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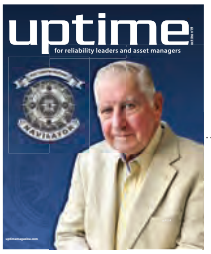

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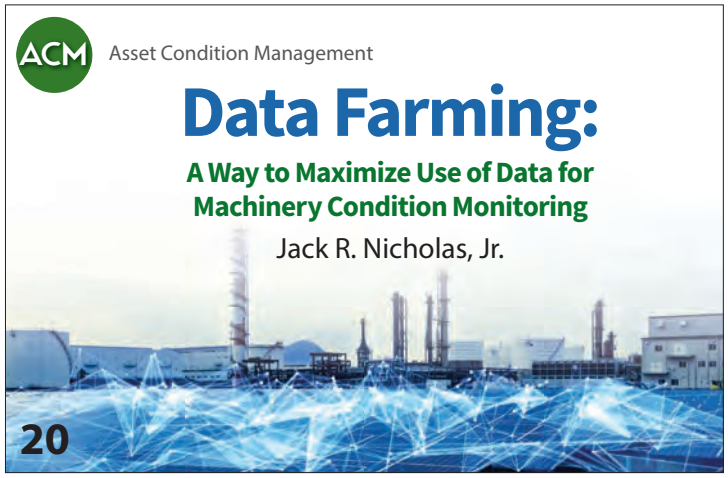
ON THE COVER
Can you find the hidden Uptime logo on the cover? uptime



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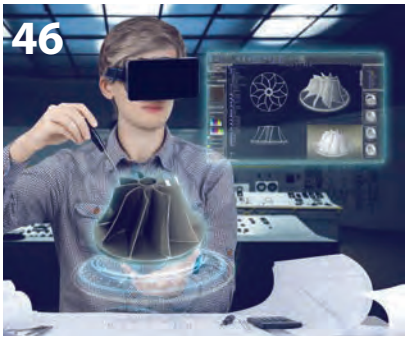

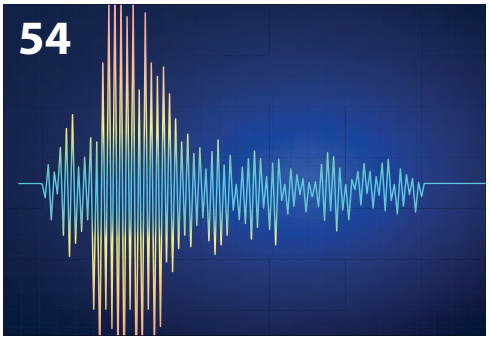

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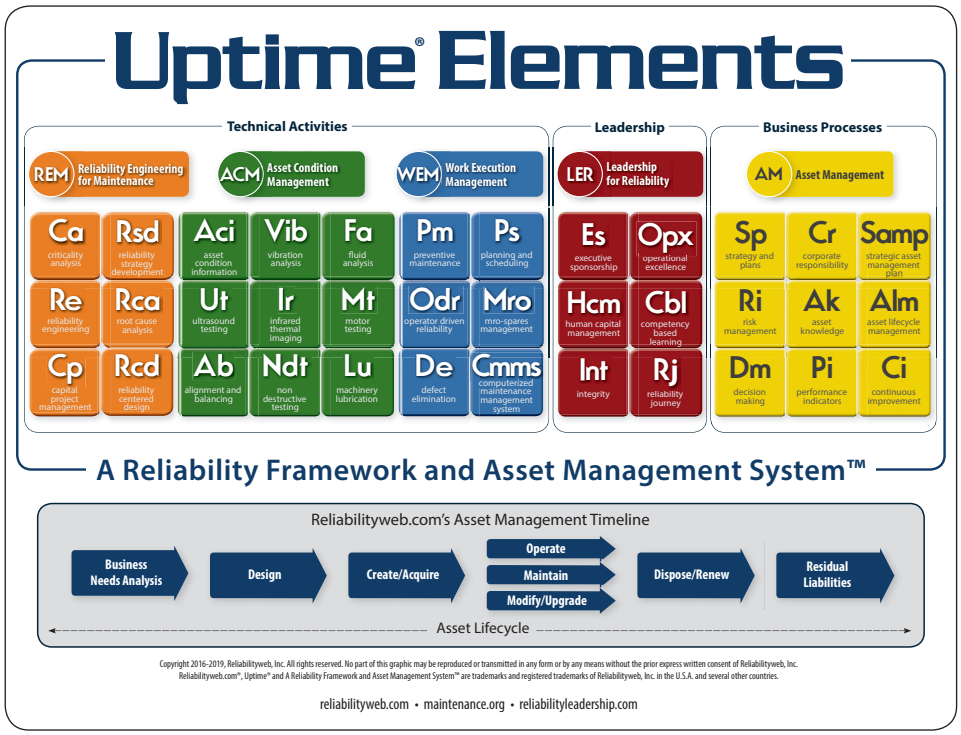
RELIABILITY PARTNERS

A powerful ecosystem of Reliability Partners who support the Uptime Elements Framework



Uptime® Elements - A Reliability Framework and Asset Management System™ is in use at over 2,800 organizations around the world to engage and empower reliability culture.

uptime®

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TURN YOUR DAY AROUND

Reliability is a team sport, and no one makes the journey alone

A friend of mine that managed sales at a large asset management software company once told me that when she was having a bad day, she picked up the phone and talked to one of her colleagues. She said it always turned her day around to realize that she was not on the journey alone, and she left those calls feeling reenergized and supported.

Reliability is a team sport, and no one makes the journey alone. But it can be quite a challenge getting others to join you when they are used to working a certain way for many years.

Change, no matter how wonderful you paint the future, is difficult for all of us.

The next time you are having a bad day, try speaking with someone from work who might become one of your reliability journey travelling companions.

I highly recommend recruiting reliability friends from the broadest cross-functional areas that you can.

Operations is an obvious place to begin, but I hope you do not stop there. How about paying a visit to Human Resources/Human Capital Management to discuss adding reliability to annual performance reviews, realistic staffing based on reliability engineering identified tasks, and competency-based learning development?

Have you ever met the people in Accounting who manage the "other" asset register? What do you have in common?

Would you be able to find a reliability friend in Engineering who could collaborate on better maintainability and reliability reviews?

Purchasing has a huge influence on reliability, so why not create allies within one of the most important influencers there is?

The more diverse your travelling companions are, the more opportunities your team will have to advance reliability and asset management.

Then when you are having a bad day, you will have someone you can call who is on the same journey, who will reenergize you, support you and can provide navigation toward the aim!

The team at Reliabilityweb.com has created another extraordinary issue of *Uptime* magazine for you. I hope you enjoy each and every page, then share it with your new reliability travelling companions.

I am grateful that you choose to read our work.

Terrence O'Hanlon, CMRP
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CEO and Publisher
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LER

RELIABILITY

IN THE NEWS

maximoworld
A RELIABILITYWEB EVENT

HIGHLIGHTS FROM MAXIMOWORLD 2019

The Electric Power Reliability Summit: SDMyers
Keynote by Terrence O'Hanlon, Reliabilityweb.com
Houston, Texas - September 19, 2019

Going Digital Round Table: Bentley Systems and Reliabilityweb.com
Advancing Reliability and Asset Management Through Digitalization
Houston, Texas - August 13, 2019

Reliability Leadership Institute Face-to-Face Meeting: DC Water
Washington, DC - September 4-5, 2019

Asset Reliability 4.0 Executive Forum on Digital Twins
Chicago, Illinois - September 18, 2019

HECO - RPM Symposium 2019: CRL Workshop
Portage, Michigan - September 17-19, 2019

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Jack

ASSET CONDITION MONITORING NAVIGATOR

Sitting in the back of a crowded room at a conference of 300+ motor testing professionals in the mid-90s, I listened to an impressive presentation from a former submariner who served on the *USS Nautilus*, the first nuclear-powered submarine in the U.S. Navy fleet. That man was Jack Nicholas, Jr.

Out of nowhere, I heard him discuss a unique approach to developing a reliability strategy using a blended approach to reliability-centered maintenance (RCM). That may not seem significant in 2019, however, to put it in context, the mid-90s was the time of what I like to call "the RCM wars," where people were usually very devoted to one specific approach to RCM and there was only *one* approach to RCM. As a frustrated student of reliability-centered maintenance, I could not find one approach that fit every situation. Through that presentation, Jack provided the navigational beacon I needed to point me in the direction that opened a world of possibilities for me. What is common practice now was uncommon then. Jack, like other navigators, lit a path that might still be dark without the beacon he shone.

Jack Nicholas, Jr., is not only a navigator, he is a friend, leader, guru, teacher, mentor, creator and practitioner of so many aspects of modern reliability approaches that it is difficult to fully describe his life's work to date. He was applying early principles of reliability-centered maintenance in the U.S. Navy submarine fleet before the discipline had a name.

He embraced the earliest forms of asset condition monitoring and brought an entire category, motor circuit analysis, into being, which led to the creation and start-up of PdMA, a global leader in motor condition monitoring.

Jack has been a frequent contributor to Reliabilityweb.com® and *Uptime*® magazine from our first day of operation. He did a lot of the heavy lifting, creating lasting programs, such as the Uptime Awards, the *Reliability-Centered Maintenance Project Manager's Guide* (originally the RCM Scorecard) and so much more, including SMRP's Certified Maintenance & Reliability Professional (CMRP) exam.

He was front and center as a navigator and contributor to the Uptime Award winning Metropolitan Sewer District of Greater Cincinnati, setting what I consider to be a new benchmark for modern reliability programs, along with Anthony "Mac" Smith, Tim Allen, Sam Paske, John Fortin, Biju George, Richard "Doc" Palmer and John Shinn. I often wonder if there will ever be another reliability "A-Team" like that anywhere.

Jack's books and related workshops have literally advanced the thinking of a generation of condition monitoring professionals, reliability leaders and asset managers 10 to 20 years beyond where it would be without him.

He seems busier in retirement than he was in his working life, with his nonstop research and projects, including keynote speaking, workshops and video productions.

If you wonder where he gets his inspiration, you do not have to look far to see his constant companion and wife, Dorothy. Together since childhood, Dorothy is the embodiment of "behind every great man, there is a GREAT woman."

So, as digital twins, the Internet of Things, predictive analytics, cloud computing, wireless technology and better, faster, cheaper low power sensors meet traditional condition monitoring and nondestructive testing, we can all use a navigator to get our minds right so we can leverage this *perfect storm* of new technology to achieve our organizational objectives.

If I were looking for Jack, all I need to do is locate this perfect storm and he would be in the center of the eye working on his next project!

I am grateful he is a navigator in my life.

Terrence O'Hanlon
CEO and Publisher
Reliabilityweb.com®
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maximoworld Awards

2019

MaximoWorld Awards recognize extraordinary achievements and team accomplishments in the MaximoWorld community. MaximoWorld 2019, A Reliabilityweb Event, hosted the first annual awards ceremony, August 6, in Orlando, Florida. Congratulations to the following winning programs!

maximoworld Awards

Best AI/Machine Learning/IIoT Implementation

Leprino Foods and Aquitas Solutions

Leprino Foods is the number one mozzarella cheese producer in the world, in addition to a leading producer of whey protein, a byproduct from the production process. Headquartered in Denver, CO, Leprino Foods operates nine full-scale manufacturing facilities thoughout the United States.

Aquitas Solutions is a leading provider of EAM and IoT solutions to asset-intensive industries. Aquitas worked with Leprino Foods to implement their Connected Maintenance solution.

After working with Aquitas to complete a company-wide implementation of IBM® Maximo® across all nine sites, Leprino then engaged Aquitas to complete an IoT pilot using the Aquitas Connected Maintenance solution. The Connected Maintenance solution leverages the leading Industrial IoT technology of ThingWorx that is integrated in Maximo for real-time condition monitoring and maintenance response to prevent failures before they happen. With the implementation of Connected Maintenance, Leprino is able to eliminate those non-value-added annual PM inspections and only perform maintenance when the assets tell them action is required. Ultimately, the implementation of Connected Maintenance for Maximo at Leprino Foods has already resulted in cost savings, labor optimization, failure prevention, the elimination of human error and improved asset reliability. Leprino is easily able to track things like unplanned downtime, OEE, MTTR and MTBF, as well as look for ways to improve processes and get more done with less maintenance.

Best Data Alignment with Business Processes

Agropur and Aquitas Solutions

Agropur Cooperative is a North American dairy industry leader founded in 1938. With sales nearing $6.4 billion, the Cooperative is a source of pride for its 3,290 members and over 8,000 employees. Agropur processes more than 6.1 billion liters of milk or 1.6 billion gallons per year at 39 locations, boasting an impressive roster of brands and products.

Aquitas Solutions is the leading provider of EAM and Internet of Things (IoT) solutions for asset-intensive industries. Aquitas has been a key provider for Agropur through their innovative approach to connecting IoT information, via ThingWorx, into IBM® Maximo®.

Agropur has been using IBM Maximo as their primary EAM solution for their U.S. operations for over 15 years. As part of the evolution of automating plant operations, Agropur looked at ways to evolve their maintenance operations. One aspect has been utilizing IoT information already being generated and used to monitor their state-of-the-art facilities. ThingWorx was the middleware of choice for Agropur as it bridged the gap between IoT operational data and Maximo asset performance management. Agropur then implemented Aquitas Solutions' Connected Maintenance solution powered by the leading Industrial IoT technology of PTC's ThingWorx integrated into Maximo. Rather than tie in directly into their SCADA system, Agropur was able to tie directly into the PLCs, meters and sensors.

Best Mobility Program

Vanderlande and Interloc Solutions

Vanderlande is the global market leader for value-added logistic process automation at airports and in the parcel market. The company is also a leading supplier of process automation solutions for warehouses. Vanderlande's baggage handling systems move 4.2 billion pieces of luggage around the world per year, 11.5 million per day. Its systems are active in 600 airports, including 14 of the world's top 20. More than 45 million parcels are sorted by its systems every day, which have been installed for the world's leading parcel companies.

Interloc is an IBM® OEM and IBM Premier and Accredited Business Partner that provides innovative consulting services and mobile solutions. Interloc harnesses Maximo® so that the greatest potential is reached from a Maximo investment.

Vanderlande sought a mobile solution for Maximo to support their services organization, which maintains their installed systems across the globe. Vanderlande had an established work management process built within Maximo that they were looking to mobilize as part of a migration to a consolidated managed and hosted CMMS solution supporting two distinct use cases: site-based engineers and field service technicians. Interloc was brought in to implement their Mobile Informer product to support Vanderlande's new mobility initiative. Leveraging Mobile Informer's sophisticated data segmentation, Vanderlande enabled a single, mobile application that was based on Interloc's standard Work Management solution. The application provided the necessary data to the site-based engineers and field service technicians. Since its deployment in January of 2019, Vanderlande users have expressed a high degree of satisfaction with the application, and the rollout continues with a target user base of over 2,000 technicians worldwide.

Best Use of Maximo & Augmented Reality/ Virtual Reality

Troia d.o.o.

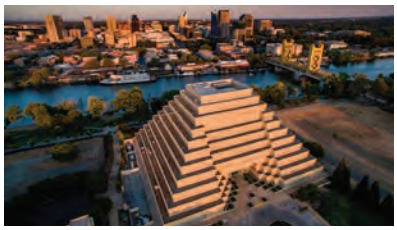
Troia is an innovative Slovenian IT company engaged in the development, implementation and maintenance of advanced IT systems for assets and services. The company has over 20 years of experience in the area of IBM® Maximo® Asset Management EAM system and IBM Control Desk implementations. Troia is an IBM Gold Business Partner — specialists for assets and operations.

Quickly growing and expanding to markets abroad, Troia's development in augmented reality solutions will be the next step for many companies who are looking to improve the current work environment and take the next step toward the future. Troia connects simplicity and complexity by integrating and optimizing solutions that best deal with today's challenges. The end result is a prosperous trio of IT, people and business. Troia is optimizing the future.

Troia won the award for its T-Sense Enterprise Augmented Reality Platform. As Abraham Lincoln said, "The best way to predict your future is to create it." This quote is meaningful to Troia in connection to the MaximoWorld award because they believe in creating their future and this award is the best confirmation that they are going in the right direction.

maximoworld Awards

Best Overall Asset Performance Program



California Department of General Services and JFC & Associates

JFC & Associates, an IBM® Business Partner since 2006, is a world leader in integrating enterprise asset management, IoT and artificial intelligence. JFC & Associates help world-class organizations add and manage new technologies to accelerate their businesses and increase ROI, finding a smarter way of doing things and solving problems in unconventional ways.

California Department of General Services - Facilities Management Division went through the process of completely revitalizing their asset management efforts. This included the reimplementation of IBM Maximo®, implementation of DataSplice for mobile computing for 400 field staff, and the rollout of iMaxeam MAXVS™ Visual Scheduler for their planning and scheduling efforts. Work included integration with the on-premise timekeeping system, custom workflow, work centers for tenant requests, as well as a variety of custom reports and dashboards for the various management levels of the organization. The entire project was delivered on IBM Cloud™ infrastructure.

Best New Implementation

WBI Energy and Cohesive Solutions

WBI Energy has 335 employees and is part of the MDU Resources Group family of companies, with more than eight decades of energy-field experience in the Rocky Mountain Region. As part of a large energy-focused corporation, WBI Energy is connected to a wide array of resources that help provide customized solutions for their customers, both large and small. They support 1.1 million customers and one billion tons of aggregate reserves. A key highlight in the company's recent history is that their pipeline business in 2018 transported a record volume of natural gas for the second year in a row.

