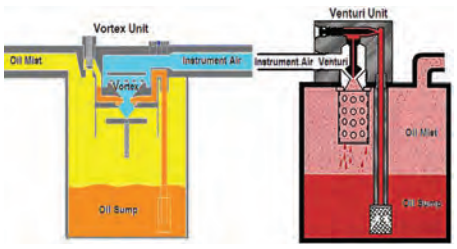


Figure 1:Vortex-type Generator (l); Venturi-type Generator (r)

Because it contains no moving parts, an oil mist generator is virtually trouble free. This component is configured to produce or generate oil mist by mixing air and oil in the proper ratio. A compressed air supply passes through a vortex, or venturi nozzle, (see Figure 1), creating a low pressure region that draws oil into a turbulent air stream. The turbulent air breaks the oil into three to five micron globules and then transports these atomized oil "particles" in a piping distribution system. The main distribution pipe is called the header. Branch lines or "drops" exit from the top of the header and ultimately lead to the equipment being lubricated.

The small globules or particles of oil can either fall out of suspension when air flow is slow, or wet out on the interior walls of the pipe when air flow exceeds the optimal flow rate. Air flow velocity in modern oil mist systems typically ranges from 20 to 24 feet per second and the oil mist lubricates equipment within a radius of 1,000 feet from the oil mist generator. The two issues affecting air flow are improper pipe sizing and incorrect installation procedures. Oil mist piping distribution systems are the most critical component in the entire system; a bad installation will prevent proper operation and reduce the reliability of the equipment being served by the system.

Installations came under scrutiny in the mid 1970s and it was then determined that changes could be made to improve the systems' reliability. With forward-thinking professionals and knowledgeable suppliers involved in the continued operation of these systems, the current installation specifications were adopted and put into place. Modern oil mist systems have a life of 20 to 30 years, with minimum maintenance and virtually zero repair issues to contend with.

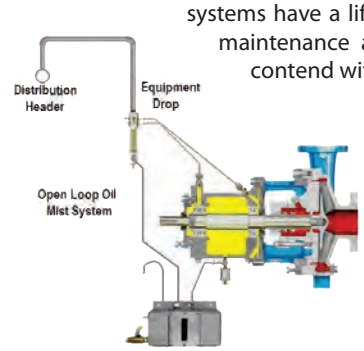


Figure 2: Open Loop System

The traditional oil mist systems are referred to as one-way or open loop systems (see Figure 2). This means oil mist is generated, sent throughout the distribution system to the equipment user and then disposed of. As of the late 1990s, hundreds of closed loop systems (see Figure 3) are being used. In these modern layouts, all excess oil is recovered and reused in the system. Closed loop systems are steadily gaining in popularity as end users want to ascertain that all environmental concerns are addressed when new facilities are constructed.

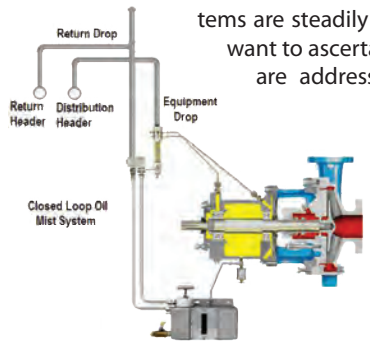


Figure 3: Closed Loop System

An additional advantage of the closed loop system is the distance the piping distribution system can be extended. Traditional one-way, open loop systems were tagged with a radius of 300 feet (~90-100 meters) from the oil mist generator. Open loop systems are easily extended up to 600 feet (~180-200 meters) with proper system design and suitable flow rates being calculated throughout the system. Now with the closed loop system, distances of 1,000 feet (~300-310 meters) or more are quite common (see Figure 4). The closed loop system allows for an orifice to be installed at the end of the distribution header to keep the flow at an optimum rate that allows excess oil mist (actually small globules of oil coalesced into liquid oil) to be pumped back continuously into the return header. All excess oil is re-

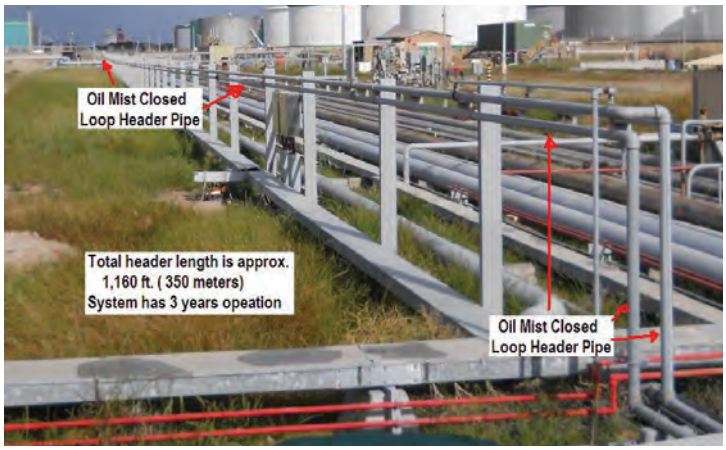


Figure 4: Tank Farm Closed Loop Header

covered in the return system and the only loss is carrier air, roughly one to three SCFM.

In addition to the horizontal runs being extended as noted above, there is also concern about runs of header in vertical structures and taking the flow up hundreds of feet. Oil mist installations on Continuous Catalyst Regeneration (CCR) towers provide superior lubrication to regeneration blowers that are at elevations of 280 feet (~85 meters) without a loss of oil mist density. Oil mist has been serving these vertical installations well for the past 10 to 12 years. There are two refineries in Romania that have oil mist on their CCR tower blowers, while all other rotating equipment located at grade is lubricated by the traditional oil sump.

As the demands for automation and greater reliability increase, the utilization of plant-wide oil mist systems is also increasing. Oil mist in the HPI has now spread throughout North America, Mexico and South America; there are also many systems in Australia, the Middle East, Singapore, Taiwan and Thailand. In the year 2000 time frame, HPI facilities in Italy, Spain and Portugal have begun adopting oil mist technology. While many of these are retrofit applications, the vast majority are grass-roots facilities that are having oil mist systems designed in and installed as the plant is being constructed. In some instances, oil mist is initially used for storage of equipment that is delivered to plant sites months and, sometimes, a full year before plant startup. As the plants are constructed, the oil mist storage system is later, and very easily, adapted for operational duty.