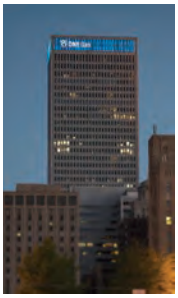
Cohesive Solutions, Inc., is a specialist in enterprise asset management and performance management. As a certified IBM® Maximo® Business Partner, Cohesive provides systems integration and transformation services that enable organizations to achieve breakthrough results in their asset management programs.

What is a best new implementation of Maximo? The one that makes a significant transformational step change in the way an organization behaves.

This new implementation at WBI Energy includes a comprehensive scope of processes and technology. This transformational plan addressed many items, such as regulatory compliance-based work management, utilizing IBM Maximo Oil & Gas with Anywhere as the primary user interface and a GIS integration using IBM Maximo Spatial. This was a multi-part data implementation from paper records of 30,000+ locations and their respective assets, including an in-depth reconciliation of the U.S. DOT PHMSA inspection and environmental requirements. This resulted in the creation of 5,800 preventive maintenance plans, associated routes and 500+ job plans. This journey's components also included change management for the field workforce, committing to a cloud-based environment and recognizing the value of training.

maximoworld Awards

Best Implementation or Upgrade Project



ONE Gas and Ontracks

ONE Gas provides natural gas distribution services to more than 2 million customers in Oklahoma, Kansas and Texas. ONE Gas is headquartered in Tulsa, OK., and its divisions include Oklahoma Natural Gas, the largest natural gas distributor in Oklahoma; Kansas Gas Service, the largest in Kansas, and Texas Gas Service, the third largest in Texas, in terms of customers.

Ontracks is an IBM® Platinum Business Partner, the #1 reseller of Maximo and a leading implementer of Maximo® in the U.S.A. and Canada. Ontracks focuses on delivering enterprise implementations and helping clients realize tangible and sustainable operational improvements using the IBM Maximo Suite.

The implementation of Maximo at ONE Gas has over 1,500 users with a concurrent usage of up to 350 individuals connected to Maximo at a single time. With the integrated nature of Maximo at ONE Gas, complete regression testing was necessary to ensure the integrations remained intact and accurate. The compatible unit library was expanded to include additional and more complete entries. Over 16,000 compatible unit records were created or modified as part of the project. The project also served to implement automated testing in addition to the existing manual tests created in-house at ONE Gas. As part of the project, 205 automated tests were created and many of these tests will be leveraged for regression testing in the future.

Special Recognition Awards

TRINMAX™

Best New Automation - TriNmax

"It is always quite wonderful when we get recognition from customers or partners, however, having impressed the MaximoWorld 2019 judges, who are industry experts and benchmark setters, is simply outstanding for us!"
~ Jean-François Désilets, President

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Best Project Partnership - Projetech and EDI

"This award not only showcases the strong relationship between Projetech and EDI, but it also proves our ability to seamlessly collaborate on such a massive technical project." ~ Mark Eaton, VP of Technology, Projetech

"Reliable assets couldn't be more important than in aviation. Projetech brings reliability to the infrastructure to help EDI look great delivering reliability through MfA for tracking labor, resources, hanger space, and turnaround times."
~ Jay Chauncey, VP of Technology, EDI

TRM total resource management

Best Consolidation to Single Platform - Total Resource Management

"We are extremely honored to have our project recognized by MaximoWorld with this award. Our team of talented and dedicated consultants completed the consolidation and then implementation in under four months, greatly surpassing the client's expectations. This is a very proud day for me and our company as a whole." ~ Don Omura, President

maximoworld Awards 2020

Do you have an extraordinary example of work to share with the MaximoWorld community?

If so, nominate your program for the 2020 MaximoWorld Awards to recognize your team. Nominations are open in the following categories:

PRACTITIONERS ONLY

- Best Overall Asset Performance Program
- Best Start Centers or Dashboards
- Best Data Alignment with Business Processes
- Best Association to the Uptime Elements Framework

PRACTITIONERS AND/OR VENDORS

- Best Mobility Program
- Best New Implementation (within the last two years)
- Best Upgrade Project (within the last year)
- Best Use with a SCADA Data Program (fault codes, report sharing, etc.)
- Best AI/Machine Learning/IIoT Implementation

VENDORS ONLY

- Best Use of Augmented Reality/Virtual Reality

BENEFITS OF BEING A MAXIMOWORLD AWARDS WINNER:

- Generate internal and external recognition and program validation
- Create the opportunity for internal and external assessment and comparison
- Validate your program with proven results
- Foster teamwork and acknowledge all stakeholder contributions
- Contribute to an emerging body of knowledge for effective asset management and EAM best practices
- Develop an opportunity for international press coverage for your organization
- Share program details and best practices with the MaximoWorld community to create external knowledge sharing and benchmarking relationships

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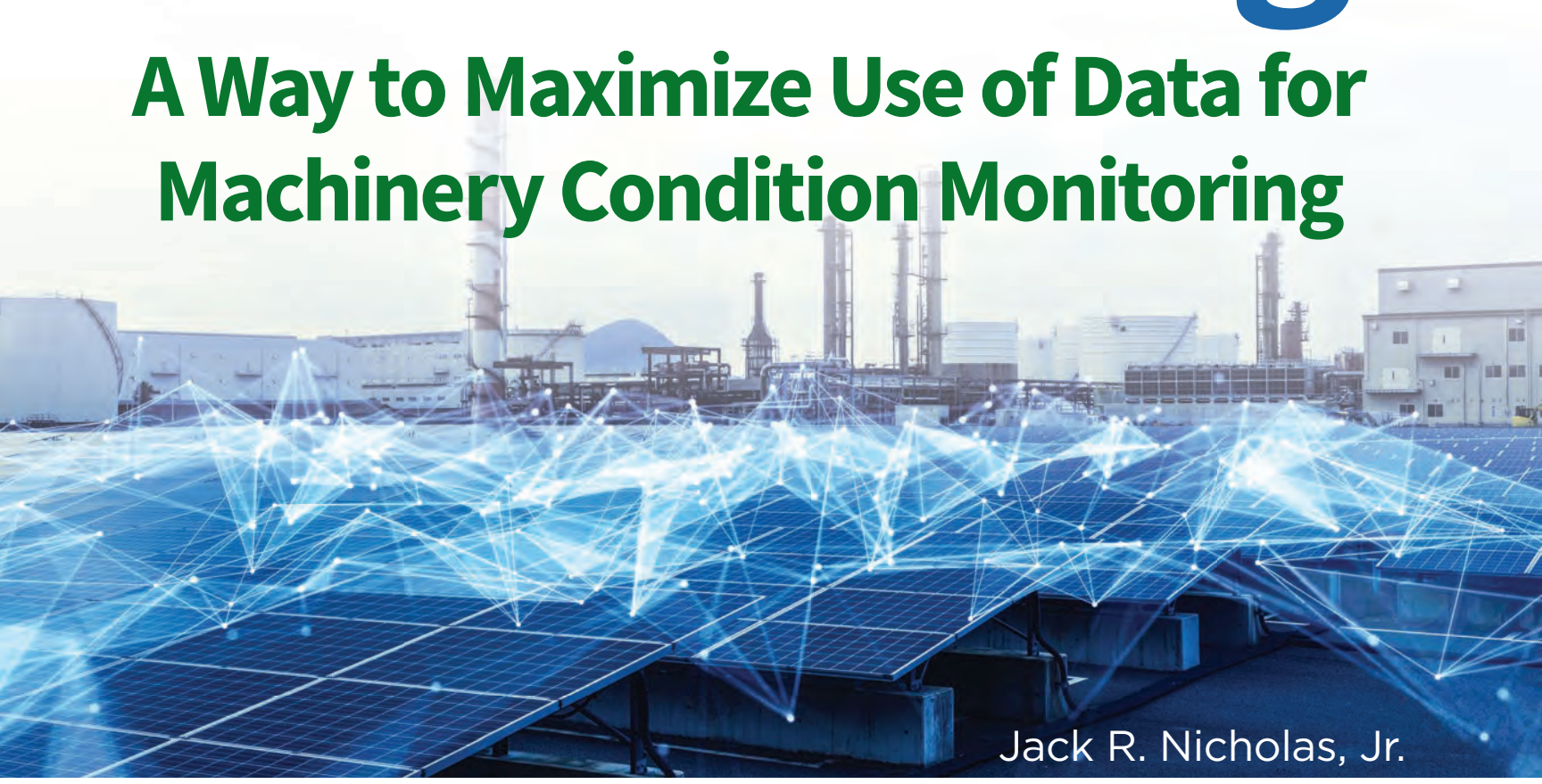
Data Farming:

A Way to Maximize Use of Data for Machinery Condition Monitoring



Jack R. Nicholas, Jr.

A survey conducted by Cisco Systems Inc., results of which were presented at the May 2017 Internet of Things (IoT) World Forum in London, revealed that:

- 60 percent of IoT initiatives stalled at the proof of concept stage;
- (Only) 26 percent of the surveyed companies considered their IoT deployments and initiatives as being successful;
- Overall nearly three-fourths of IoT initiatives were considered a failure, while a third of all projects being completed were **not** seen as a success.[i]

Planning, managing and expanding the transition to Industry 4.0 and selling it to the executive level of an organization are skill sets that most reliability and maintenance (R&M) practitioners don't possess. However, R&M personnel do have skills and proven methodologies, such as reliability-centered maintenance (RCM), that are ideally suited to supporting a controlled transition to use the Industrial Internet of Things (IIoT), advanced analytics, cloud computing, artificial intelligence (AI) and related subjects to yield early maximum return on investment and greater machinery reliability. This linking of old and new tools is called data farming.

> This linking of old and new tools is called data farming

This article shows how to maximize the use of data for condition monitoring. It also describes how data farming can help overcome another major problem with today's digital transformation – the fact that only a small portion of the data being accumulated is being analyzed in any meaningful way.[ii] The cost of these problems can be quite large, with no appreciable benefit to an organization's bottom line.

Past, Present and Future

Today's and tomorrow's capabilities involve wireless technology, in-house analytics, big data management, the IIot and/or IoT, cloud computing and advanced analytics. In contrast to the seemingly huge amounts of condition and performance data that had to be developed and managed manually with much less capable computers and peripherals over 30 years ago, consider the advantages made possible by today's networks and devices. With IIoT

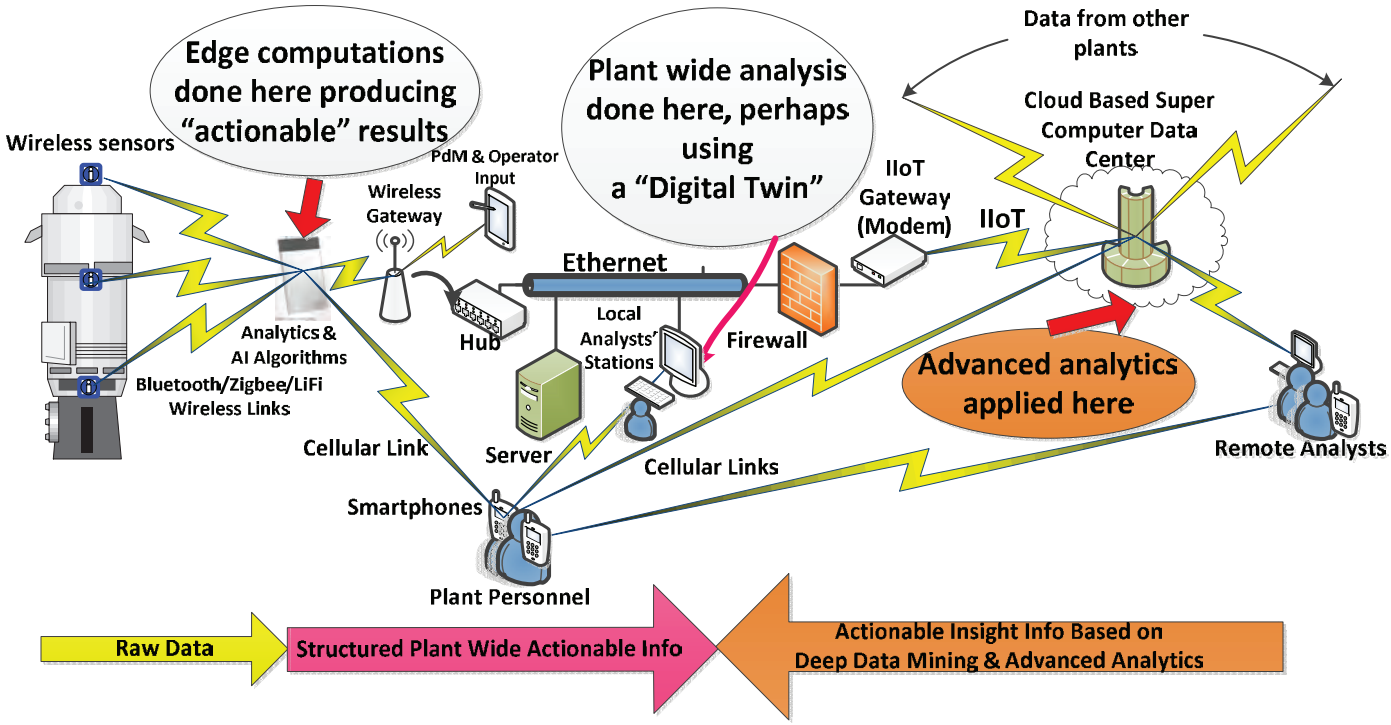


Figure 1: Example mid-2019 machinery monitoring scheme showing levels of analysis and nature of feedback (Source: Jack R. Nicholas, Jr., All Rights Reserved)

and IoT data capacity and speed, plus related communications capabilities provided by internal and external wireless network protocols, data can flow from machine to remote data center(s) almost instantly. Added to this, mobile 4G long-term evolution (LTE) cellular network capabilities in use today are, or in the near future, being eclipsed by vastly superior 5G mobile network speed and capacity in the very near future (50 to 1,000 times greater than 4G by two estimates[iii]). None of these communications capabilities existed in the 1980s.

Most importantly, the number of personnel needed to carry out a modern predictive analysis program for hundreds of clients is becoming far less than before. The variety of analytic methods available has grown significantly and become much more sophisticated. With AI, human involvement is being reduced to only the most difficult analysis and interpretation tasks. With shared computer resources in the Cloud, costs are dropping due to fewer people involved and seemingly continuous reduction in unit cost of data storage in digital form.

While analytic capabilities, such as pattern recognition, regression analysis, correlation, tests against limits and ranges, relative comparison and statistical analysis, were applied in the 1980s, computer storage and recall capacity, speed, and costs limited their use largely to the highest priority programs, such as for national defense.[iv]

By mid-2019, for industrial and utility sectors of the world economy, a typical condition and performance monitoring initiative involving internal and external wireless connectivity and the IIoT applied to critical machinery might look like what is depicted in Figure 1.

For condition and performance monitoring, an increasing number of easily installed digital wireless sensors are available for application to machinery. The energy to power the sensors and wireless links most often comes now from batteries, the life of which are dependent upon battery design technology, capacity and frequency of data transmission. Alternative power sources, such as fuel cells, are in the development pipeline. These show promise of vastly increased power output and increased life over today's batteries. However, the biggest advancement in this field may be the development of ambient harvesting or scavenging methods to charge galvanic cell power circuits using sources of mechanical, thermal, natural, light, magnetic field and nuclear radiation energy.[v] These sensors generally provide raw data and send them to nearby computers directly or via associated programmable logic controllers (PLCs) for basic analysis (e.g., checks against alert and alarm limits, relative comparison) and communications of abnormal conditions to designated personnel.

> "Ideally, a single device receiving inputs from many sensors in a local area, along with effective programming, can provide actionable intelligence"

A key principle of modern condition and performance monitoring is to conduct as much analysis as close to the edge of the network as feasible. This is becoming possible with the introduction of smart sensors that can be customized to suit the application and provide actionable information.[vi] Each sensor point should be assessed for its ability to indicate an actual or likely failure mode standing alone or in combination with any other source(s) of data, such as may be done with the computer card, which is described next. But first, the failure modes and related mitigating digital analysis tasks must be determined.

The most effective methodology for doing this is RCM. In order to get the earliest return on investment in RCM, regardless of the most desirable outcome, a Pareto analysis should be conducted to determine which of the worst bad actors should be investigated.[vii]

Actual failures for which a proper root cause analysis (RCA) or defect elimination (DE)[viii] activity is conducted may also yield digital analysis tasks.

Early 2017 saw the introduction of a credit card sized compute card that provides a modular approach to designing edge computing power and connectivity to consumer or industrial products. The card is a full computer with memory, storage, input/output options, WiFi and Bluetooth connectivity.[ix] Today, there are many more minicomputers and microcomputers and chips designed for edge analysis with the same or even greater capabilities. These include analysis methods, such as regression or trend analysis, tests against limits or ranges, pattern recognition and correlation analysis, supported by an artificial intelligence software resident in chips integral to the edge computer.[x]

Ideally, a single device receiving inputs from many sensors in a local area, along with effective programming, can provide actionable intelligence of a basic, but quite useful, nature, if not also a specific course of action.

> …Fertile fields for data farming are found in methodologies, such as RCM, RCA and DE

Wireless links and gateways are used to connect sensors to computational devices and then to transfer structured information to the next level of analysis, usually with an Ethernet or other wired network protocol. At this level, the whole plant can be monitored once proper connectivity is established. Data lakes or local cloud storage capabilities can be created for accumulation of data without having to go outside the facility. A local computer or server may be loaded with the digital twin of the plant being monitored. A virtual (i.e., digital) twin plant has all the characteristics of the real plant integral to it. The virtual twin contains all the information that describes normal, safe operations for comparison with actual plant conditions from start-up through full production to shutdown. Ideally, anything out of the ordinary comes to the attention of in-house analysts, operators and maintenance personnel, along with what to do to correct any abnormal condition.

Connectivity options are increasing. In addition to wireless network protocols, such as Bluetooth, WiFi and Zigbee, a totally new path for data transfer is emerging called LiFi. LiFi works with light emitting diodes, which are becoming commonly used in many permanent structures and vehicles, such as aircraft, in place of higher energy consuming space lights. It encodes messages in flashes of light. Local area networks can be created in ways similar to microwave based systems, but at less expense, although the aforementioned computers, cell phones and the like would have to be altered to receive the signals. One major technology company revealed in early 2016 that the operating system in its newly released smartphone has LiFi capabilities.[xi]

The total analysis capability implied by Figure 1 includes off-site or cloud computing using advanced analytics, perhaps combined with data from sources outside the organization having the same types of assets employed in similar ways. Advanced analytical methods include data mining, clustering analysis, classification and time series analysis, among other methods.[xii] The benefits, a subject beyond the scope of this article, are many, as described in the book, *Asset Condition Monitoring Management*.[xiii]

Focusing the Data Collection and Analysis Effort through Data Farming[xiv]

As previously indicated, fertile fields for data farming are found in methodologies, such as RCM, RCA and DE. Seeds to plant are the tasks derived from these proven schemes, especially if the tasks are nonintrusive and involve data collection and interpretation using mathematical algorithms and/or visual analysis.

Once the tasks have been implemented, the data being collected have value, even if the value lies in assuring that everything is all right and no remedial action needs to be taken. This sounds simple, and it is straightforward. However, it requires careful resource management (e.g., by filtering) in order to prevent the system collecting, aggregating and analyzing the data from becoming overwhelmed with repetitive and redundant information.[xv]

The overall data farming process is depicted in Figure 2.

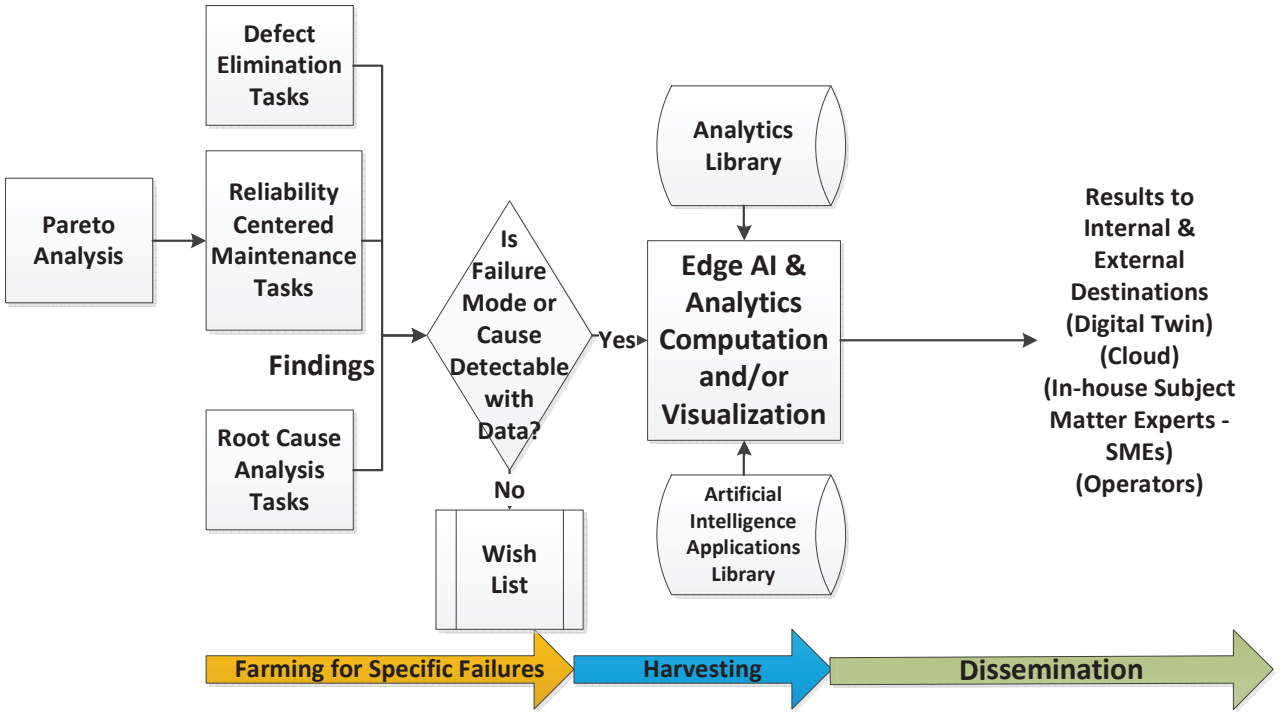


Figure 2: Data farming process in support of advanced analytics (Source: Jack R. Nicholas, Jr., All Rights Reserved)

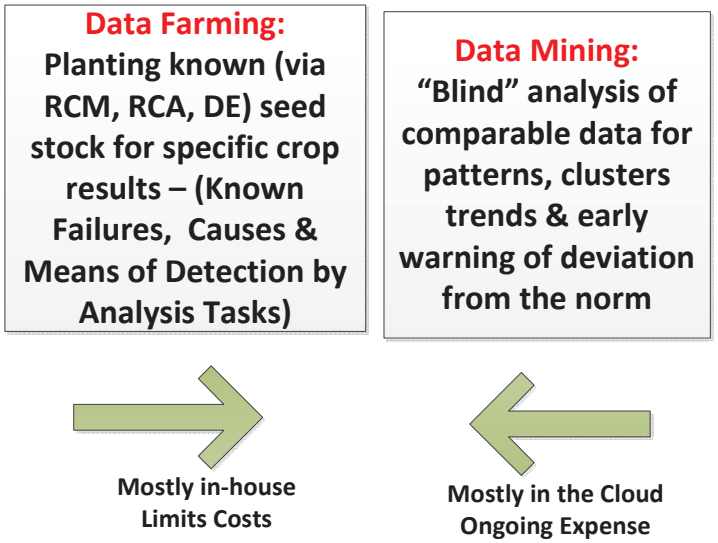


Figure 3: Data farming and data mining differences

Initially, not all tasks may be managed using this concept. Thus, a wish list should be established to search for solutions providers that may have answers to unknowns unresolved in-house. The wish list should be used when organizations send personnel to conferences and exhibits featuring firms involved with Industry 4.0 issues, such as machine analysis in the Cloud, plant, or at the edge. One of the advantages of attendance is the opportunity to locate answers for hard to solve problems by gaining knowledge about specifics on your wish list not only from vendors, but also from other attendees.

Harvesting the results from defined data source(s) for which failure modes are known may be done using commercially available software programs or services providers, such as software as a service (SaaS). Interpretation may be done by humans now, but will undoubtedly be performed in the future using AI software programs, many of which are becoming available off-the-shelf from a rapidly increasing number of providers around the world.

Results from analyses must be managed. First, decide what to use in-house and select those that will be sent off-site to a Cloud for aggregation, analysis and interpretation in conjunction with data from other sources. Sending results to any Cloud, whether internal or external, requires synchronization or structuring of results terminology and formatting to avoid mixing "apples" and "oranges," wasting resources and producing meaningless or useless information.

Time series database management systems (DBMS) comprise the fastest growing and most popular database segment in Industry 4.0 circles from early 2016 into 2018.[xvi] Manufacturing leads by far in this regard.[xvii] This implies where organizations are investing the most money in IIoT pursuits. The big question is: Are they getting their money's worth from this investment? In time series analysis, abnormal patterns, trends, or conditions relative to established ranges or limits are analyzed and reported for follow-up action by owners of the machines or processes being monitored. This is called data mining or exploratory data mining. While this makes common sense, it can be very expensive in terms of data storage costs and searches for degraded conditions. Often, it takes a long time for clusters or patterns to develop, even with the help of deep learning machine diagnostic or other AI programs. This may be useful if the conclusion is there are no problems or none being detected. The concept of data farming, however, is to target the search for early warning when known causes and defects are recognized as probable. Blind searching can continue while targeted analysis based on data farming is being performed.

The basic difference between data farming and data mining is depicted in Figure 3.

Figure 3 stresses the cost factor. Farming provides a means for controlling the cost by concentrating on known failure modes and causes, without inhibiting the great potential of data mining. Ultimately, the influence of data farming should be reflected in off-site, cloud-based analysis, increasing the value of the output. This permits organizations to increase the amount of data that is being productively analyzed. Other data may still be subjected to advanced analytics processing when it is deemed of value in identifying yet unknown problems created by aging and other factors.

A conceptual depiction of a monitoring scheme involving both data farming and data mining using the IIoT is illustrated in Figure 4.

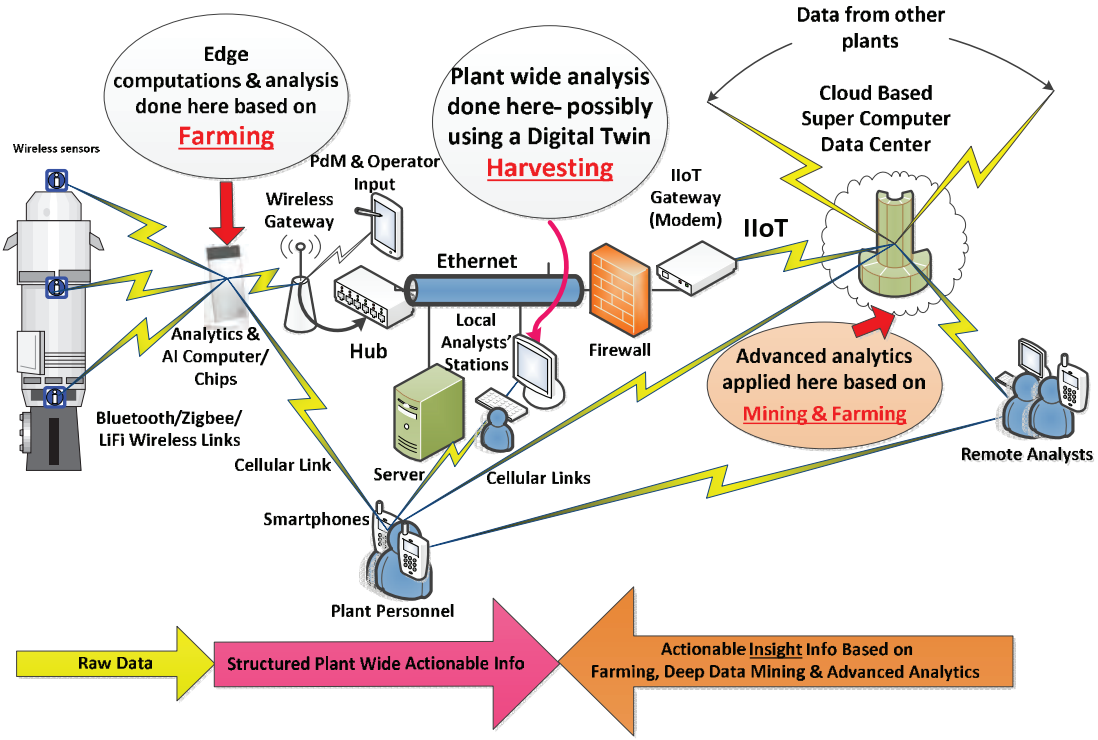


Figure 4: Example future machinery monitoring scheme showing levels of analysis and nature of feedback (Source: Jack R. Nicholas, Jr., All Rights Reserved)

Data farming can result in early and more valuable gains, both internally at a plant site and externally from the Cloud. It doesn't diminish the value of data mining, but may greatly increase the useful outputs and value of the data being processed, resulting in a higher percentage of successful IoT and IIoT projects than recently revealed in the Cisco Systems survey.

Conclusion

Data farming uses well established methodologies (e.g., RCM, RCA, DE) to target specific failure modes and causes by analyzing the sensor information that reveals them. Contrary to the positions posed by some IoT/IIoT enthusiasts and big data database management organizations, these methodologies will not, at least in the short term, become obsolete. They can be used to great advantage in gaining value from the data being collected, accumulated, structured, filtered, analyzed and acted upon. This will overcome the current trend of IoT/IIot initiatives failing in the vast majority of cases that involve machinery condition and performance monitoring.

The main advantage of data farming as defined in this article is in controlling costs, allowing for value to be gained while the digital revolution begins to show its real potential in increasing machinery reliability and decreasing production costs in manufacturing.

References

[i] https://www.i-scoop.eu/internet-of-things-guide/internet-things-project-failure-success/

[ii] It is difficult to judge from the many estimates being made in various publications and on the Internet and even more so to separate out machinery data from all others being collected either internally or externally in the Cloud. Machinery data subjected to any type of analysis using local or advanced analytics is at present estimated by the author to be less than 5 percent of all data.

[iii] Gill, Bob. "Industrial IoT and the Promise of 5G, Industrial IoT/Industrie 4.0." Viewpoints, May 4, 2016. Also see https://industrial-iot.com/2016/04/industrial-iot-promise-5g/ and Anthony, Sabastian. "South Korea to spend $1.5 billion on 5G mobile network that's '1,000 times faster' than 4G." ExtremeTech, January 22, 2014, https://www.extremetech.com/computing/175206-south-korea-to-spend-1-5-billion-on-5g-mobile-network-thats-1000-times-faster-than-4g. Deployment started in 2017 in anticipation of a pre-commercial 5G trial during the Pyeongchang, Seoul, South Korea 2018 Winter Olympic Games. See http://gsacom.com/global-spectrum-situations-5g-positioning-countries/. Mobile network providers in the United States are beginning to advertise deployment in 2019 of 5G LTE capabilities in some markets.

[iv] Nicholas, J. "What Organizations Must Do to Take Best Advantage of Big Data and Predictive Analytics in the Operations, Maintenance and Reliability Field." Paper presented at The RELIABILITY Conference, Las Vegas, NV, April 2017. Describes the Submarine Maintenance Monitoring and Support Program, arguably one of the most comprehensive asset condition monitoring programs ever conducted in the 20th century (Applying 26 predictive technologies on up to 65 systems on each of 122 nuclear powered subs operating from ports in Europe and westward to Hawaii').

[v] Nicholas, J. *Asset Condition Monitoring Management*. Fort Myers: Reliabilityweb.com, December 2016 (ISBN 978-1-941872-52-9), Chapter 10, pp170-171. Provides more detail on battery alternative power sources for sensors.

[vi] Smart sensors may be quite sophisticated with integral microprocessors. However, these require much more power than a sensor that can transmit digital data periodically and are not necessarily the first choice in all cases. ABB has developed a compact sensor that is attached to the frame of low voltage induction motors. No wiring is needed. Using on-board algorithms, based on ABB's decades of motor expertise, the smart sensor relays information about the motor's health (e.g., vibration, temperature) via a smartphone and/or over the Internet to a secure server. This solution can make huge numbers of motors into smart devices, enabling them to benefit from intelligent services. The solution was launched in the North American market in 2016. See http://new.abb.com/motors-generators/service/advanced-services/smart-sensor

[vii] Khan, F.I. "Bad Actor Program." *Uptime Magazine* Aug/Sept 2019, pp 56-60. Article provides an excellent approach to Pareto analysis. Although the article is aimed at preventive maintenance optimization, lifecycle costing, spare parts forecasting and reliability, availability and maintainability (RAM) modeling, it is equally useful for focusing on which systems to conduct reliability-centered maintenance.

[viii] Ledet, W. P., Ledet W. J. and Abshire, S. M. *Don't Just Fix It, Improve It!* Fort Myers: Reliabilityweb.com, 2009. (ISBN 978-0-9825163-1-7). Provides details on defect elimination.

[ix] de Leeuw, Valentijn. https://industrial-iot.com/2017/01/intel-compute-card-iot-moduless-potential-impact-product-life-cycle-, January 27, 2017.

[x] Vincent, James. "Google unveils tiny new AI chips for on-device machine learning." *The Verge*, July 26, 2018: https://www.theverge.com/2018/7/26/17616140/google-edge-tpu-on-device-ai-machine-learning-devkit. Article states: Google is moving its AI expertise down from the Cloud, and has taken the wraps off its new Edge TPU, a tiny AI accelerator that will carry out machine learning jobs in IoT/IIoT devices. The Edge TPU is designed to do what's known as inference. This is the part of machine learning where an algorithm actually carries out the task it was trained to do, like, for example, recognizing an object in a picture. Google's server-based TPUs are optimized for the training part of this process, while these new Edge TPUs will do the inference. Six of these chips will fit within the perimeter of a U.S. one cent coin.

[xi] The Economist newspaper. "In a Whole New Light." September 24, 2016, pp76-77. The article identifies Velmenni, an Indian firm, PureLiFi, a British firm and Luciom, a French firm, marketing various applications of this technology. Apple's iPhone operating system released that year is described as LiFi capable, but a sensor (not provided with the phone) must be added to make the capability useful.

[xii] Ibid, reference v. Page 179 provides a typical list of the names of some analytical methods.

[xiii] Ibid, reference v. Chapter 10, pp 178-184.