Figure 5: Oil Mist Generator Console

Oil mist suppliers keep up with the market and monitor the annual growth of oil mist systems. Over the last decade, an annual growth of approximately 100 large-scale systems has been experienced. We should emphasize that these are large-scale systems (see Figure 5) with console-type oil mist generators, not the many thousands of modular units that presently serve two to 10 pumps and drivers on pump slabs or in tank farms. A recent survey of the refining industry has conservatively numbered large-scale systems worldwide at 2,400 to 2,500. With each system serving an estimated 35 to 45 pumps, the total equipment count would be in the range of 100,000 pumps. This number does not include off-site areas, such as tank farms and pump slabs that could have hundreds of pumps on oil mist. Moreover, the estimate is based on worldwide refining facilities only and does not account for the thousands of electric motor drivers that are hooked up to oil mist at reliability-focused user plants. Finally, petrochemical and chemical manufacturing plants also were not included in the survey and it would be fair to point out that many more thousands of pumps in these facilities are being served by oil mist lubrication.

Many individual application needs are addressed with a LubriMate oil mist generator. This small, closed loop unit has the capacity to serve one to two pumps and drivers (see Figure 6). At last count, these units have been produced at the rate of approximately 60 units per year for the last six to seven years. These units work well on isolated or "bad-actor" pumps when a large scale system is not cost justified or is not located nearby. The LubriMate is commonly retrofitted to existing equipment, such as pumps, motors, gear boxes and FD/ID fans incorporating two pillow block type bearings and a driver.

Interviews with reliability professionals that use oil mist throughout their facilities disclosed that bearing failures due to lubrication issues are a thing of the past. One such user in Australia with 15 large-scale, closed loop systems affirmed that his facility has not had a lubrication-related bearing failure in at least 10 years. Similar statements were also obtained from a number of U.S. oil refineries that have 50 to 60 large-scale systems in operation. One particular refiner on the U.S. Gulf Coast has more than 120 large-scale systems in operation, along with many modular units on pump slabs or off-site applications. In this instance, they serve more than 3,500 pumps and motors.

Oil mist systems serve equipment in extreme temperature locations, such as the very hot, often dusty climate in the Middle East, to the cold, often damp climate in northern Canada. An oil mist user in the Canadian province of Alberta has one of the largest populations of closed loop oil mist systems in a single facility, where temperatures drop down to -40 degrees in almost every winter season.

Figure 6: LubriMate Oil Mist Generator

Oil mist lubrication is being used worldwide in many HPI and non-HPI process facilities. As new facilities are being designed and constructed, the principals are including oil mist lubrication up-front to help meet their profitability goals for long-term operation and future growth. The use of oil mist lubrication to help meet reliability goals is certain to progress as the world's process facilities continue to develop.

Heinz P. Bloch, P.E., Process Machinery Consulting, Westminster, Colorado, is a practicing consulting engineer with over 50 years of advising process plants worldwide on failure analysis, reliability improvement and maintenance cost avoidance topics. He has authored or co-authored 18 textbooks on machinery reliability improvement and over 500 papers or articles dealing with related subjects. His two most recent books, "Pump Wisdom" and "Compressors: How to Achieve High Reliability & Availability" were published in 2011 and 2012, respectively.

Don Ehlert is currently Manager for EPC Sales with Total Lubrication Management Co., Division of Colfax Corp., Houston, TX, previously Lubrication Systems Co. His current responsibilities include providing technical training and sales presentations to end users, engineering companies and the TLM sales staff. He is also responsible for quotation packages for domestic and foreign engineering companies and end user projects. He has over 35 years of experience with oil mist installations, maintenance, system design and equipment applications. www.colfaxcorp.com

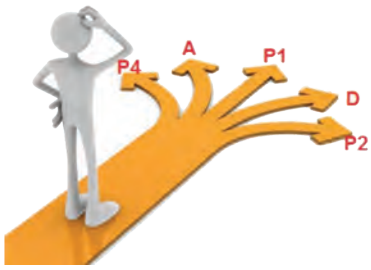
Missing Link in Work Management

Krishna Kumar

Maintenance engineers in today's environment are finding it difficult to decide and act on three main issues:

- Job priority by consensus with operations on a daily basis by knowing consequences and risk.
- Operations clearance to execute PM jobs for failure-finding tasks and standby equipment.
- Operations in process plants postponing the equipment release to annual turnaround, thus increasing the shutdown scope.

How do you reach a better understanding between operations and maintenance regarding equipment criticality, work priority and system condition so the missing links and gaps are identified, thus making the maintenance processes more effective?



Criticalilty or priority? Which is first?

In the day-to-day work order management of process plants, the operating team mainly dictates priority from the view of production loss only. Sometimes, it may not be the actual case and we need to look into other impacts, like health, safety and environment (HSE) consequences due to problems in the asset. Mostly, operations dominates and insists that the maintenance crew accepts the priority and breaks the schedules, which affects the planning and scheduling process.

Equipment changeover from running to standby is another nightmare for operating supervisors due to fear of plant trip or product off spec. Most of the times, either it gets declined or postponed, or may even be refused for changeover. Also, a shift supervisor may decline a permit to carry out a PM task on standby equipment, reasoning that the job may upset or trip the system, or suggesting to plan and execute the job during shutdown. These are all common problems and issues in many process plant operating companies.

The biggest challenge for a maintenance organization is to give the confidence to operations and get the clearance to execute PM jobs for failure-finding tasks or on standby equipment and allow them to accept the equipment changeover. An even more challenging task is preventing all the jobs from accumulating, which makes an uncontrollable shutdown scope at the end. This may lead to extended shutdown duration, which is a huge loss compared to the fear of a plant trip while executing a PM or changeover.

This can be resolved and a consensus reached if we have a better understanding of the following:

- Equipment criticality;
- Consequences of loss of function;
- Job priority for execution;
- System or plant condition to execute the job.

In defining criticality and priority, understanding is very crucial for work order management, otherwise we will work on what is urgent to a supervisor rather than what is important to preserve the function of the asset.

It is well known that an equipment criticality assessment is the starting point for a maintenance work order management system and in developing maintenance strategies that assure the sustained reliable performance of equipment over the lifecycle of the asset. It begins with the identification and ranking of risk of systems and equipment within systems.

Equipment Criticality Assessment helps in:

- Applying maintenance strategies and frequencies appropriate to equipment depending on the level of criticality.
- Defining maintenance strategy development.
- Prioritizing and scheduling preventive, predictive and corrective maintenance work during discussions with operating team.

- Defining priorities for shutdowns and turnarounds.
- Identifying training needs of critical equipment for operating and maintenance crews.
- Performing bad actor analysis and defect elimination.
- Spares identification and procurement based on criticality of the equipment.