[xiv] The author of this article cannot locate the specific source of the term, *data farming*, and cannot claim to have originated it. The idea came from reading an article in the U.S. Naval Institute Proceedings on a totally different subject. Its definition may not even be the same of that of the author of the Proceedings article, who used the term without defining it that triggered the idea of its value in digital machine monitoring.

[xv] Valerio, Pablo. "Managing Resources on IoT and Edge Computing." *IoT Times* website, August 12, 2019: https://iot.eetimes.com/managing-resources-on-iot-and-edge-computing/.

[xvi] Risse. Michael. "The new rise of time-series databases." *Smart Industry* website, February, 26, 2018: https://www.smartindustry.com/blog/smart-industry-connect/the-new-rise-of-time-series-databases/

[xvii] Ibid.

Jack R.Nicholas, *P.E., CMRP, CRL, CAPT USNR (Ret.), became an internationally experienced and recognized author, workshop leader, advisor and consultant on reliability and maintenance, asset management and related subjects since retiring after 35 years from U.S. government service in 1988. He holds a certificate in Asset Management from the Institute of Asset Management in the United Kingdom.*

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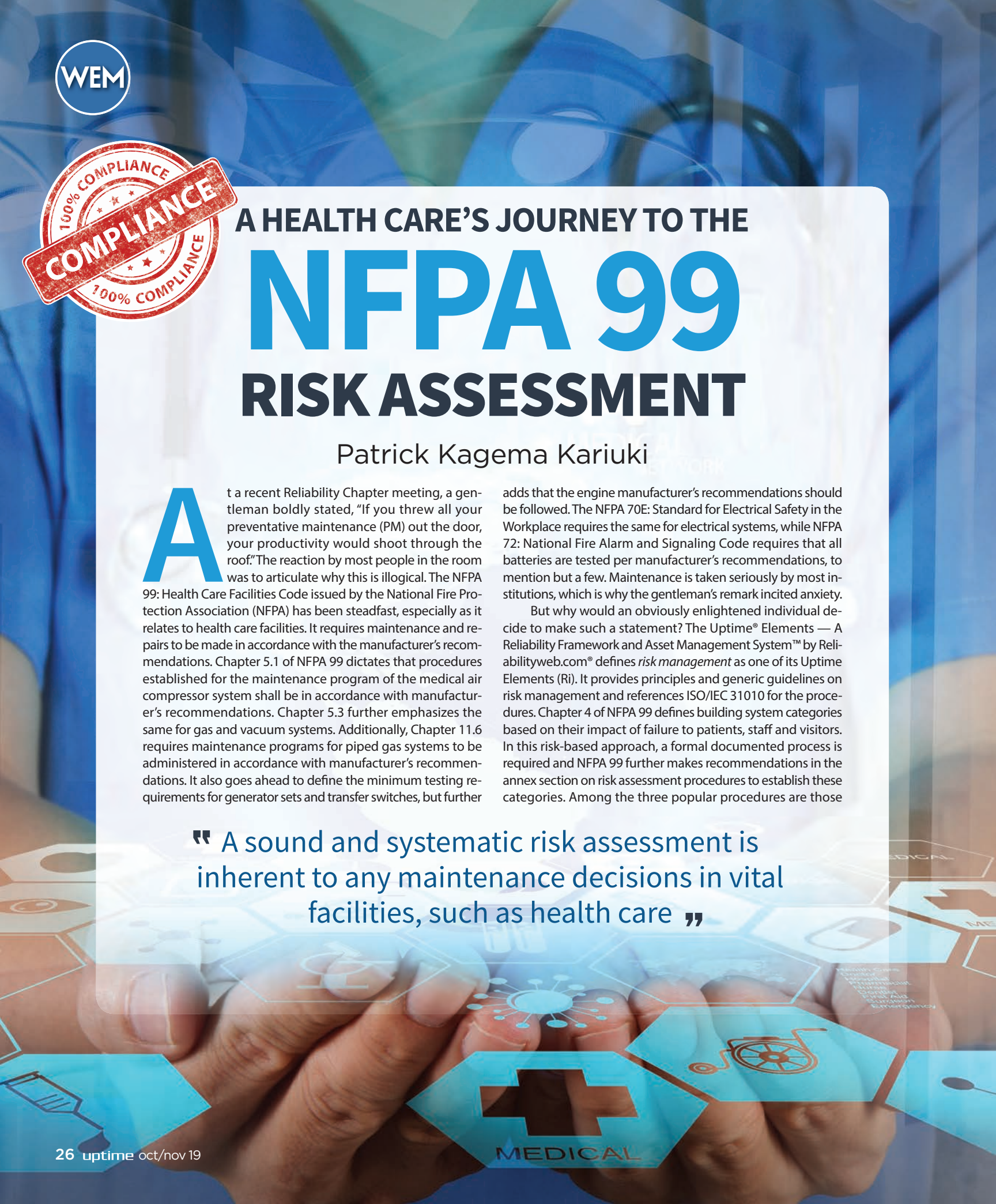

A HEALTH CARE'S JOURNEY TO THE

NFPA 99 RISK ASSESSMENT

Patrick Kagema Kariuki

At a recent Reliability Chapter meeting, a gentleman boldly stated, "If you threw all your preventative maintenance (PM) out the door, your productivity would shoot through the roof." The reaction by most people in the room was to articulate why this is illogical. The NFPA 99: Health Care Facilities Code issued by the National Fire Protection Association (NFPA) has been steadfast, especially as it relates to health care facilities. It requires maintenance and repairs to be made in accordance with the manufacturer's recommendations. Chapter 5.1 of NFPA 99 dictates that procedures established for the maintenance program of the medical air compressor system shall be in accordance with manufacturer's recommendations. Chapter 5.3 further emphasizes the same for gas and vacuum systems. Additionally, Chapter 11.6 requires maintenance programs for piped gas systems to be administered in accordance with manufacturer's recommendations. It also goes ahead to define the minimum testing requirements for generator sets and transfer switches, but further adds that the engine manufacturer's recommendations should be followed. The NFPA 70E: Standard for Electrical Safety in the Workplace requires the same for electrical systems, while NFPA 72: National Fire Alarm and Signaling Code requires that all batteries are tested per manufacturer's recommendations, to mention but a few. Maintenance is taken seriously by most institutions, which is why the gentleman's remark incited anxiety.

But why would an obviously enlightened individual decide to make such a statement? The Uptime® Elements — A Reliability Framework and Asset Management System™ by Reliabilityweb.com® defines *risk management* as one of its Uptime Elements (Ri). It provides principles and generic guidelines on risk management and references ISO/IEC 31010 for the procedures. Chapter 4 of NFPA 99 defines building system categories based on their impact of failure to patients, staff and visitors. In this risk-based approach, a formal documented process is required and NFPA 99 further makes recommendations in the annex section on risk assessment procedures to establish these categories. Among the three popular procedures are those

> "A sound and systematic risk assessment is inherent to any maintenance decisions in vital facilities, such as health care"

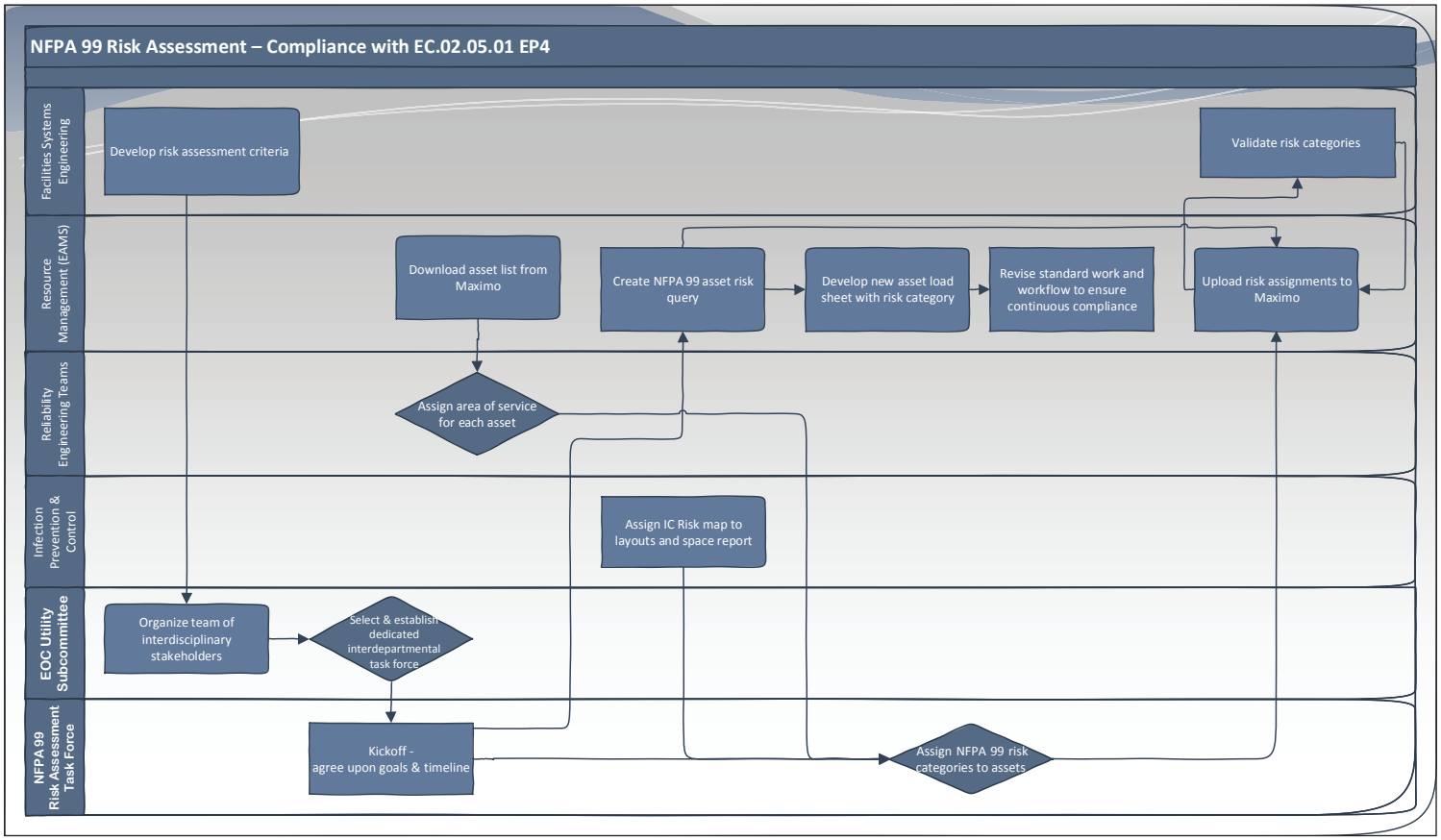

Figure 1: Risk assessment task force formulation and process

found in ISO/IEC 31010: Risk management – Risk assessment techniques, NFPA 551: Guide for the Evaluation of Fire Risk Assessments, and SEMI S10-0307E: Safety Guideline for Risk Assessment and Risk Evaluation Process. A sound and systematic risk assessment is inherent to any maintenance decisions in vital facilities, such as health care.

To preserve the efficiency, equity, quality and safety of health care, the Centers for Medicare and Medicaid Services (CMS) provides protective regulations, policy and guidance to hospitals. Compliance to this program may be achieved through accreditation by agencies, such as The Joint Commission (TJC). TJC sets standards known as the Elements of Performance (EPs), which are based on the CMS's requirements, and packages them in the Environment of Care Standard. This standard is used by the TJC to survey member hospitals for eligibility and maintenance of accreditation.

One hospital from the Stanford Health Care system embarked on a journey to perform a risk assessment and establish NFPA 99 Chapter 4 categories for the asset inventory, as required by the Environment of Care standard EC.02.05.01. A collaborative effort was critical to the success of this process. As demonstrated in Figure 1, the process began with the establishment of an interdisciplinary team dubbed the NFPA 99 Risk Assessment Task Force. This team was comprised of members from various committees and departments, including the Environment of Care Utility Subcommittee; systems engineering; facilities management; resource management; infection prevention and control; clinical; and the frontline engineering staff. A risk assessment procedure to evaluate the categories would be developed and executed. In this regard, ASHE, the association for health care facility managers, engineers and other health care professionals, made a recommendation for a room-by-room assessment, which the team determined was inadequate for its needs. Further, NFPA 99 proposes a simplified risk assessment procedure, which fails to establish how the impact on patients, visitors and staff is determined, as shown in Figure 2. To fast-track the process, risk assessment criteria were established by the systems engineering team and proposed to the task force for review and approval.

To fully recognize the basis of the assessment process selected, it is necessary to quickly review the scope of NFPA 99. Chapter 4 Fundamentals define the four system risk categories as:

- **Category 1** – Facility systems in which failure of such equipment or system is likely to cause major injury or death of patients or caregivers shall be designed to meet system Category 1 requirements as defined in this code.
- **Category 2** – Facility systems in which failure of such equipment is likely to cause minor injury to patients or caregivers shall be designed to meet system Category 2 requirements as defined in this code.
- **Category 3** – Facility systems in which failure of such equipment is not likely to cause injury to patients or caregivers, but can cause patient discomfort, shall be designed to meet system Category 3 requirements as defined in this code.
- **Category 4** – Facility systems in which failure of such equipment would have no impact on patient care shall be designed to meet system Category 4 requirements as defined in this code.

Additionally, the minimum criteria for the performance, maintenance, installation and testing of the facility systems is defined in the subsequent chapters covering:

- Chapter 5 – Gas and Vacuum Systems;
- Chapter 6 – Electrical Systems;
- Chapter 7 – Information Technology & Communication Systems;
- Chapter 8 – Plumbing Systems;
- Chapter 9 – Heating, Ventilation and Air Conditioning Systems;
- Chapter 10 – Electrical Equipment;
- Chapter 11 – Gas Equipment.

These facility systems in the health care world can generally be functionally categorized as:

- Life support systems;
- Utility infection control systems;
- Environmental support systems;
- Equipment support systems;
- Communications systems and data exchange.

Thus, it was essential that the service locations for each of the assets under these categories were documented in order to perform a comprehensive risk assessment.

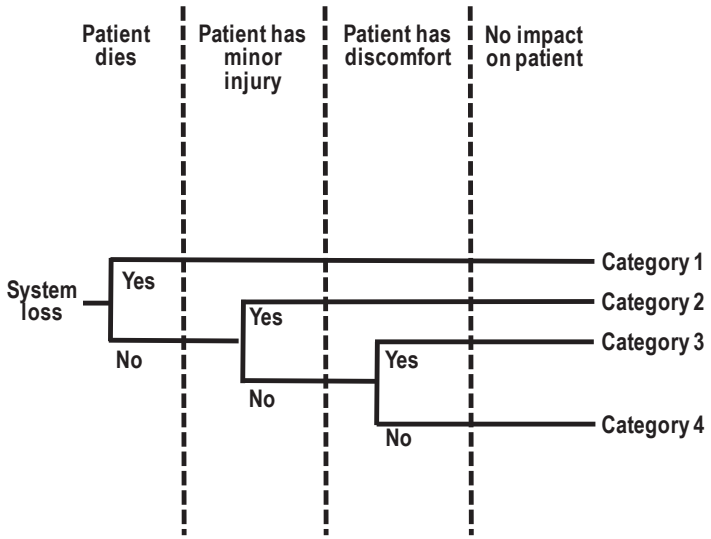

Figure 2: Sample risk assessment (Source: NFPA 99, 2018)

Back to the risk assessment journey, the task force was officiated with the establishment of a charter and management plan. The charter describes the purpose of the task force, its sponsorship, its goals, the guiding principles, scope of work, membership formulation and responsibilities, and meeting protocol. The management plan details process objectives, scope of implementation, the procedure itself and the plan to achieve the expressed objectives. A plan-do-check-act (PDCA) approach was adopted in the development of the management plan, and by extension the workflow, to successfully execute the risk assessment demonstrated in Figure 1. After establishing system types, as defined in NFPA 99, assigning service locations for each asset, as defined in the plan, creating schedules for each of the buildings, as well as rigorous investigations by the reliability engineers, the risk assessment criteria used to determine the system risk category was applied, as shown in Figure 3. A system function was determined for each asset, as defined by ASHE and related health care establishments. An infection risk assessment score, based on a well-defined institutional infection risk assessment criteria, was assigned. NFPA 101 Life Safety Code occupancy categories, namely health care, ambulatory health care, assembly, business and industrial, were assigned to the service locations, as defined in the fire life safety drawings. Objective data for each attribute was derived from this analysis. These attributes were then weighted and tallied in order to determine the risk category for the associated asset and space.

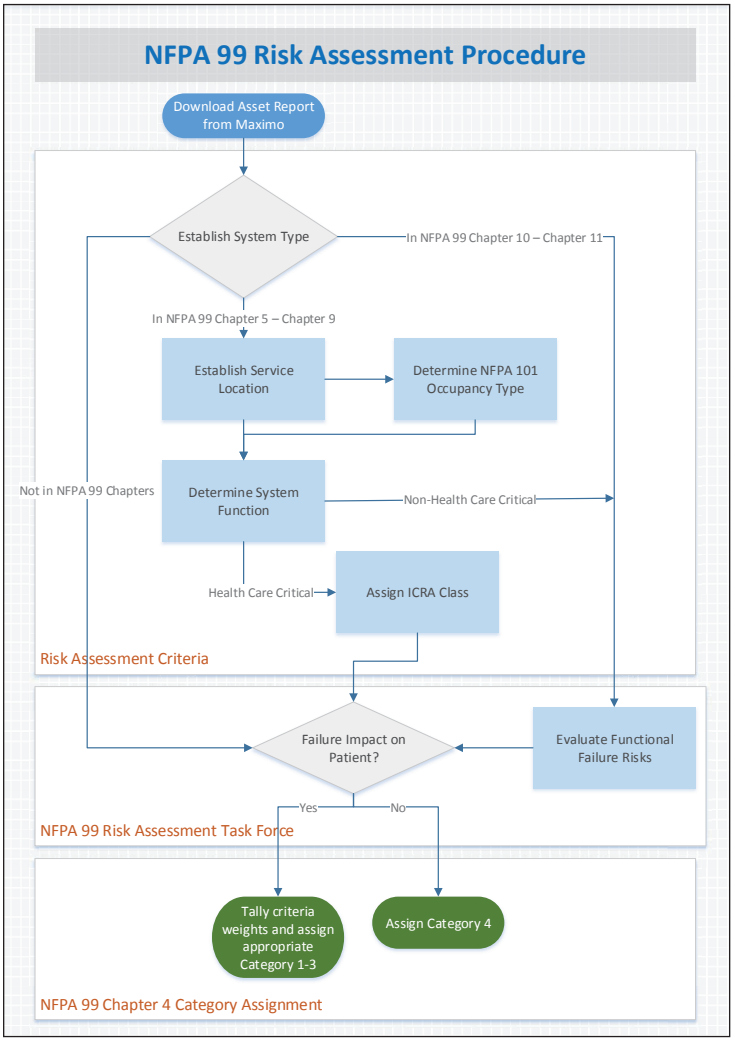

Figure 3: NFPA risk assessment procedure

It is important to note that not all assets in the health care enterprise belong to a critical system, as defined in NFPA 99. Owing to the interdisciplinary nature of the task force, a somewhat subjective analysis was applied on noncritical systems to define their categories. A bulk of these were determined to be Category 4.

By the end of the exercise, a total of about 5,000 assets in over 30 facilities had been assessed and categorized. The end goal is to have these categories loaded into the enterprise asset management software (EAMS) and apply them in the optimization of the PM program.

The fundamentals of such a program will be based on decisions that are risk based. Thus, in the general sense, risk based decision-making offers more value and increases productivity than a traditional PM program for health care facilities.

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Patrick Kagema Kariuki *is a Facilities Systems Engineer at Stanford Health Care and an active member of the California Society for Healthcare Engineering, Inc. – Silicon Valley Chapter. He has amassed a wealth of experience in both technical and business processes involving asset reliability and management in the renewable energy and healthcare sectors. www.stanfordhealthcare.org*

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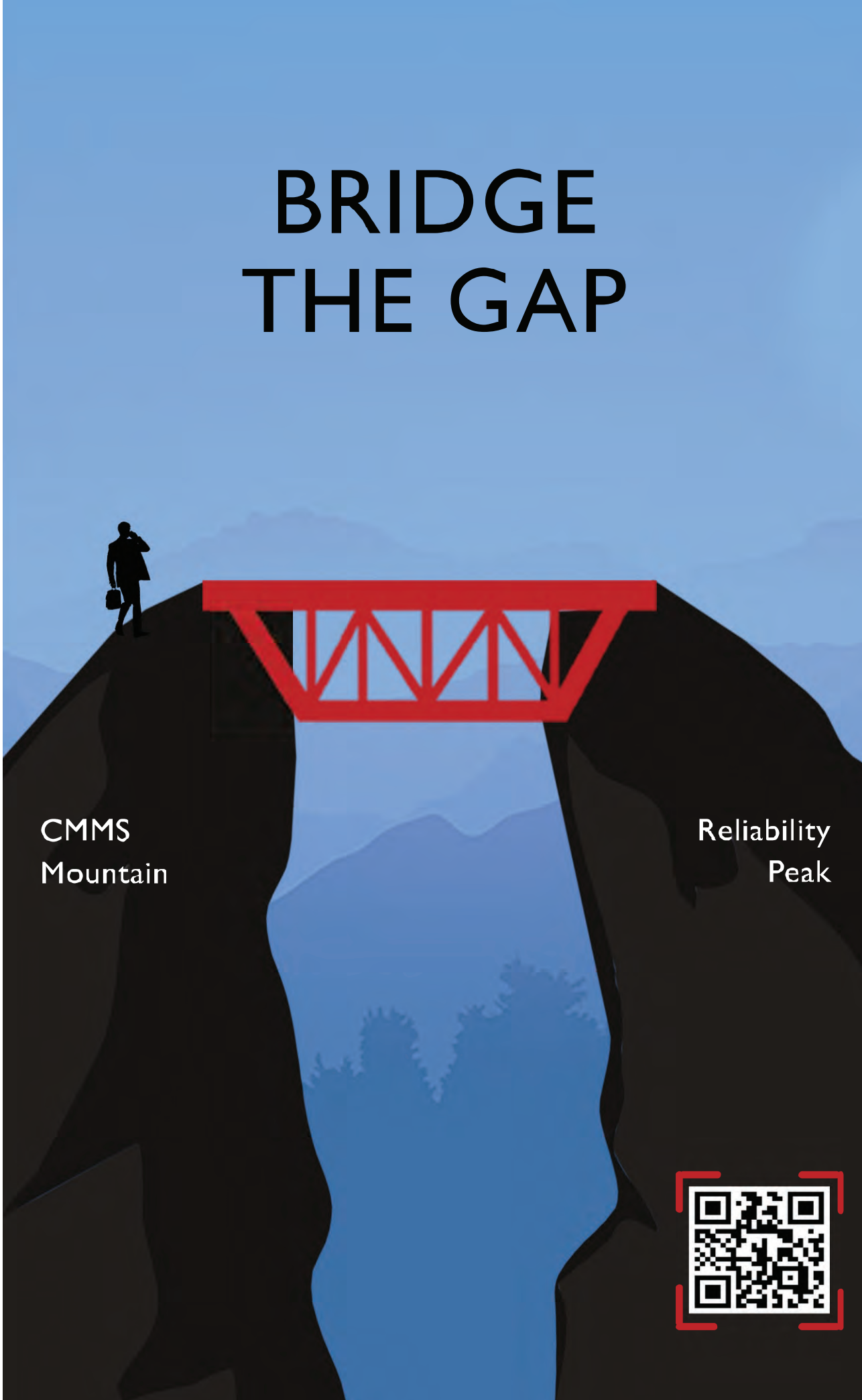

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Getting Started on Equipment Reliability?

Look in the Dumpster!

Mike Barkle

Author's Note: *Growing up in a home of meager means with an older brother very close in age, it was important to ensure that any special treats were distributed equally. Among other things, my brother and I learned to look in the trash if we were ever separated and you just might receive a special reward. This technique must have followed me to my industrial maintenance and reliability career. This article is an attempt to share a very simple, no cost method of assessing what is going on at a site or in a department. It's a practice I call, "Look in the Dumpster."*

> "If used as a checklist, it should lead to more specific questions and reveal any patterns, symptoms and opportunities for improving equipment reliability"

The definition and concept of reliability remains elusive in terms of application. Ask as many folks as you can to explain what reliability means to them or their situation and the responses will vary wildly. This can be especially nebulous among the decision makers for resource allocation, but what they usually want is lower costs and more quality output.

Much has been written and proven beneficial with respect to doing things right in terms of asset care. Most, if not all, methods and philosophies require dedicated resources of material, manpower, C-suite support, training and execution discipline to even get close to improving or extending industrial asset life and performance. If those resources are at your disposal, then apply them and continue your journey along the maturation path of greater mean time between failures (MTBF), utilization and overall equipment effectiveness (OEE). If the resources are not at your disposal, here's a simple way to gain insight into what is happening at your site or department – look in the dumpster! What you learn may be valuable in gaining information to convert into action for improvement and better reliability.

Here's a simple list of what to look for when rummaging through the dumpster and what could be suggested for improvement.

Is there anything new or unused?

If there are new items in the dumpster, question why:

- Were they ordered wrong?
- Were too many requested?
- Is it too difficult to return unused items to stores or suppliers?
- Is the bill of material (BOM) wrong?
- Has the machine or part been out of service for an extended period?

Are there items that appear to have remaining life?

If there are items that appear to have remaining life, question why they were replaced:

- Could there be other premature failure mechanisms?
- Could preventive maintenance (PM) plan intervals be excessive?
- Could there be poor definitions of failure?
- How premature are the failures?
- Can the age of the material be determined?

Is there more than one of the same part?

If there is more than one of the same part, question why there are two or more.

- Could this be a chronic issue?
- Could this be a design issue?
- Could this be an operational issue?
- Could this be a purchasing issue?
- Could this be a maintenance issue?

Is there any evidence of having the wrong material?

If there is evidence of wrong material, try to determine whether it is due to:

- Corrosion – Oxidation or chemical attack failure
- Erosion – Wear failure
- Fatigue – Cyclic failure
- Overload – Instantaneous failure

Have the components been disassembled for autopsy (root cause) inspection?

If assemblies have not been opened for inspection, question the support, expectation and encouragement to do so:

- Does the work order expect an autopsy?
- Is there any curiosity to examine for root cause?
- Does the work order closure debrief session determine what was observed?
- Does it appear to be a replace rather than a repair strategy? If so, why?

What are the differences in area dumpsters?

If there is more than one disposal container, check them all:

- Does one area discard components that appear newer than another?
- Does one area have more electrical related parts?
- Does one container have lubrication related evidence?
- Do multiple areas have the same components?

What crafts contribute the most content?

Try to determine who placed the material in the dumpster:

- Are the items mostly piping and related fittings?
- Are there a lot of shafts, bearings and belts?
- Are there wiring and fuses?
- Are there gauges and instruments?
- Is there insulation?
- Are there empty grease cartridges?
- Are there bolting fasteners?
- Is there sheet metal or ductwork?

Is there any evidence of poor craftsmanship?

Look for mishandling:

- Are there jaw marks on shafts?
- Are there old hammer marks?
- Is there evidence of poor rigging practices?
- Are there damaged tools?

This list of things to look for when examining a site's maintenance dumpster is offered as a start to determine what is normally going on with current expectations and practices. If used as a checklist, it should lead to more specific questions and reveal any patterns, symptoms and opportunities for improving equipment reliability. Beyond what can be learned from a dumpster dive, the challenges of resource commitment could become a boundary. Once armed with physical evidence of poor practices, premature failures, chronic poor performance, inadequate training, or poor operation, support should be easier to obtain, especially if you link it to lower costs and higher output.

Here are some scenarios the dumpster may help reveal:

- There are pipe wrench marks on the shafts that may indicate the process is causing a blockage that needs to be manually cleared. If the process cannot be adjusted to prevent those occurrences, then a non-destructive tool, such as a strap wrench, could be used in lieu of a pipe wrench.
- If there is a broken shaft, it may be the result of a start-up issue or an overload condition. If it can be determined when it occurred, a solution could be offered that may include a soft start, rotate by hand technique before starting, or a variable frequency drive (VFD) to eliminate the start-up or overload condition.
- If all the bearings or seals have excessive grease or if there is grease everywhere, this could be a training opportunity. Excess grease creates excess heat and destroys the lubricant. Perhaps a bearing should have a red grease and the dumpster content has a green grease. Could that be the reason for the dumpster fodder?
- There are wear parts, such as seal materials, that could benefit from a material change or better installation instructions.
- If the dumpsters are always full and overflowing, this could be a manpower assignment or scheduling issue. What can you discern from a scenario where something should be in the dumpster, but is nowhere to be found? Could that be a culture that assigns blame or is there something to hide?

Here are some actual findings at dumpsters in manufacturing facilities:

- One area of the site had multiple 10 hp motors in the dumpster. Could these failures with a short MTBF be an operational issue or a design problem? Things that are chronic typically have a good payback when resolved.
- An aluminum tube manufacturer found a large amount of machine tool cutting inserts in the dumpster. Why are so many inserts being consumed? The answer has the potential to lead to an improvement.
- A medical device manufacturing site found a motor in its dumpster with the shaft exposed. When a gloved hand attempted to rotate the shaft to ascertain if it was in there because it had seized, the glove returned coated with oil. Why is a motor shaft oily?

Depending on your specific circumstances, practices, work management processes and execution discipline, there could be other revelations that are uncovered for no cost or additional resources by simply looking at a lagging indicator of what is going on based on hardware consumption.

Looking in the dumpster can provide quick insight into your site and its practices. Please share what you discover from your dumpster inspection: crm@reliabilityweb.com.

Mike Barkle, *CRL, CMRP, is a Senior Reliability Engineer with Infralogix, and previously worked at AlliedSignal/ Honeywell for 36 years. Mike is passionate about solving problems at the root(s) and eliminating causes.*
www.infralogix.com

Felix sure breathes more easily with his head out of the sand.

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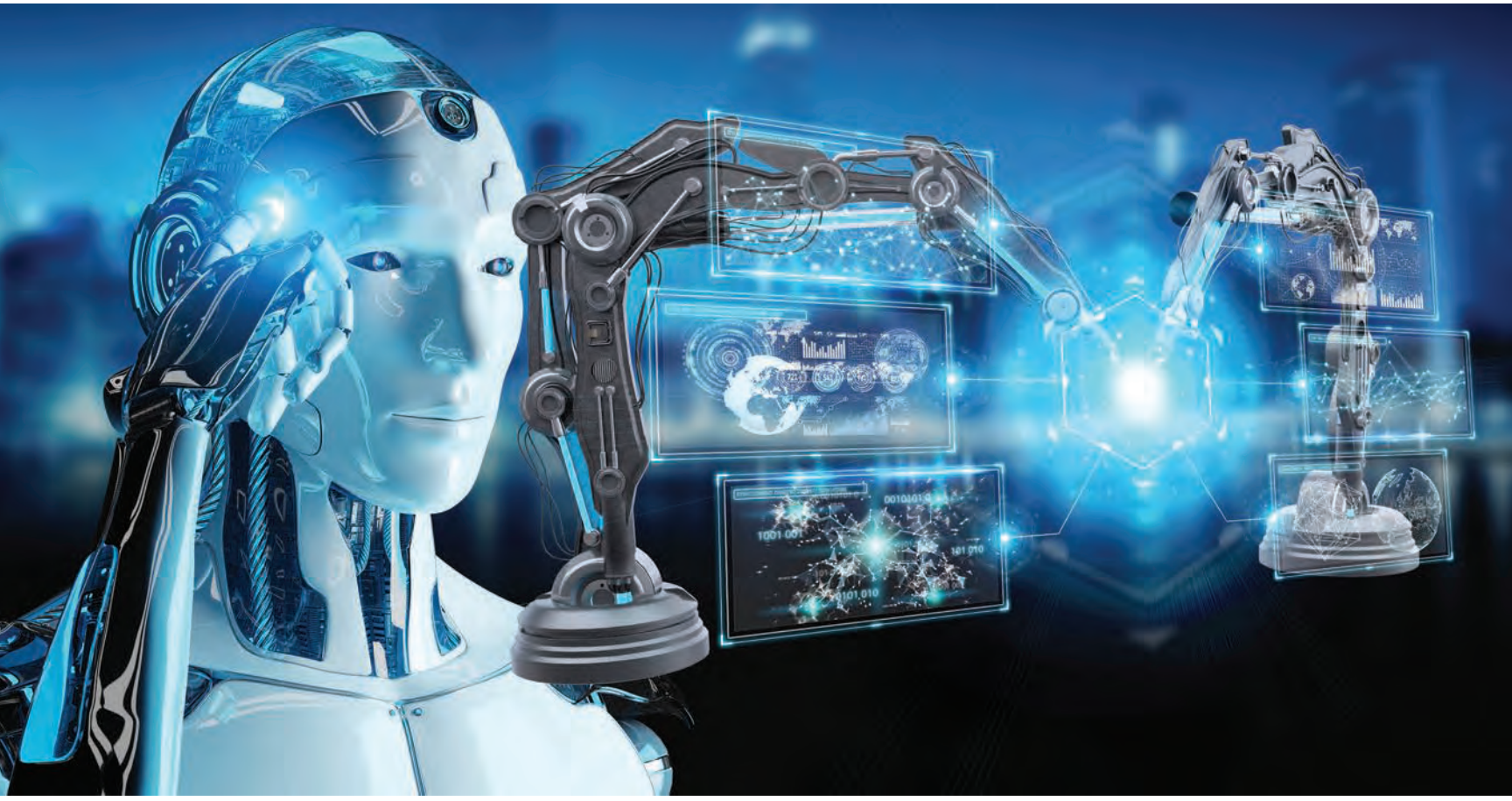
THE FUTURE OF ARTIFICIAL INTELLIGENCE: START SMALL



WIN BIG

Antony Bourne

A new generation of point artificial intelligence (AI) solutions will prove themselves within the next year. They'll build new trust, urgency and an understanding of what AI actually is, and show just how much AI can deliver. Voice-driven solutions will lead the charge. And there'll be pick-and-place robots in smart warehouses delivering a major competitive edge as companies advance their use of robotic process automation. Here are three key predictions for manufacturing for 2020 and beyond.

The manufacturing sector still has a long way to go to achieve total process automation, but some realistic steps are around the corner—with new technologies driven by artificial intelligence set to move from confusing luxury to proven business tool. AI won't mean the same thing for every manufacturer, but manufacturers have one thing in common: they can all start somewhere, however small their first steps may be.

> "The year 2020 will be all about that new AI realism spreading…"

PREDICTION #1:

Fifty percent of all manufacturing companies will be using AI in some form by the end of 2021.