The equipment criticality process is how we look at the equipment in our processes and determine how critical it is to the overall process functionality and risk. There are many factors to be considered when ranking a piece of equipment with a criticality assessment. Many questions need to be answered and factors analyzed before assigning a level of criticality to a piece of equipment.

Which is critical?

Identifying functionally HSE critical equipment and assigning an exclusive criticality ranking will help in complying with increased HSE regulatory requirements. Moreover, we can have a clearer control on the operation and maintenance issues of assets functioning for HSE. Balance equipment can be classified based on business function, such as business high critical, medium critical and low critical.

A typical example of criticality ranking is shown in Table 1.

Criticality	Criticality Rating Criteria
A	Functionally identified as HSE Critical Equipment
B	Functionally identified as Business High Critical Equipment
C	Functionally identified as Business Medium Critical Equipment
D	Functionally identified as Business Low Critical Equipment

Table 1

The priority is nothing more than how quickly we need the equipment back in operation when there is an outage and notification is raised (see Table 2). If we do not have a better understanding, then the priority gets distorted and people work only from their gut feeling than with a logical mind. What they see is only what they work with and what is behind or beneath is ignored. The concern with this is when a problem gets more urgent, it also gets more important and at the end will be more confusing. How can we ignore one problem that will "bite me" this week and work on another that won't affect me until next month when we have a whole month to fix the second problem? In the real world, there is often not enough time to do both. What makes a non-urgent job more important than an urgent job? The answer is the level of likely final consequences of doing it totally at a wrong time.

Many combinations of criticality and priority may come in real situations, but it is not necessary for all "A" critical equipment to always undergo P1 priority. Figure 1 explains the combination of an "A" critical equipment with all priorities.

System condition is an often ignored factor when creating a PM order, or specifically, a corrective maintenance order. Planners receive notification in the CMMS and convert it to a maintenance work order without considering the system condition in which operations is ready to release the work. This will lead to confusion at shop level. A well-defined system condition in the CMMS and regular use of this system status will help

Status	Description
P1	Emergency: The reported problem poses an immediate hazard to personnel, process, or equipment. Overtime is authorized to correct the discrepancy. Corrective action must commence immediately and continue until completion (in CMMS, default start date is reported date plus 0 hours).
P2	High: Corrective action must commence within 24 hours of the reported date and be completed within 7 days (in CMMS, default start date is reported date plus 24 hours and default end date is reported date plus 7 days).
P3	Medium: Corrective action must occur within 8 to 30 days of the reported date (in CMMS, default start date is reported date plus 8 days and default end date is reported date plus 30 days).
P4	Low: Corrective action must occur within 31 to 90 days of the reported date (in CMMS, default start date is reported date plus 31 days and default end date is reported date plus 90 days).

Table 2

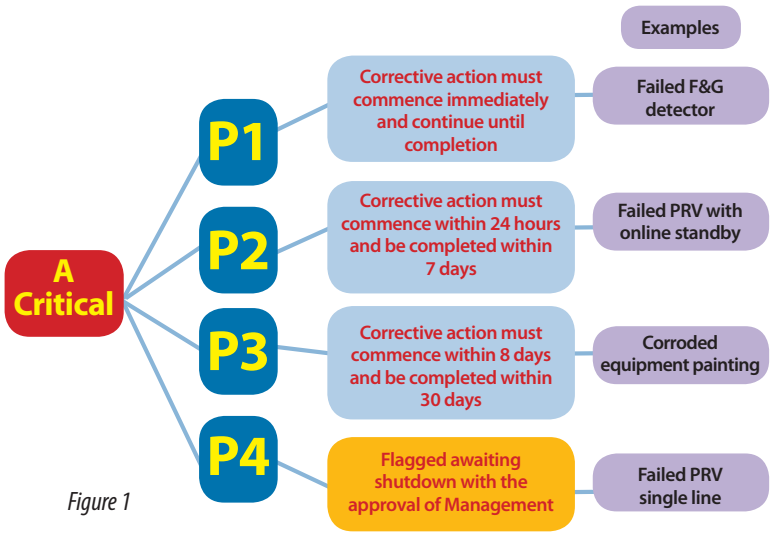


Figure 1

System Condition	Description
P	Plant Shutdown: Work on this equipment only can be conducted during the course of a plant-wide shutdown (Turnaround Event).
S	System Shutdown: Work on this equipment only can be conducted during the course of a complete system isolation. (A steam system is an example of a system shutdown).
U	Unit Shutdown: Work on this equipment only can be conducted during the course of a complete unit isolation. (A boiler unit is an example of a unit shutdown).
E	Equipment Shutdown: Work on this equipment must be conducted with the equipment isolated. (On a standby pump, for example).
O	Operation: Work on this equipment can be safely conducted while the equipment is in operation.

Table 3

THE PRIORITY IS NOTHING MORE THAN HOW QUICKLY WE NEED THE EQUIPMENT BACK IN OPERATION WHEN THERE IS AN OUTAGE AND NOTIFICATION IS RAISED.

teams understand the jobs to plan and execute for various system conditions.

Table 3 illustrates well-defined system conditions captured at each work order level, which makes the categorization easier.

A typical matrix of criticality, priority and system condition, shown in Figure 2, will help in gaining a better understanding for the work order management process.

As in Figure 2, similar logics can be arrived for B, C and D critical equipment. In many companies, the operations supervisor insists on designating the job as priority, irrespective of the criticality level. However, one factor alone should not dictate the real priority of the work order. To form a logical conclusion, the consequence, probability and risk of each work order must be assessed keeping the above factors in mind.

While this article is a typical example of a company that has criticality, priority and system conditions defined, different companies may be following different methods for assigning criticality, priority and system conditions. In this instance, the information conveyed here can be used as a guide and adopted to get better clarity and understanding of these three factors for a better work order management process.