Make no mistake, the implementation of AI solutions will change everything. And everything means every industry, business, process and company. But let's not forget that for many businesses, targeted AI solutions are already here. They're already delivering a competitive edge. The year 2020 will be all about that new AI realism spreading, with new targeted, project-based AI solutions hitting the ground running.

AI's Small Solutions Win Big

A big stumbling block for AI has always been the term *AI* itself. It misleads many manufacturers, suggesting a large end to end system. In reality, AI is a collection of targeted technologies, from natural language processing to vision identification to chatbots to analytics to automation, each with its own strengths and applications. What these technologies all share is the intelligence factor: a high degree of accuracy and an incredibly fast, smart ability to learn from their mistakes.

That high degree of accuracy is evident at one Northern Europe manufacturer. As a household brand, the company uses an AI demand planning solution to forecast projected consumption in its sector. The accuracy of the forecast before and after the AI solution was a real eye-opener. The demand planning forecast produced by the AI solution proved far, far closer to real market results. And forecast demand planning proved an excellent choice of application. For this business, a concrete, achievable target meant concrete, measurable results.

AI Solutions Are Precision Tools, Not Blunt Instruments

When thinking of AI, you need to remember that you can't *implement AI* any more than you can *implement the Internet*. Before you initiate any project, you must figure out your "why." What exact business goal and target are you aiming at? What exactly do you want to improve and enhance? The more targeted your objectives, the more competitive and transformative your results.

PREDICTION #2:

Twenty-five percent of manufacturing planners will be talking to their systems by the end of 2020.

AI solutions are smarter and more eloquent than most people realize. A year ago, a major global AI customer survey found that two thirds of people who said they had never used AI actually had through chatbots. The quality was so high that the chatbots had been indistinguishable from human speech. The same survey found that 84 percent of respondents were comfortable using voice-activated AI at home, in the form of the popular virtual assistant devices. And, if simplicity, speed and accuracy are crucial consumer benefits, imagine what they could do on a manufacturing line.

The smart integration of virtual assistants in cars by certain auto makers is being widely applauded. And rightly so. The integrated voice activation goes way beyond skin deep, adding layers of service and performance capability to the whole driving experience. What's less well-known is that voice-activated solutions are also already being used on the production side of the automotive sector.

In Japan, companies are already using voice-activated solutions in their order picking process, where line personnel simply give spoken instructions and their order is instantly created.

PREDICTION #3:

Pick-and-place robots will put away 25 percent of manufactured goods by the end of 2020.

Robots on production lines have been essential for decades. But what kind of savings and competitive edge will AI-enabled robots in the warehouse deliver? With big e-commerce companies making headlines with their smart warehouses staffed with swift, inexhaustible robots, it is clear that robots raise the performance and savings bar in a huge way. With no eyes or flesh, robots do not need lighting or heating, so energy costs plummet. There are no time or weight limits on breaks, shifts, or loads. And the flexibility, fluency, reach and economy of robot-driven picking and placing means no wasted time or effort—and far better utilization of space. Twenty-four hour, fully automated warehouses will be able to store and do more, without having to get bigger.

And, as it is with AI, so it is with robots. It's already happening, with small, targeted use cases that will keep growing bigger. For example, several North American companies are extending their use of robotics from loading boxes to complete material handling. For some, it's another small step on their longer journey to digital transformation.

Although full lights-out warehouses may be some years away, it has begun. Innovative companies are already beginning work with automated warehouses. Heavy parts that may have once required a team of workers can now be plucked off the shelf by one robot with no wasted effort, no wasted time and no additional costs.

Take the First Steps to AI

In 2020, you will see the technologies in all these predictions gaining traction in the world of business. They will become more targeted and more project-driven. They will be more focused on achieving small, concrete improvement results that will lead to big change.

For many companies, 2020 will be the year when they realize they don't actually need to climb an AI mountain. They just have to keep taking the right, small steps. By doing that, they will still be able to reach new heights.

Antony Bourne *is President of IFS's Industry Business Unit. Antony is a lead spokesperson for IFS and has extensive experience in multiple industries, including manufacturing, construction, life sciences and high tech. Antony has over 20 years' experience in the IT industry. www.ifsworld.com/us/*

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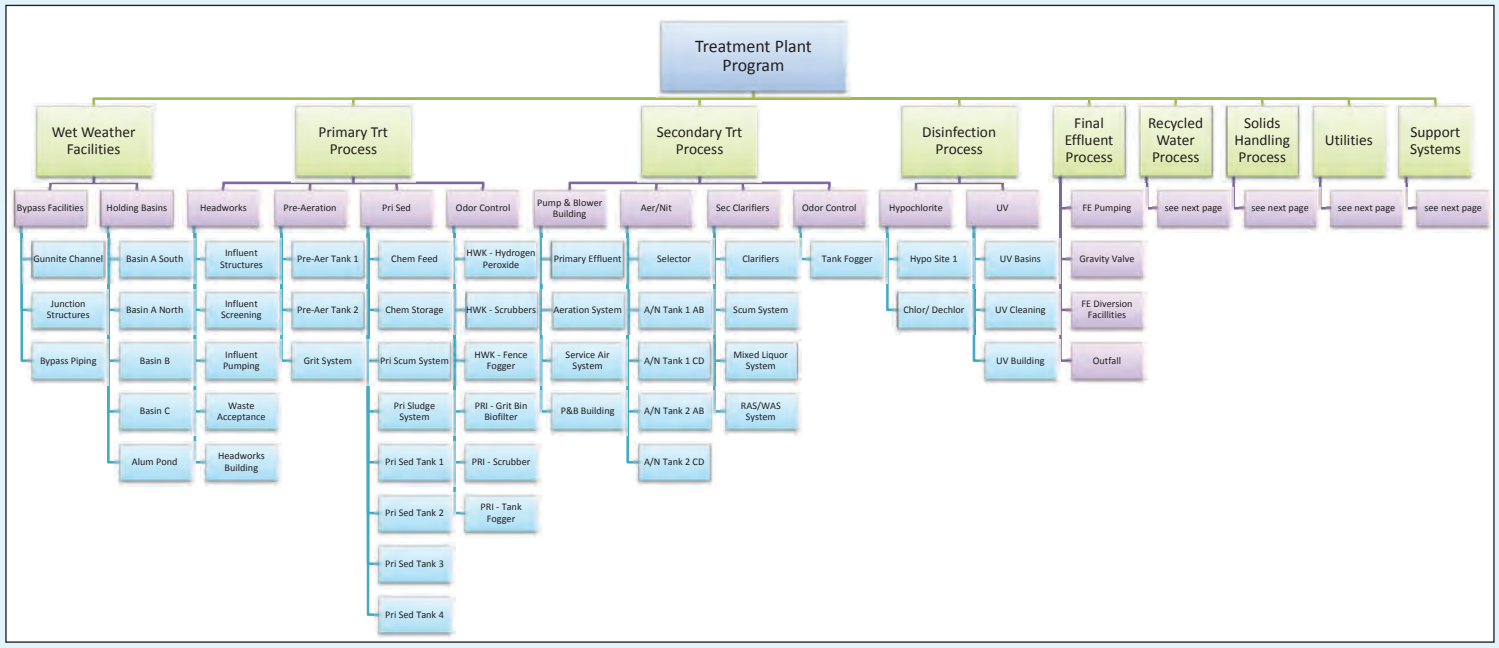

Figure 1: Asset hierarchy

Central Contra Costa Sanitary District (Central San) is an organization providing wastewater collection and treatment for over 481,600 residents and 3,000 businesses in Contra Costa County, California, located about 25 miles from San Francisco. Central San's main facility is a treatment plant in Martinez, California, processing an average of 32 million gallons per day of municipal wastewater and providing up to three million gallons per day of recycled water to several businesses in the community.

In 2014, Central San started formalizing an asset management policy, then developing an asset management implementation plan. The plan was developed to align with the vision, mission and values of Central San, and translated to a strategic plan with goals that create the path to success.

The first step toward improving reliability was to review and improve the data stored in the computerized maintenance management system (CMMS). The information in records was gathered to assign install dates, service life, asset cost, work area and asset type. To facilitate characterization of the assets and the plant's processes, a process-based asset hierarchy was developed, as shown in Figure 1.

> "Data integrity is vitally important"

Attributes critical for improving the reliability program included installation date; warranty data; standard nameplate data; condition score; consequence of failure (COF); likelihood of failure (LOF); and business risk exposure (BRE).

Data integrity is vitally important, therefore, Central San added components to the CMMS, such as a color-coded quality assurance/quality control (QA/QC) panel, which summarizes the status of key areas of the work order that must be completed. Also added were fields for regulatory and safety compliance to identify the work order as such. A third improvement was adding a field for planner or geographic information system (GIS) updates. When these boxes are marked, the CMMS sends an e-mail to the appropriate group identifying changes for things, such as to update the standard operating procedures (SOP), the asset attribute, or remove and replace assets.

Concurrently with the CMMS implementation, and what would become the cornerstone of the maintenance strategy, Central San piloted a reliability-centered maintenance (RCM) approach. The pilot was led by Anthony "Mac" Smith, a pioneer in RCM. The maintenance division's goal was to formulate a systematic approach to developing a comprehensive maintenance program based on asset criticality and consequence of failure. As was found through the pilot, RCM is a qualitative decision methodology that identifies the most effective preventative maintenance (PM) task for treatment plant equipment and systems. Additionally, RCM with a CMMS establishes a repeatable program with documented processes and procedures.

Prior to jumping into an analysis, the maintenance team spent a week with the consultant and his company discussing Central San's current maintenance practices and issues, then

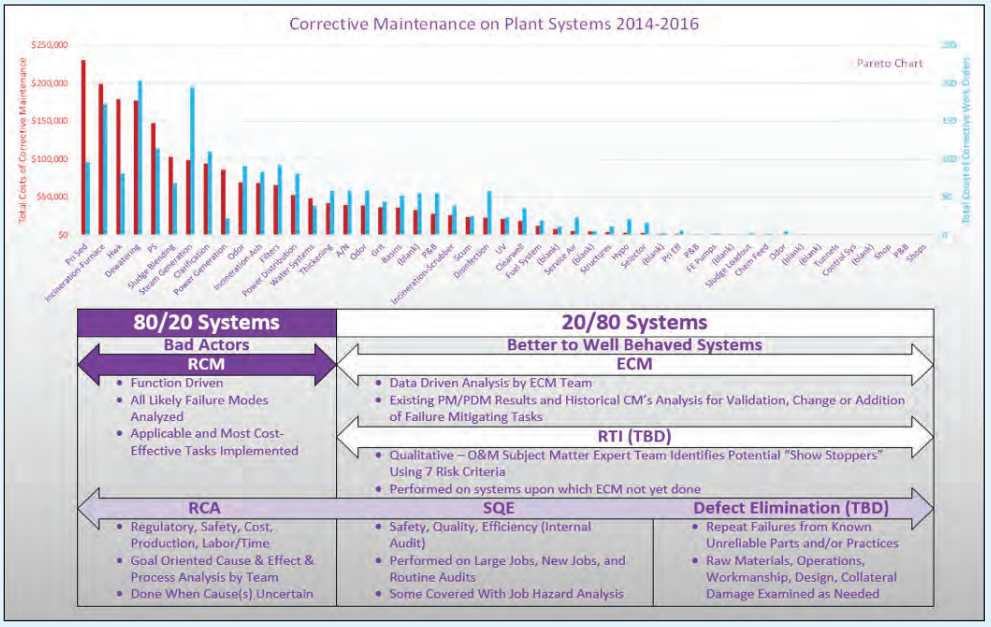

Figure 2: Reliability strategic framework

learning classical RCM methodology. The discussion covered details of the seven step RCM systems analysis process and case histories. Included was the strategy for the deployment and use of RCM, experienced-centered maintenance (ECM) analysis, defect elimination (DE) and root cause analysis (RCA).

Plant maintenance developed the strategic framework, shown in Figure 2, which would become the road map of Central San's efforts to optimize its maintenance program. After completing the RCM analysis, the organization piloted an experienced-centered maintenance (ECM) analysis on the primary process, ultraviolet (UV) system and boiler feedwater system, all with successful results.

The strategic framework identifies Central San's approach moving forward to perform RCM analysis on the 20 percent of assets that are "eating our lunch," optimize the PM program for the better behaved system (i.e., the 80 percent of assets) by performing an ECM analysis, and perform DE as the situation or opportunities arise. Also, at any time, or as needed for new or complex tasks, perform an internal audit for safety, quality and effectiveness (SQE) of the tasks. And finally, perform RCA on regulatory, safety, or high impact operational failures.

Identifying ways equipment can fail was well understood after completing the RCM pilots, so another proactive way to eliminate them was created. To address failures caused by the five sources identified by the Uptime® Elements, a DE program was developed. This program would be used across the board on both well behaved and bad actors, as needed. Potential triggers for defective elimination were discussed and used, such as failure before the asset's useful life, repeat failures showing up on the bad actors list, when there's more than one reactive work order with a priority of "1" or "2" on a specific asset between PM tasks, or simply as an optimization idea.

With an already strong PM program running, a logical stepping point was to expand the use of condition-based maintenance (CBM) and predictive maintenance (PdM) to complement the existing PM program by incorporating asset condition monitoring (ACM). It is fundamental to RCM to

Figure 3: Top, smooth transition eliminates buildup points shown in bottom image

Asset Maintenance Information

Asset: **72101 Furnace 1**

Cityworks Work Orders

Show 10 entries

Search:

No.	Status	Date	Requested By	Description	Instructions	Comments	Compliance WO?
463382	COMPLETE	08/29/2019	N/A	Reliability Analysis	Perform RCA on Furnace 1	**Wellner, David** **08/29/2019 7:23 AM** The open output to the emergency bypass damper on Multiple Hearth Furnace (MHF) No. 1 was inadvertently raised while the damper selector switch in the Control Room was set to "Natural Draft," directly opening the bypass damper.	
460628	CLOSED	07/29/2019 12:00	Harris, Garland	Troubleshoot/Repair	Tim F. worked on AGM module #1 furnace. hearth 1	**Francis, Timothy** **07/29/2019 8:25 AM** AGM module temp. dropped to 500 degrees. Replaced	

Figure 4: Work order history

Asset Management Documents

Asset: **72101 Furnace 1**

Name	Description	Author	Date	View Document
Condition Assessment				
72101 - MHF 1 Inspection Rpt - 2014.pdf	PO 41353	BSP Thermal Systems	03/25/2014	
72101, 74136-40, 97400-1 NG Leak Test Log.doc	Plant Operations Department MAINTENANCE DIVISION NG MAINTENANCE LEAK TEST LOG	PJ Tunrham	12/14/2006	
Furnace 1 Rabble Teeth - Condition Assess 2012.PDF	2012 Furnace 1 (Turn-aroound work) Rabble Teeth Condition	PJ Turnham	08/01/2012	
O&M Manual				
O&M - Furnaces & Scrubbers.pdf	Furnace & Scrubbers O&M Manual	CCCSD	01/17/2006	
Permit				
Permit to Operate BAAQMD (all) 2014 1201.pdf	Title V Permit to Operate #A0907	BAAQMD	12/01/2014	
Procedure				
72101 HECP Long term.pdf	HECP	PJ Turnham	10/15/2010	
72101 HECP Long term.pdf	HECP	PJ Turnham	10/15/2010	
72101 HECP Offline Long term.pdf	HECP	PJ Turnham	10/15/2010	
72101 HECP Offline Long term.pdf	HECP	PJ Turnham	10/15/2010	
Schematic				

Figure 5: Asset information

Asset-Related ȣ b Information

Jobs Linked to Legacy ID: **72101 Furnace 1**

Job No.	Title	Job Type
X3694D	Incinerator Systems Repairs and Modifications - Incinerator Equipment Access	Original Construction
7193	Furnace Air Inlet Improvements Project	Improvement
X3694B	Bottom Ash Control Panel	Original Construction
X3694E	Incinerator Ash Handling System Improvements	Original Construction
X3694C	Incinerator Systems Repairs and Modifications - Incinerator Burner Piping Systems	Original Construction
6108	Scum System Odor Control Project	Improvement
X3760	Water Reclamation Plant - Stage 5A - Phase 1	Original Construction
X3694A	Waste Heat Boiler Feedwater Control System Mechanical Modifications (Boiler Area)	Original Construction

Figure 6: Project documents

apply the most applicable and effective task that most often leads to the least intrusive choice of tasks. Existing CBM tasks were updated and new PdM methods were identified and implemented.

Another crucial element identified was for the maintenance staff to be actively engaged in all phases of the assets' lifecycles to assure equipment maintainability and reliability. It became extremely important for maintenance to engage in the planning, design and construction phases of each of Central San's capital projects, including participation with the selection of the design teams.

A major component of the new involvement with capital projects was a comprehensive asset handoff protocol to ensure assets and their documentation were properly transferred from the capital projects division to the relevant team once installation work was completed. This defined what information is reviewed and passed onto operations and maintenance (O&M), as well as when during the project phases. Some of the changes included detailed workflows, which identified key timelines for the development of asset nameplate data, PM tasks, spares, and reviewing training materials and agendas. The protocol also lent itself to using failure mode and effects analysis (FMEA) early on when staff is engaged in planning and design talks. Also key to the capital project review process was the use of 3-D modeling in planning and design. This helps with ensuring new equipment is serviceable and aids in identifying any obstacles by being able to virtually walk through the layout. This provides visualization of accessing and working on the equipment.

Data and document management was paramount to these efforts. Engineers, operators and maintenance staff needed to readily access information to work effectively and efficiently. A geoportal allows one to easily navigate back and forth between other databases and the CMMS to find assets and other important asset information.

- Work order history (Figure 4) allows access to history in the CMMS for both the current and previous system.
- Asset management information (Figure 5) includes records, such as job plans, condition assessments, O&M documents, etc.
- Project documents (Figure 6) list all project work done on the asset and includes associated documents.

This has proven to be an invaluable resource for many work groups as it compiles information from all the different databases and software systems Central San uses to allow easy access to virtually all the information associated with any given asset.

It is well understood that staff members are the key to success. To meet the challenges when it comes to recruiting and retaining skilled technicians who can maintain an industrial complex, the following steps were taken:

- The succession planning committee developed an action plan for each division.

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Bad Actors

ftor7/1/2018 tihrough3/1/2019

Asseti ID	Legacy ID	RM WO Counti	RM WO Costi	Asseti Costi	% RM WO Costi/Asseti Costi	Condition	Condition Datie	Instiall Datie	Service Lifte	Consequence oft Failure	Possibilitiy oft Failure	Business Risk Exposure	Process	Sub Process	Systiem	Entitiy Type
1431	47000 Clearwell Basin	5	$3,730.69	$13,300,000.00	0%	40.00	2014-08-08	1978-01-19	300	3	4	12	10	Clearwell	ClrwlStrcti	Basin
5536	74139 Aux Boiler 1	15	$23,602.54	$248,000.00	0%	15.00	2014-08-08	1984-09-01	35	8	8	64	7	StieamGene	AuxBoilers	Boiler
5537	74140 Aux Boiler 2	17	$18,156.69	$248,000.00	0%	20.00	2014-08-08	1984-09-01	35	8	8	64	7	StieamGene	AuxBoilers	Boiler
10	10000 HOB	19	$6,291.99	$3,000,000.00	0%	30.00	2014-08-08	1988-05-01	75	1	3	3	12	HOB	Stiructiures	Building
1898	52300 Planti Operations Building	6	$7,003.58	$5,000,000.00	0%	40.00	2014-08-08	1972-01-01	60	2	4	8	12	PBB	Stiructiures	Building
2569	71999 SCB	10	$7,897.11	$15,000,000.00	0%	80.00	2014-08-08	1972-01-01	60	5	8	40	6	SldgThick	Stiructiures	Building
3787	96000 HHW Building	4	$1,098.78	$5,797,000.00	0%	20.00	2014-08-08	1997-07-01	60	1	2	2	12	HHW	Stiructiures	Building
909	35000 Laboratiory	12	$5,042.33	$5,065,000.00	0%	20.00	2014-08-08	2001-08-06	60	7	2	14	12	Lab	Stiructiures	Building
3021	74004 Centiriftuge Position 1	10	$5,039.40	$149,000.00	0%	60.00	2014-08-08	1999-05-20	20	5	6	30	8	IT	PrcCtirl	Centiriftuge
3022	74005 Centiriftuge Position 2	8	$7,379.67	$149,000.00	0%	60.00	2014-08-08	1999-05-20	20	5	6	30	6	SldgDewati	Centiriftuge	Centiriftuge
3023	74006 Centiriftuge Position 3	25	$12,929.54	$149,000.00	0%	60.00	2014-08-08	1999-05-20	20	5	6	30	6	SldgDewati	Centiriftuge	Centiriftuge
3024	74007 Centiriftuge Position 4	10	$6,528.24	$149,000.00	0%	60.00	2014-08-08	1999-05-20	20	5	6	30	6	SldgDewati	Centiriftuge	Centiriftuge
667	31234 D O Probe/Mon-1D	4	$4,284.81	$1,000.00	4%	100.00	2014-08-08	2000-07-28	20	8	10	80	2	Aera/Nitir	ANBasins	Instirumentis
523	25120 Motior, Inftuenti Pump 1	4	$4,680.71	$80,000.00	0%	10.00	2018-10-05	1994-03-01	35	10	1	10	1	Headworks	InftPmpg	Motior/Engine
5953	97407 1W Piping Systiem	7	$1,775.90	$767,000.00	0%	50.00	2014-08-08	1977-01-01	50	8	5	40	7	WtirSysti	1W	Piping Systiem
1117	37013 Hypo Pump 4 (17.5/0.5HF	5	$4,461.03	$2,000.00	2%	80.00	2015-10-30	2005-09-29	35	6	3	18	3	Hypoch	HypoSitie1	Pump
2790	73002 Cake Pump 2	4	$8,835.11	$83,000.00	0%	60.00	2015-10-30	1991-04-18	35	5	8	40	6	SldgDewati	CakePumps	Pump
520	25110 Inftuenti Pump 1	4	$59,415.51	$300,001.00	0%	10.00	2018-10-15	1993-09-20	35	10	1	10	1	Headworks	InftPmpg	Pump
698	31900 FE Sampler	9	$5,379.39	$1,482.00	4%	100.00	2014-08-08	2014-12-02	15	6	10	60	8	Equipmenti	Lab	Sampler
387	22202 Drive, Long Flighti Collecti	4	$1,408.25	$16,000.00	0%	5.00	2018-09-23	2015-06-19	20	9	1	9	1	PriSed	PriSedBsn	Scum Sludge Collectior
5455	200000 Treatimenti Planti	6	$9,106.07			40.00	2014-08-08	1974-09-01	100	10	3	30	11	DistiProp		Sitie
6478	72117 Boiler H2O Softener A	5	$5,670.15	$15,000.00	0%	10.00	2018-11-20	2017-11-20	20	8	1	8	7	PwrGene	Cogen	Softener
6479	72118 Boiler H2O Softener B	4	$3,180.10	$15,000.00	0%	10.00	2018-11-20	2017-11-20	20	8	1	8	7	PwrGene	Cogen	Softener
1643	51220 Aer Uniti 2 Turbine	6	$2,450.70	$336,000.00	0%	60.00	2015-10-30	2002-10-01	35	7	2	14	2	Aera/Nitir	AerSys	Stieam Turbine
1018	36113 UV Lamp Bank/PDC 3611:	4	$3,416.80	$21,000.00	0%	60.00	2015-10-30	1998-02-05	35	7	4	28	3	UV	UVBsns	UV Equipmenti
1021	36121 UV Lamp Bank/PDC 3612:	4	$5,165.30	$21,000.00	0%	60.00	2015-10-30	1998-02-05	35	7	4	28	3	UV	UVBsns	UV Equipmenti

Figure 7: Repeat failures tracked in CMMS

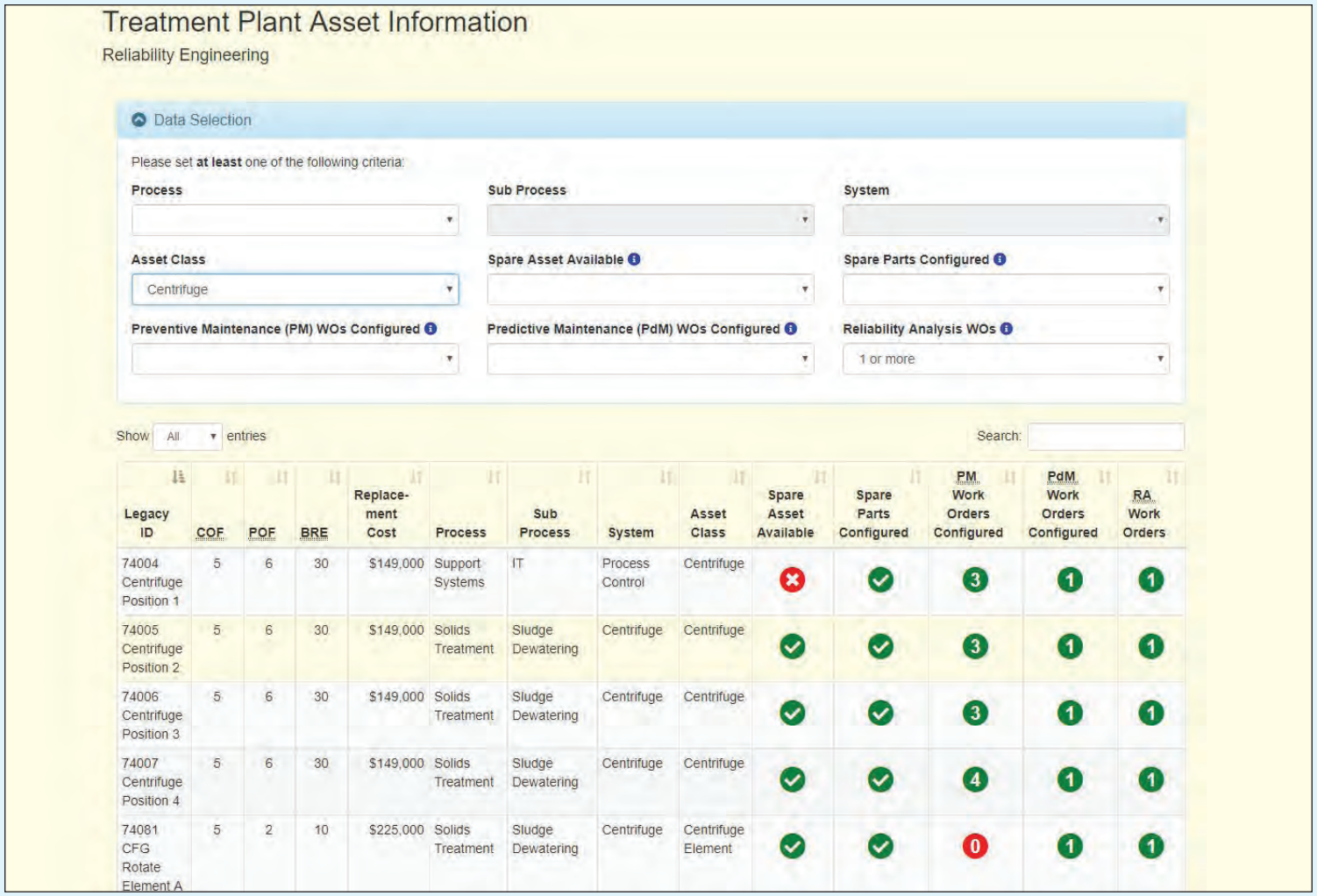


Figure 8: Query report allows for easy review of any asset

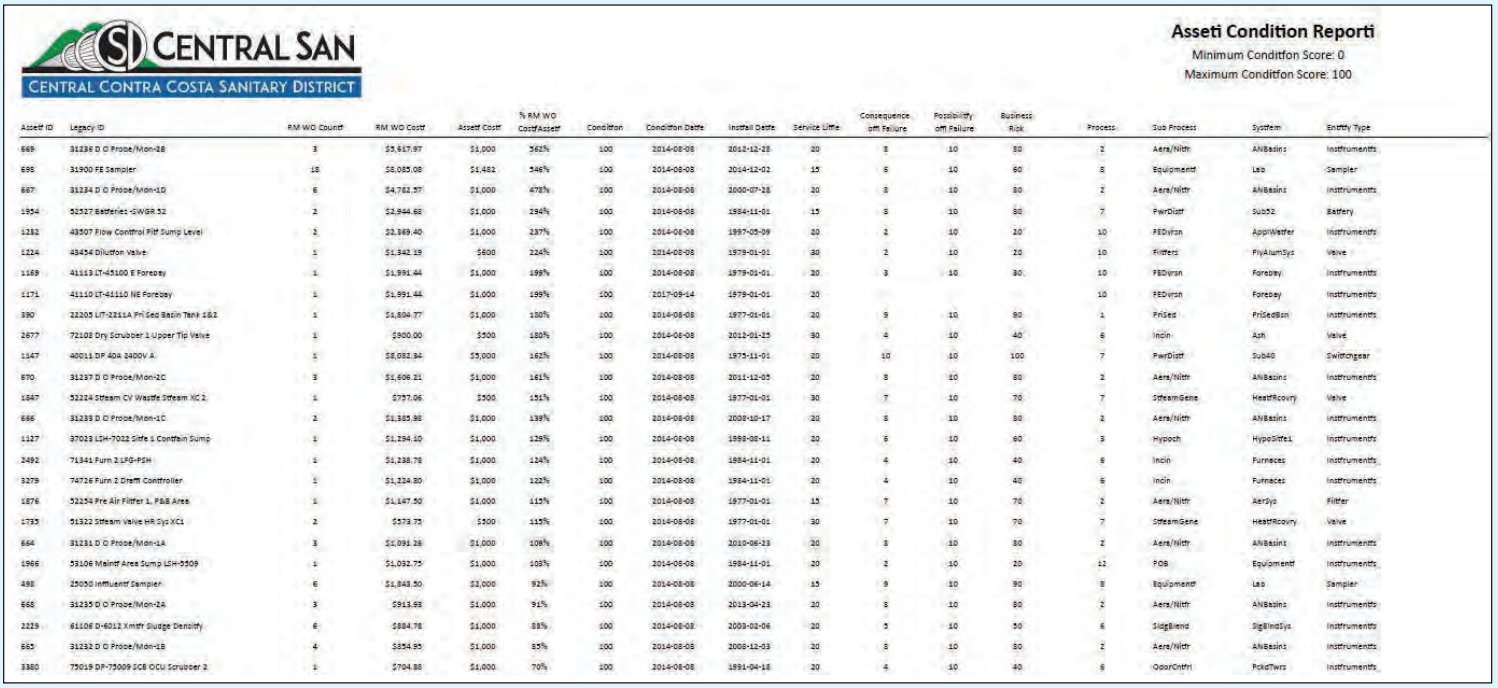


Figure 9: Asset condition report gives latest values for COF, LOF, BRE, cost to date charged to asset and other important information

> Identifying ways equipment can fail was well understood after completing the RCM pilots

UPTIME AWARD WINNER:

2018 Best Reliability Engineering for Maintenance Program

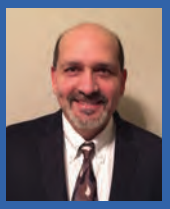
- Training and development checklists were produced to identify knowledge, skills and abilities needed by staff for each craft shop. Each training and development checklist discusses expectations of the job, outlines cross-functioning, broad-based training, includes a development road map and provides a tracking document.
- Internal programs and resources were developed, which included a supervisor academy, mentorship program, leadership academy and several other development opportunities.

Access to information was crucial for decision-making during implementation of the asset management program and it continues to be an extremely valuable resource in Central San's day-to-day operations and maintenance. A variety of reports (Figures 7-9) are accessible through the CMMS and geoportal. The report list can be generated using a custom selected parameter.

One report is the query, shown in Figure 8. The query report provides a quick review of any asset for spare units, spare parts, PM tasks, PdM tasks, and if the asset ever had an RCM, PM optimization (PMO), RCA, or other type of assessment performed on it. It is a powerful tool that helps Central San continuously improve its maintenance program. The report has dynamic links to the associated documents.

Workflow monitoring can be done by supervisors and technicians in a variety of "in-boxes," which can be configured to display on the user's home screen in the CMMS.

Because of these and other initiatives, Central San has made tremendous gains in operational reliability and efficiency, which was recognized by *Uptime* magazine with the 2018 Best Reliability Engineering for Maintenance Program award. All objectives continue to be in support of and in alignment with the organization's principal aim of its mission and vision: "To protect public health and the environment" and "to be a high performance organization that provides exceptional customer service and regulatory compliance at responsible rates."



***Neil Meyer**, CRL, is the Maintenance Division Manager at Central Contra Costa Sanitary District. Neil has 30 plus years of diversified experience in engineering, operations and maintenance of water and wastewater facilities and systems, including various aspects of design, operations and maintenance of treatment plants, facilities and systems. www.centralsan.org*

***Clint Shima**, P.E., Senior Engineer, leads the reliability engineering group at Central Contra Costa Sanitary District. Clint has 16 years of experience in the wastewater industry and has experience in work on cogeneration, ultraviolet disinfection and multiple hearth incinerators. www.centralsan.org*

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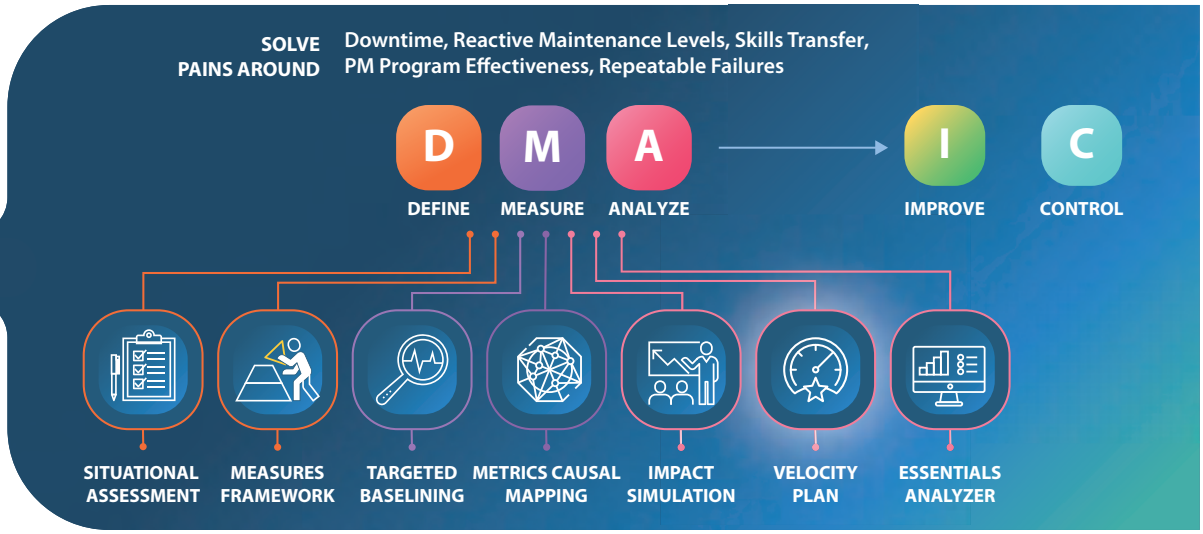

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SIMULATION TRAINING TO TO DIGITALLY DEVELOP THE NEXT MANUFACTURING WORKFORCE

Debra Schug

With automation and artificial intelligence changing the nature of manufacturing work, many of the skills necessary to operate the plants of the future will be completely changing in the next decade.