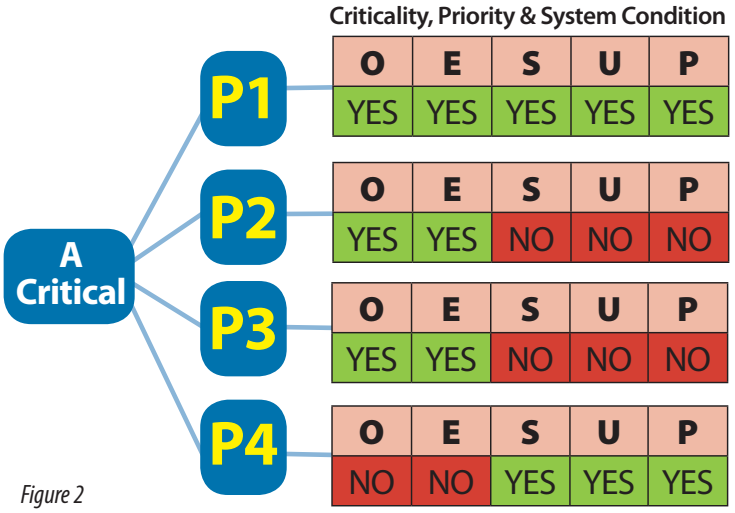


Figure 2

YES = Work order must be or to be executed at that priority level; NO = No work order should be assigned with the conditions, example A Critical P2, P, Plant shutdown. YES = Work order must be or to be executed at that priority level; NO = No work order should be assigned with the conditions, example A Critical P2, P, Plant shutdown.

Krishna Kumar, CMRP, is currently working as RCM Lead in Qatargas Operating Company. He has been with Qatargas for over 17 years. Krishna is responsible for implementing RCM for all the expansion projects as well as running plants. Qatargas LNG has the overall capacity to produce 44MTPA of LNG with 7 process trains with associated upstream and downstream facilities.

How Do You Justify the Purchase of a New CMMS System?

John Reeves

Questions

1. Are you purchasing a new system which is "best of breed?"
2. Are you after a different system because the current product is declining?
3. Are you trying to improve process, utilization, analytics and decision-making capabilities (at the same time as purchasing a new product)?

A best of breed product could cost more, but it would also provide more capabilities, e.g., screen/report tailoring or electronic workflow. And product tailoring could be a key feature because a computerized maintenance management system (CMMS) seldom provides an exact match to your needs. Either way, upper management will need more information before releasing budget dollars. Software vendors often focus on features, functions and navigation, but not process improvement. So it is up to you, the project manager, to have a comprehensive plan for utilization. Often, the best time to consider process improvement is in conjunction with implementation of a new CMMS system. But my question to you is, **"What is the real reason for the change?"**

Understandings

1. You most likely have an existing CMMS, but you want to make a change.
2. You are after newer technology, additional functionality and improved ease of use.
3. You want to use a product that accommodates a larger base (users) and more add-on choices.

Other Probable Circumstances

1. Senior management is complaining about value for money (of existing system).
2. Management is concerned that standardized value-added processes are missing across the enterprise.
3. Very few, if any, meaningful reports exist.
4. The current data (master data and transactional) is poor and impacting report analytics.

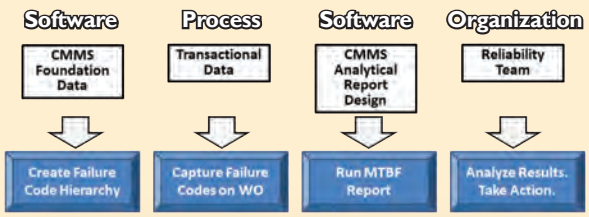
If these circumstances are correct, maybe the software isn't totally to blame. Maybe the CMMS's "rules for use" were never fully described. And maybe the administration is weak and the vision unclear.

COMPARING SOFTWARE PRODUCTS

You can always get cost comparisons between products. You can also compare costs to implement and to operate (annual support). In addition, you can get comparisons on product functionality as shown in Figure 1.

	Legacy	New CMMS
PMs, Job Plans & Safety	✔	✔
Work Orders	✔	✔
Failure/Cause Coding	✔	✔
MTBF Reports	✔	✔
Inventory & Purchasing	✔	✔
Mobile Solutions	✔	✔
GIS	✔	✔
Electronic Workflow	✔	✔

In most cases both software products will have pretty much all of the same capabilities. The point is this: Most products are going to have similar features. When you are looking at the differences between systems, **be sure to consider the complete process.** For example, when **evaluating a capability such as MTBF reports**, do you have someone to run them, analyze, and act on results? Are problem codes captured which appear on the MTBF reports? Do you have a reliability team? Do you have a basic **failure analysis process?**



The software may have capability to store a failure code hierarchy, and a MTBF report, but what about the surrounding process and organization? This is a common oversight.

Figure 1

LET'S REVIEW THE REASON FOR THE CHANGE

You could have the best product already, but still not achieving the desired results.

"Insanity is doing the same thing over and over again and expecting different results." - Albert Einstein

So why exactly do you need to make a change? It is understandable that you desire new technology. But does purchasing a new CMMS really fix poor processes and procedures? If your current processes are weak, then purchasing this software will not make the data more accurate. In fact, you could be entering bad data on the second day.

SO, WHAT IS THE REAL QUESTION?

Wouldn't it be great if you could just install the software and all your problems would be solved? Unfortunately, that is not likely. It is up to

you (and other stakeholders) to create a meaningful strategy and establish value-added processes. But have you identified industry **best practices**? Have you conducted any form of **benchmarking** to identify areas of opportunity? Have you **surveyed** the internal user groups to verify buy-in and process adherence? And are you regularly meeting with the **core team** and formally tracking change requests? Computerized maintenance management systems are as simple or complex as you want them to be. Processes with the **largest potential return on investment** are usually complex in nature.

SOMETIMES A FRESH START IS NEEDED

I agree that sometimes a fresh start is needed. You may have reached a tipping point where confidence in the system is lost. Installing a new CMMS product would force a change of routines. But the underlying problems might still exist. Examples of some of these problems are:

- ◊ Wide spread user frustration.
- ◊ Staff was never fully trained on the purpose of a CMMS.
- ◊ Mistrust -- a lot of data is entered, but not sure what management is doing with it.
- ◊ Meaningful reports do not exist.

The goal of upper management is to make more informed decisions regarding asset management. The stakeholders and project team need a strategy for improvement that accommodates not only software, but continuous improvement and optimized costs.

Maybe the CMMS project and cost justification should be as much about the surrounding process as about implementing new software. Additional activities might include:

1. Conduct workshops to review asset management/reliability management, and goals therein.
2. In these workshops, discuss problems associated with the software and process. Verify that roles and responsibilities are clear. Ask who owns the data?
3. Also ask, How can the CMMS be converted into a *true knowledge base* that enables better decisions? Outputs could be identified and the steps to get there. In some cases, the processes would need to be refined or reengineered.
4. Visualize "what could be." Ask the question, How can the organization become more efficient, improve reliability and generate more product?
5. Set stretch goals. Create a roadmap to reach these goals.

The above workshop series should be part of any CMMS implementation.

TECHNIQUES TO GET THE MOST OUT OF YOUR CMMS

More often than not, the focus is on (1) loading data, (2) altering some screens and (3) conducting training. The budget typically comes from the IT department. They have a good understanding of software, e.g., integrations, version upgrades and change requests. But what's typically miss-

Figure 2

ing is a department called "**Process Improvement**" or "Asset Reliability." Figure 2 provides an illustration of what should define a CMMS.

In the circle diagram in Figure 2, **Software** includes data, reports, integration, mobile devices and other hardware elements. **Process** includes vision/mission statement, goals/objectives, KPI hierarchy, business rules, CMMS usage guides and CMMS definitions. **Organization** refers to CMMS administration (core team, power users, business analyst, management advocate, punchlist tracking and system change documentation), CMMS navigational training (including better/best practice training) and key roles within the operations and maintenance (O&M) organization, e.g., maintenance manager, maintenance supervisor, reliability team, planner/scheduler. All three circles are needed to make a complete computerized maintenance management system.

The techniques and strategies are also common challenges for many companies as seen in Figure 2. Business rules are often forgotten or unclear. These rules (or lack thereof) can have a dramatic impact on meaningful data. Many organizations fail to periodically survey the user community, which helps identify problems, ascertain buy-in and validate process. Most importantly, advanced processes are seldom discussed in adequate detail; however, they provide the best return on investment opportunity. Thus, if the organization is serious about CMMS benefits, then it should realize that accurate data requires a comprehensive plan and a **new way of thinking** – not just new software.

WHAT IS THE COST BENEFIT FOR IMPROVING PROCESSES?

The real struggle is in understanding best practices for your industry, creating a vision for operational excellence and then building a roadmap to get there. If you were to create such a roadmap and successfully implement a system that includes software, process and organization, then the **cost benefits** as shown in Table 1 would be realized.

Enter Annual Maintenance Budget	25 million
Expected reduction in unplanned breakdowns based on systematic failure analysis and supported by analytical reports and reliability team	5-10%
Work productivity gains coupled with increased job safety; fewer delays	5-10%
Improved outage planning and backlog management	3-5%
Improved materials management; less stock outs; less overstock; fewer rush orders; able to find parts quicker due to standardized classifications	3-5%
The right maintenance strategy - but not too much PM	3-5%
Potential Savings	**4.75 million**

Table 1

As you can see, the areas of opportunity are mostly **related to the way the software is deployed & utilized from a process perspective** versus a **software installation & data load project.** So who is taking into account the "cost of lost opportunity?" With the savings gained from your annual maintenance budget, you could now spend this money elsewhere. And with this cost savings, upper management may have to decide between purchasing new technology/equipment, expanding R&D, or building more products. *But isn't that a good problem to have?*

John Reeves is a seasoned professional with over 25 years of diverse industry experience with expertise in work, asset and reliability management system design. He is an avid student of EAM system purpose, best practices therein and methods promoting continuous improvement. As a working level consultant, he provides value-added information on a daily basis, interacting with clients across multiple industries and international locations.

ULTRASOUND The Final Frontier... Or, Is It?

Jim Hall

Recently, I received an online alert for a used ultrasound instrument to purchase. When I got to the website, I found a fictional spacecraft featured in "Space: 1999," a 1970s era British television series.

Seeing it listed among ultrasonic instruments for predictive maintenance (PdM) reminded me of the opening of the "Star Trek" television series: *"Space, the final frontier. These are the voyages of the Starship Enterprise. Its five-year mission: to explore strange new worlds, to seek out new life and new civilizations, to boldly go where no man has gone before."* -- ***Captain James T. Kirk of the Starship Enterprise.***

Within the past 15 years, ultrasound instruments for predictive maintenance have seen phenomenal changes as they evolved from analog to digital instruments. Today's ultrasonic instruments are performing analysis that's far from just trending decibels over a period of time. But, has ultrasound reached its final frontier? Are we at the point where we say, what's next?

Figure 1a: Fast Fourier transfer (FFT) displayed on a touch screen ultrasound unit during an in-field motor bearing inspection. Photo courtesy of UE Systems, Inc.

Within the past 12 years in airborne ultrasound instruments for predictive maintenance, we saw the introduction of an instrument with its internal recorder storing and displaying data on a never before seen large 2 x 2.5 inch screen. It included decibels (db), frequency (kHz), data point, sensitivity and more all visible on-screen at one time. It was viewed as the latest and greatest.

Yet, in June 2010 came an ultrasound device with touch screen, onboard camera, laser pointer, internal MP3 recorder, temperature and decibel readings, and unique only to this instrument, a massive display screen that supports in-field viewing of time series (TS) and fast Fourier transfer (FFT), separately or simultaneously. The "wow" factor was there! See Figures 1a-d.

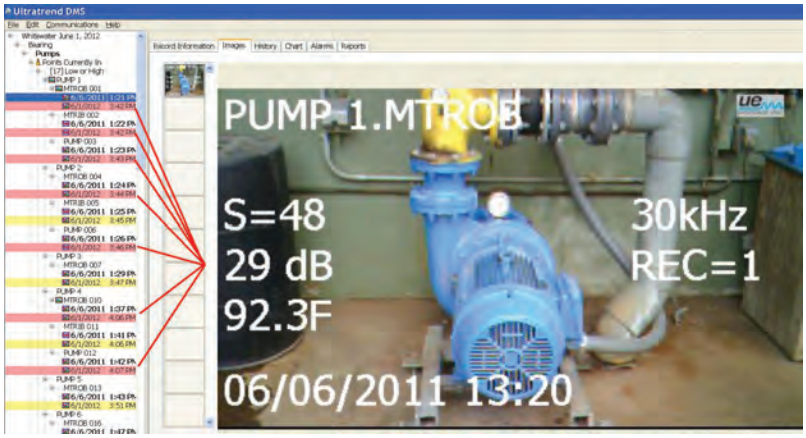


Figure 1b: A photo and database report captured by an ultrasound intrument with advanced technology features. Photo courtesy of UE Systems, Inc.

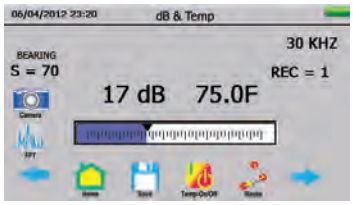


Figure 1c: Typical touch screen.
Photo courtesy of UE Systems, Inc.

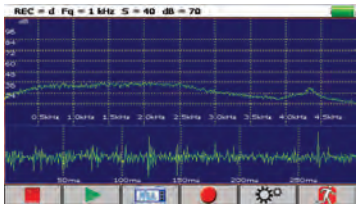


Figure 1d: Time series (TS) and fast Fourier transfer (FFT) simultaneously displayed on touch screen ultrasound device. Photo courtesy of UE Systems, Inc.

Four months later in October 2010, the latest in ultrasound for predictive maintenance instruments was introduced, featuring an onboard SQL database to capture and manage survey data in the field and synchronize with PC data, providing in-field alarms and analysis. It was described as a "building blocks" concept that set the stage for even further progressive and smart ultrasound instruments that get used every day, including the addition of an accelerometer to measure vibration severity measurements. See Figure 2.

Figure 2: An ultrasound instrument with accelerometer.
Photo courtesy of SDT North America

With more changes in the past three years then in the past 12 years, you can't help but wonder, where do we go from here?

The skill level of today's maintenance technicians vary from general maintenance techs to certified techs in the various mechanical skills to mechanical engineers with hands-on real-world maintenance experience. So it's no mistake that today's ultrasound instruments offer various models that can perform various tasks, such as temperature, rpms, record and store wav-files and capture digital pictures, and are equipped with laser pointers, Bluetooth, touch screen display panels that can simultaneously display time domain (TD) or FFT and now even take vibration severity measurements. The latter, offered as an accessory, can be considered the next major step forward for ultrasonic condition-based monitoring. Oh dear, did I write, ultrasonic? Maybe I should have written "high frequency" condition-based monitoring?

I know of a few vibration and ultrasound technicians that for the past 25 years have been performing Ultrasonic Down Conversion (UDC). That is, transferring the Ultrasonic Down Converted (UDC) high frequency signal from the headphone jack of an ultrasound receiver and playing the sound file through spectra analysis software.

It was in the early 1990s that I first experienced UDC, when a leading manufacturer of ultrasound instruments published an article detailing the process of linking a portable ultrasound to a vibration analyzer by simply taking the signal from its headphone jack (output) to the vibration analyzer.

Then in the late 1990s, we saw the introduction of a set of headphones as an accessory to vibration analyzers to listen to high frequencies above 20 kHz. Many vibration technicians

found it useful to listen to ultrasound to aid them in the diagnostics of a motor. Other ultrasound instrument manufacturers/users were most likely performing similar tasks utilizing the UDC. I personally was not familiar with the other manufacturers until the late 1990s.

I once wrote about the use of ultrasound and vibration in a previous "Ultrasonic War Stories" newsletter (UWS No. 58 titled: *"U.S. Submarine Fleet Listening to Valves Opening & Closing")*.

In the article, I wrote: *"While visiting with a vibration tech at the Performance Monitoring Team at Naval Station Pearl Harbor Sub Base in Hawaii, I was shown how he used an ultrasound device with his vibration box to assure the valves of the main ballast tanks were closed completely and not bleeding air or allowing water intrusion. He stated a valve gives off high amplitudes of noise as the valve is closing and is completely quiet as the valve is 'fully' closed. During this application the Time Domain (TD) or Fast Fourier Transfer (FFT) signal easily detects the condition".*

ULTRASOUND IS FOR THE TECHNICIAN, THE RELIABILITY ENGINEER AND THOSE INDIVIDUALS WHO JUST WANT TO LOWER PLANT UTILITY COSTS OR REDUCE DOWNTIME.

Simplicity...

*Leonardo da Vinci was quoted as saying, "Simplicity is the ultimate sophistication." The meaning is not to be mistaken as simply a simple tool is better. But perhaps as Albert Einstein put it, "Everything should be made as simple as possible, **but not simpler,**" is a better interpretation to da Vinci's quote.*

Many have looked at ultrasound as being that predictive science that does not require a college degree or two years of advanced calculus to understand it. Rather, it's an instrument that a technician could simply pick up and be very familiar with its use within minutes.

Ultrasound, as I have stated many times, is for the technician, the reliability engineer and those individuals who just want to lower plant utility costs or reduce downtime yet still interface and/or complement all other PdM technologies, such as vibration or infrared thermography. But ultrasound should never be mistaken for "just" a leak detector.

Sitting in on one of the many breakout sessions at the 2012 International Maintenance Conference sponsored by Reliabilityweb.com this past December in Florida, I was reminded of how many of you are still not familiar with ultrasound theory, complex applications, or even some of the more general applications as it pertains to predictive and preventative maintenance inspection, particularly electrical inspection.

One presenter in a breakout session mentioned that he was unsure if ultrasound would have detected the corona discharge they had discovered with the corona camera. Almost assuredly, from what I saw in his presentation, the decibels would have been loud and clearly discernible.

Uptime magazine's "Best Maintenance Reliability Program Awards" recognized several

companies for their very deserving reliability programs. The programs using ultrasound ranged from little experience to expert. Don't kid yourself. A world-class reliability program is **not** without an ultrasound program. A great reliability program starts with knowledge; knowledge that your average salesman or distributor may not be able to provide.

In the future, I would like to see all the winners of the "Best Maintenance Reliability Program Awards" return again and again with more success stories, more cost savings and more familiarization regarding the ultrasound program within their reliability program.

With advances in technology, circuitry, firmware, software and data acquisition, ultrasound may empower today's technicians to move laterally or vertically as their role as reliability technicians changes. Some technicians may simply move laterally, combining vibration or signal analysis with the use of ultrasound. Others with no previous understanding or knowledge of ultrasound, vibration, or signal analysis may have to seek out training for a better understanding of how they all pertain to high frequency condition-based monitoring in order to move vertically. But regardless of technical experience, the average person or the average technician of any skill level can certainly use an ultrasound instrument to locate compressed air leaks.

What's next? Will vibration boxes have accessories capable of performing an infrared scan or detecting an air leak? Will the next generation of instruments be able to perform those monotonous tasks of trending bearings, scanning electrical switchgear and locating compressed air leaks in some strange and effortless new way never seen before?

I contracted with a pulp mill recently to locate vacuum leaks within the evaporator system. I asked what ultrasound instrument they had on-site and they replied that they have none. A major pulp and paper facility and there is no ultrasound instrument on-site? Come on! When I heard this, I could only imagine the missed opportunities for cost savings. Compressed air, steam leaks, steam trap diagnostics, acoustic lubrication and motor bearing inspection, just to name a few. Not to mention the electrical inspections of switchgear or substations for corona, tracking, or arcing. Electrical inspection, in particular, could save the life of someone, or at the very least, prevent an unscheduled shutdown.

Define your goals, define your reliability program, define your ultrasound program within your reliability program and define what you really know about ultrasound theory and applications. Then get the training you need to meet the goals.

I am excited about the future of ultrasound and predictive maintenance. I am hopeful, in a time when manufacturing is down and we are seeing cuts in technology and research, that designers will become even more creative by defining the wants and needs of the reliability technician.

Star Trek fan on page 58 by artist Dennis Holmes. Picture courtesy of Jim Hall and Ultra-Sound Technologies.

Jim Hall is the President of Ultrasound Technologies Training Systems (USTTS). He has over 20 years experience and is a "vendor-neutral" company providing on-site ultrasonic training and consultation. USTTS provides an Associate Level, Level I and Level II Airborne Ultrasound Certification. He is also the author of a free, biweekly newsletter called "Ultrasonic War Stories". www.ultra-soundtech.com

Q&A

Uptime Magazine recently caught up with Anthony "Mac" Smith

The team at Uptime magazine congratulates Anthony "Mac" Smith on his extraordinary career and amazing accomplishments. Fifteen years ago, Mac invited me to lunch while he and his lovely wife Mary Lou were on holiday in nearby Marco Island. I was in awe and honored to meet such a pioneer and legend in reliability centered maintenance. He was kind and generous with his knowledge and his experience based on a rigorous process combined with common sense practicality. Since then, we have worked together to deliver workshops, a powerful DVD, short courses, keynote presentations and RCM case studies. If you do not own a copy of RCM - Gateway To World Class Maintenance *(ISBN: 978-0-7506-7461-4)*, ***pick up a copy right away at MRO-Zone.com or Amazon.com. — Terrence O'Hanlon***

Q You and the late John Moubry are credited with introducing the Classical RCM process to industry many years ago. Can you tell us the interesting and common link that you both shared?

A When John suddenly passed away, the M&R community lost a true giant in creative maintenance thinking. John and I had more similarities than differences because we both learned the RCM process from the inventors at United Airlines. Our differences were in the details of how we analyzed the four RCM features.

Q Did you ever expect that the RCM process would grow to such success that it enjoys today?

A When I personally experienced the benefits that RCM could create for plants and systems, I was certain it would become a major successful tool for the maintenance practitioner. Today, however, it still has a way to go to achieve the universal success it deserves. Much of this reason for this is that many facilities are ingrained in the "old culture" that frequently takes a long time to change.

Q What sets the RCM process apart from the many other reliability models in the marketplace?

A It is a unique mindset process that requires one to initially define just what a plant or system does, which is called functions, and then proceed to focus on what specifically can defeat those functions. We call these failure modes that can lead to serious safety, operation, or economic consequences. Once we have established this relationship, we can focus our resources where they can do the most good. I know of no other M&R process that can do this effectively.

Q With that said, there have always been critics of the RCM process. Can you address that?

A The main criticism seems to be "it takes too long and too much effort." Well, you get what you pay for in this world! I use the 80/20 rule as Step 1 in the RCM process, i.e., which are the 20% of the systems in a plant that cause 80% of the corrective maintenance and downtime? When we know that, it is common sense to invest in the classical RCM process for the 80/20 systems.

Q What is the secret to your long and successful career?

A Behind every successful man stands a strong, understanding and supportive woman. I certainly have that. Couple that with a professional career that is filled with interesting and technical challenges plus fascinating, experienced and friendly peers and associates, and you have an unbeatable combination.

Q What has been most rewarding to you?

A Professionally, I have always been most fortunate to be on the leading edge of technology and innovative ways to make things better. In my private life, I had an equally fascinating challenge as my wife and I raised six very different and talented children.

Q Can you tell us one of your favorite projects?

A Three come to mind quickly. One is my current role in helping to guide over the past four years the successful M&R program at the Greater

Three Mile Island

Boeing Commercial Airplanes

Cincinnati Metro Sewer District. A second is my role after the 1979 Three Mile Island Unit 2 (TMI-2) nuclear accident where I helped to install a completely revitalized PM program on the 80/20 systems at TMI-1, which had the world's highest capacity factor in 1991. A third is my RCM program with Boeing Commercial Airplanes from 1998 to 2002 where my RCM programs saved MILLIONS in reducing production downtime for the 737, 767, 747 and 777 airplanes.

Q How about one of your worst?

A It was not a matter of any one "worse" project. I had about a 65% success record. But the 35% not-so-successful were usually characterized by the client's failure to follow through with implementation. One example that stands out is the USPS where a very successful project on its new automated flats sorting machine was proven to be a huge success at its Phoenix demo site, but the USPS never followed through implementing this on the other 534 machines throughout the country! What a loss (do the arithmetic)!!

Greater Cincinnati Metro Sewer District

Q Where do you see the RCM industry heading in the future?

A Unfortunately, the U.S. industry is still mainly in the reactive maintenance mode. RCM can change that situation with a shift to proactive maintenance. The opportunity is there for those who choose to seize it.

Q You have had a long association with JMS Software, can you tell us how that started and where do you see the future of this relationship?

A From 1980 to the mid-1990s, all of my RCM analyses were recorded by hand. It was obvious this had to be computerized. Through my RCM projects at NASA-Ames, I met three very talented people who agreed to develop to my specifications a computerized RCM analysis program (called RCM WorkSaver). This effort led to the 1998 creation of JMS Software, which today continues to actively market this software and has sold to over 78 sites in eight different countries. In the future, JMS will continue to supply and service this software as there continues to be a demand for it.

Q And lastly Mac, congratulations on your successful career. What do you have planned for your retirement?

A My professional career has been an extraordinary trip. At age 82, I shifted to a 90/10 lifestyle – 90% retired, 10% still active with selected clients. I am NOT a golfer, but my time is spent with my wife, Mary Lou, seeing our six children and six grandchildren, keeping in shape at the gym, doing activities with our community plus some non-business travel and writing my memoirs. Life is busier than ever.

Maintenance Storerooms and MRO Made Simple

Written by Daniel M. DeWald • Reviewed by Nancy Ball

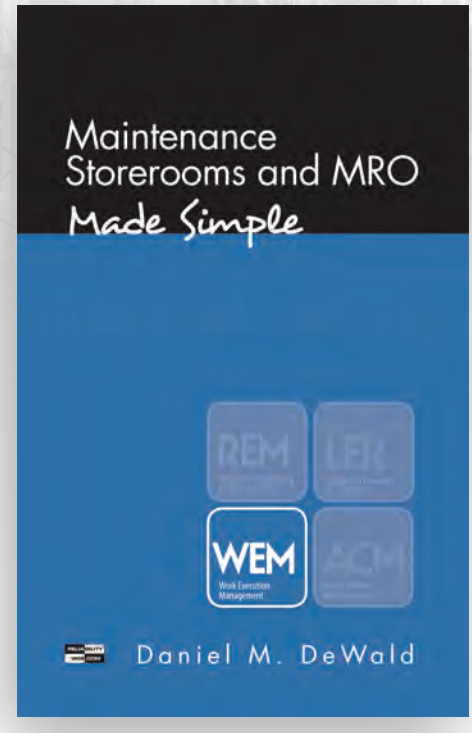
"Maintenance Storerooms and MRO Made Simple" by Daniel M. DeWald is the definitive guide for inventory control, maintenance, repair and supply management via best practice procedures.

It illustrates the links of management commitment, departments and facilities. Varied in method with ample flow charts explained in detail and differing processes to reduce downtime of equipment and manage inventory and supplies, this book is a real winner.

By reviewing the recommended procedures and implementing the action plans provided, any company that maintains equipment and purchases supplies or parts will benefit from this book. Managers of equipment or supplies and warehouses, production line personnel, sales and customer service groups, purchasing teams and buyers, comptrollers and logistic teams will discover clearly illustrated and specific steps, goals and flow charts.

It is a straightforward approach that helps in understanding the complexities of all five areas of running a maintenance parts, repair parts and operating supplies storeroom (MRO) by addressing management of purchasing, work process flows, inventory, storeroom and supplies. The idea is to put reliability first in the management of a parts system to reduce downtime, store quality parts, store only what is needed and to remove parts no longer usable or required. The storeroom goal is to control costs and be an asset.

Mr. DeWald's recommendations cover precise descriptions of the critical success factors in a storeroom that support maintenance and operations. It makes sense out of proper cash flow needed for inventories and parts. This guide covers the integration of a computer system for parts management.



Maintenance Storerooms and MRO Made Simple (ISBN 978-0-9853619-4-5) ***can be purchased at: www.mro-zone.com***

Additionally, Mr. DeWald covers proper procedures to facilitate and plan for kitting and determining points of failure. Detailed methods to set up and manage a storeroom are delineated by key performance indicators (KPIs). Action steps for scheduling, training and refreshing staff on parts management functions, as well as visible methods of layout and design, are clearly explained.

Work process flows are identified and generic flow charts provided are guidelines for establishing the optimal workflow techniques. Employing new workflow targets will probably reduce cycle time and cost.

Mr. DeWald also explains different methods to quantitate inventory. Carrying costs are clarified through precise percentage ranges. Steps for a conversion from an expense to an asset inventory are conveyed through ABC value management.

The book demystifies and offers systems for difficult decisions, including reducing storeroom inventory, applying minimum and maximum requirements for different types of parts and supplies (toilet paper anyone?), assigning a value and required inventory for components, deciding what is obsolete and salvaging methods.

Techniques are illustrated for managing suppliers through a rating system to uncover the best sources of quality parts, service and timely carrier delivery. Maintenance, repair and operations departments may follow the author's specific recommendations to base purchases on reliability information, such as procedures to prolong a part's life through maintenance tactics in the storeroom and methods to determine the point of failure for equipment.

This book demonstrates that proper management of a storeroom is cost effective, provides improved parts management and delivers optimum results as evidenced by meeting customer deadlines with quality products – a win-win for any company.

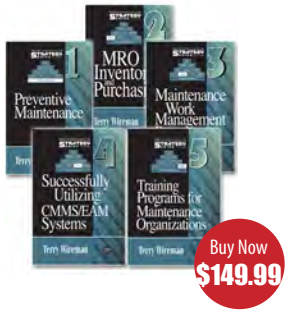
Nancy Ball has an A.B. and M.S. from Indiana University. She is an Office Manager for Pathfinders Advertising & Marketing Group, Inc. in Mishawaka, Indiana. She resides in Cassopolis, Michigan.

Daniel DeWald, CPIM, has a MBA in Management from Xavier University in Cincinnati and a BS in Marketing from Indiana University in Bloomington. He has over 30 years experience in warehousing and distribution, production control, materials management, logistics, supply chain management and purchasing.

Maintenance Reliability Professional Library Collection

by Terry Wireman, John Moubray, Darrin K. Wikoff, Ron Moore, and Winston P. Ledet

Planning to earn a Maintenance Reliability Professional Certification? We recommend these 5 books which cover all five topic areas of the CMRP certification.



The Maintenance Strategy Series

by Terry Wireman

World renowned author and maintenance expert Terry Wireman has completed a 5 book collection including a valuable maintenance maturity model.

Made Simple Series

by Ricky Smith, David A. Martin, Jerry Wilson, Stephen J. Thomas, and Dave Bertolini

Interested in learning about reliability engineering, asset condition management, work execution management, or leadership for reliability? These books make it simple.

Turn Your Potential into Reality

Book/DVD Sets Bring Value to Your Education

Special Improvement Series

by Jack R. Nicholas

Save hundreds when you buy Predictive Maintenance Management, Root Cause Failure Analysis, Advancing Reliability & Maintenance, and Reliability Centered Maintenance as a four book set.

What Tool? When? and Making Common Sense Common Practice - Two Book Set

by Ron Moore

Case studies and models illustrate how to increase uptime, lower costs, increase market share, and maximize asset utilization.

Reliability Leadership DVD Series

featuring Ron Moore, Jack Nicholas, Ricky Smith, and Terry Wireman

Learn from industry experts! The extensive knowledge of maintenance and reliability leadership experts is at your fingertips with this brilliant 4 DVD workshop set.

Vibration Bundle Set

by Glenn White, Charles Jackson, and Arthur Crawford

From basic explanations to comprehensive case studies, this book bundle is a crash course in performing proper vibration analysis. Read this set to learn how your operation will benefit from vibration analysis.

MRO Zone BOOKSTORE

Call: **239-333-2500 or 888-575-1245** | Visit Online: **www.mro-zone.com** | Email: **mrostore@mro-zone.com**

Count on Des-Case to help prevent them.

In any industry, contamination control is crucial to keeping equipment operating at its absolute best. Downtime is simply not an option. That's why companies around the world count on Des-Case for breathers, fluid handling and filtration systems, consulting and training to keep their equipment running strong.

For more information call 615.672.8800 or visit us at descase.com

DES-CASE™

Keeping Contamination Under Control.®