Key to plant operations running smoothly are the maintenance professionals tasked with keeping the production line equipment in good repair. But attaining the best staff can be challenging, given the current manufacturing skills gap. Deloitte's new study estimates nearly 4.6 million manufacturing jobs will likely need to be filled in the next decade. Yet, due to the lack of skilled workers, over two million of those jobs are predicted to stay open.

According to a report from McKinsey Global Institute's research program, more than half of the companies surveyed said they would have to help build the workforce of the future. In order to do that, businesses have five options: retrain and teach employees' the skills; redeploy or redefine work tasks and processes; hire people with the right skills; contract external temporary workers; and release workers without the necessary skills by either attrition or layoffs.

For those manufacturers looking to train either new or existing workers, a good technical program that is cost-effective and ensures employees develop the skills their jobs demand will be an imperative. Therefore, businesses will have to take a critical look at competency-based teaching and learning methods.

The Learning Pyramid for Manufacturers

A common trope used to explain the ways in which people gain knowledge is the learning pyramid. This approach breaks up different learning activities into categories, such as lecturing, reading, practicing, etc. Studies show that those using passive ways of learning, such as listening in a classroom or reading a textbook, retain less of the material than those using active methods, such as practicing a task or teaching others how to do it.

In manufacturing environments, using demonstration to train personnel is typically referred to as the buddy system. This is when a seasoned professional takes a rookie onto the plant floor and shows him or her how to troubleshoot problems and fix equipment. In terms of retention rates, it is more effective than a classroom setting, but the method does come with drawbacks, namely the passing down of both good and bad habits to a nascent employee.

Teaching by having learners practice a skill produces some of the best retention rates. However, in a manufacturing environment where there is both expensive and potentially dangerous equipment, having a newbie take a shot at fixing machinery might not be the most cost-effective training method.

This is where simulation can help. In simulation training, real conditions are artificially represented as an instructional strategy for students to learn and practice problem-solving skills in a realistic environment, but without the risk of danger. For this reason, simulation training is particularly useful in applications, such as the manufacturing plant floor, where trainees could cause harm to others or themselves, or damage expensive equipment.

Simulation Tools for Training

For high rates of engagement and maximum material retention, learners interacting with simulation tools can practice on equipment and observe the changes they make, allowing them to explore "what if" scenarios and test hypotheses. Plus, practicing activities is done in a safe way, so

Figure 1: New 3-D simulation tools include PLC sensors that focus on teaching industrial PLC analog inputs, PLCs and associated devices

> In simulation training, real conditions are artificially represented as an instructional strategy for students to learn and practice problem-solving skills in a realistic environment, but without the risk of danger

no students can actually harm themselves, others, or equipment.

Moreover, simulation software that employs cutting-edge graphics and video game techniques can use gamification methods to teach. Gamification is the concept of using game design elements to motivate participation and engagement in some existing entity, whether it be with a website, app, brand, etc.

In training applications, gamification elements can take the form of leaderboards, merit badges and buttons to encourage peer competition and motivate both new workers and existing staff to learn more skills. Using gamification to teach manufacturing workers' skills, such as how to operate programmable logic controllers (PLCs) and sensors, can be effective, but must be designed properly so trainees are not just interacting with a game, but with actual concepts.

By using instructional 3-D simulation tools, a more immersive experience can be provided for those learning how to operate advanced automated equipment and solve electrical maintenance problems on the plant floor. For instance, when trainees interact with 3-D simulation tools, they can look around a simulated plant environment and make observations, such as if there is water on the floor, and see how these conditions affect operations. This element provides observational stimulation that is important for the development of the critical thinking skills required of a manufacturing staff.

Attracting a Younger Generation of Manufacturers with Simulation

Another benefit of using digital simulation tools is to attract a younger generation to the manufacturing workforce. The manufacturing industry had been in a decline for the last few decades in Western countries, and these jobs were not seen as promising nor desirable.

Now, the modern production plant is employing advanced automation and cleaner technology, so the vision of manufacturing being dark and dirty is quickly becoming antiquated. Even so, millennial and Gen Z job seekers are largely not looking to manufacturing as a career path.

Therefore, manufacturers that use digital simulation training can signal to those entering the workforce that they are ready for the future and will prepare their workers with the skills needed to succeed. Plus, the younger generations have grown up playing video games and are comfortable using and learning from them.

Additionally, the new generation of workers want a custom experience in their training, not just a one-size-fits-all approach. Younger people also want training to be on multiple platforms to enable training whenever and wherever. Additionally, the training needs to be an immersive and competitive experience involving gamification elements, as previously described.

Simulation training tools that incorporate artificial intelligence (AI) technologies can help identify strengths and weaknesses of a user and plan the best route of learning for each individual. This technology can help learners more effectively reach their goals by matching their progress and performance data with the difficulty of the training provided.

Also, having AI helps management train and assess workers' skill levels. This helps busy human resources departments in screening manufacturing applicants without requiring them to be physically present on-site. For example, a digital assessment test can be created and sent to job applicants to gather information about their technical skill level before spending time and money to bring them in for interviews.

Upskill Existing Workers

Baby boomers are retiring in droves, which is not only leaving open positions behind them, but also taking out years of institutional knowledge from organizations. On the other hand, older workers who are still in the workforce and dealing with increasing advanced automation in plants need upskilling quickly.

However, finding ways to inspire and motivate older workers who have a wealth of knowledge, but may be resistant to change and new ways of doing things, can be challenging. Remember, there is a benefit to keeping the wealth of legacy manufacturing knowledge to inform digital processes in the plant. Therefore, gamification also can be useful in training older workers, as well as the next generation.

For operations that are becoming more automated, heed this warning: If new technology is added without making any changes to training or other processes, the organization will just consist of the same people with the same skills running the plant. At best, the new investment will be either used improperly or not up to its potential. At worst, the new technology won't be used at all. Training is key for incorporating new technology that will transform your organization.

Debra Schug *is a freelance writer, as well as the communications manager for Simutech Multimedia, a company providing simulation-based training tools for the manufacturing industry.*
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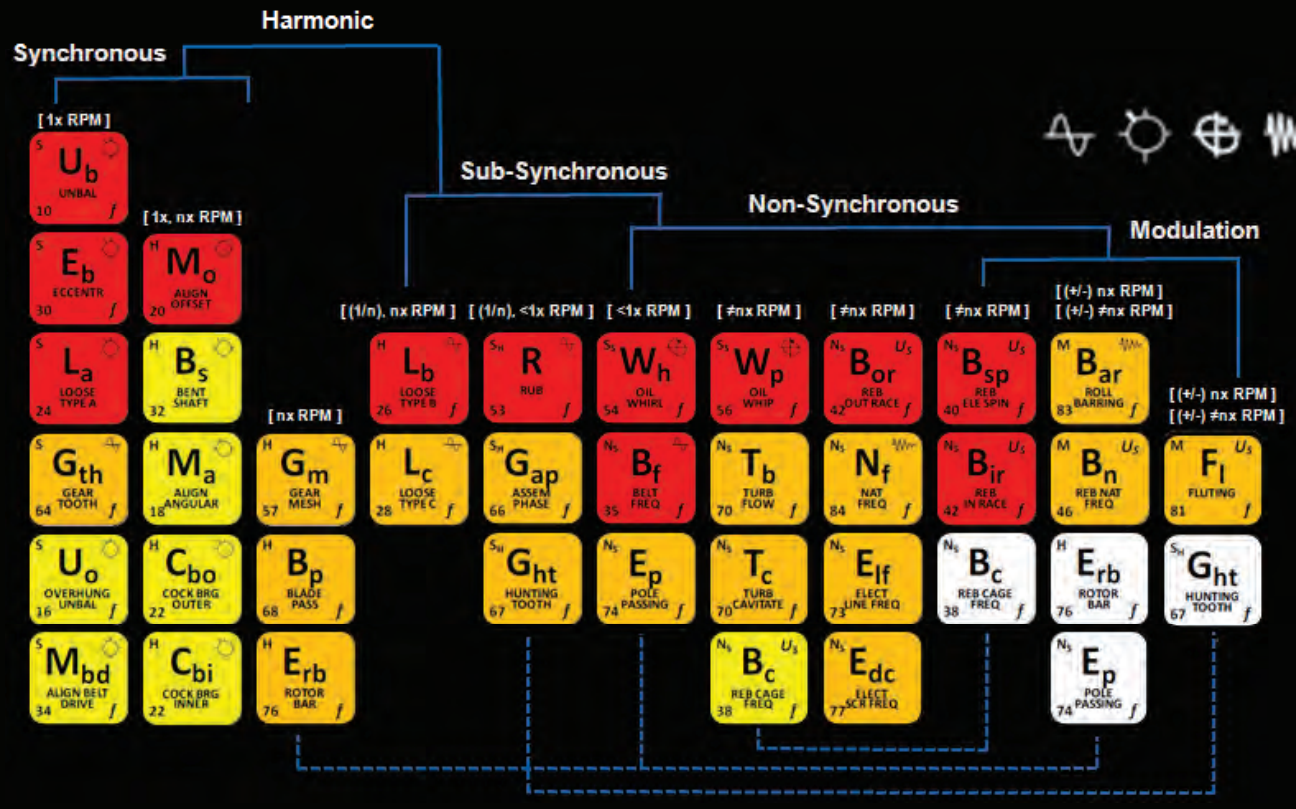

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THE PATH TO LUBRICATION RELIABILITY

Following the 5 Rights of Lubrication Is Only the Beginning of the Journey

Chris Tindell

Two wrongs don't make a right. This proverb states that repaying a wrong deed with another wrong deed doesn't justify a wrong action. However, can five rights make a wrong? The phrase, "the five rights of lubrication," has earned its place in the dogma of reliability slogans and buzz words. They are: The right type, the right quality, the right amount, the right place and at the right time. This concise list outlines critical steps for achieving reliable lubrication, but more can be done to achieve lubrication reliability in a machine.

1. THE RIGHT TYPE OF LUBRICANT

"You cannot maintain your way to reliability." This quote from Reliabilityweb.com® is spot on. Plants and other facilities have to plan for reliability from the beginning. Installed assets are chosen because of their ability to be reliable. Maintenance is a way to keep these assets running optimally. This includes the lubricants selected for each asset type.

Selecting the ideal lubricant type for the application and the asset is the first step. This choice includes determining primary factors, such as:

- Viscosity;
- Additives in the formulation;
- The equipment's operating loads, speed and temperature.

Without considering overall system reliability, full plant reliability cannot be achieved. Determining the right type can minimize wear and improve uptime.

2. THE RIGHT QUALITY OF STORAGE AND HANDLING

Quality does not just happen. It requires a deliberate process to control the storage and handling of lubricants from warehouse receiving to delivery at the machine. The steps are simple and easy to measure. That is exactly why it must be measured. Simplicity can lead to complacency. When handling lubricants, only one broken link in the chain of custody can render all prior steps useless.

Lubricants must be tested at receiving to ensure they meet the defined specifications before they are mixed in the storage systems. Simple ASTM tests measure the properties and the cleanliness of the fluid. Then, they most likely need to be filtered and polished to meet the quality specifications for the equipment. The transfer containers must be clean and sealed to prevent any contamination as the lubricant is transferred to the asset.

> When handling lubricants, only one broken link in the chain of custody can render all prior steps useless

3. JUST THE RIGHT AMOUNT

The right amount follows the Goldilocks paradigm of finding the level that is just right. Too little lubricant is an obvious problem, but more is not necessarily better. Too much oil or grease can be just as destructive to systems. Extra lubricant volumes may hinder oil slinger rings, as well as splash lube systems. Excess volume also increases bearing operating temperatures and can blow out oil seals.

4. THE RIGHT PLACE

Ensuring lubricant reaches the right place is not as simple as it may sound. Many lubricants are produced in different viscosities. The also have multiple additive packages required for specific machine conditions.

Care must be taken to ensure lubricant containers are color coded and labeled by type. This helps teams prevent mixing lubricants in storage and transfer containers. The same precautions also must be used when labeling the matching points where the lubricant is added to the machines.

CAN OIL CHANGES BE ELIMINATED?

Oil changes because of contamination may be eliminated or, at the very least, minimized with noncontact, compound labyrinth bearing isolators. They allow for longer periods between oil changes and less oil used. The design of this isolator type, with expeller technology, forces any contaminants out of the seal with centrifugal force. They are moved away from the bearing and lubricant and out of the rotating asset.

When equipment is static or shut down, contaminants enter the bearing housing. A typical bearing housing interacts with the surrounding environment by always attempting to achieve equilibrium (see Figure 1). Under dynamic conditions, the housing vents to the atmosphere because it is at a higher temperature and pressure than the atmospheric side.

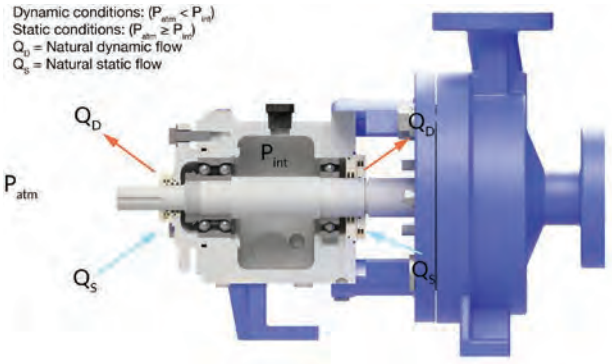

Figure 1: Air flow during shutdown

When the machine shuts down, the internal housing cools and because cool air is denser than warm, the bearing housing consumes the air inside and begins to draw air from the atmospheric side as it moves to equilibrium. Moisture and dust accompany this external air. As the contacting O-rings of traditional isolators wear, even more contaminants enter the housing, and therefore the lubricant. These contaminants continue to migrate into the bearing's housing unless the seal is replaced or a different design is chosen.

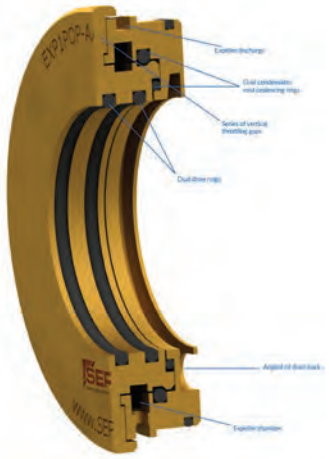

Figure 2: The components of compound labyrinth bearing isolators

Noncontact bearing isolators may solve this problem. However, static sealing can present even more of a challenge for a true noncontact seal, such as compound labyrinth bearing isolators. With these seals, the bearing housing still takes in air under static conditions. But, in contrast to traditional isolators, as airborne contaminants and vapor enter, noncontact oil seals break down their energy as they are forced through a series of vertical, throttling gaps (see Figure 2). There, contaminants are captured within the internal condensate trap. They drain out through a small static weep hole at the six o'clock position of the bearing's isolator.

5. THE RIGHT TIME

Timing provides the biggest opportunity to improve reliability. Yet, determining the right time to replace the lubricant can be the most subjective. The most diverse opinions and variability from one plant to another involves the timing of lubricant changes.

For example, Company A, B and C may all have the same equipment type in the same operating environments. However, Company A changes the oil every quarter. Company B changes the oil once per year. Company C changes the oil every three years. Why? With this much variability, more reliability engineers and maintenance managers should be asking this question.

If All Is Done Right, What Can Go Wrong?

If the lubricant makes it into the machine clean and fit for use and the operating environment is the same, how does it become contaminated? The answer lies in the oil seals, breathers, filters, or some combination of these components. Seals, breathers and filters have a finite lifetime.

If these components are not maintained properly, the lubricant becomes contaminated and bearing failure begins. Filter life can be measured using differential pressure. These components can be replaced when the pressure differential indicates.

Also, many breathers use a color changing desiccant material to indicate their effective life. They can then be replaced as needed. Deciding when to replace them is not a guessing game.

The function of oil seals is to keep lubricants in and contamination out. Oil leakage is easy to see and measure. Determining the lubricant's contamination level is more difficult. However, oil testing for contamination is available and is the only way to know whether an oil seal is operating effectively.

Oil seal performance can be measured. Oil analysis reveals how successfully the seal operates and helps determine functional failure rates. Understanding these failure rates is essential to the more ambiguous fifth right of lubrication, which is to determine the right time to change the oil. This analysis replaces the subjective process, which creates a lot of variability across the industry, with a more objective, precise process for measuring oil life and performance. You cannot improve what you cannot measure. This is the biggest opportunity to improve equipment performance.

The Financial Impact

Companies spend considerable money to ensure proper lubrication. The correct color-coded containers and transfer containers are purchased. Filters and breathers are also kept in inventory. Therefore, these components can be replaced as soon as they indicate the end of their life.

In addition, personnel are trained to know the proper processes and procedures. They learn how to store and handle lubricants from warehouse receiving to delivery at the machine. They learn how much lubricant is added to each machine.

After spending all this money, time and effort, an ineffective oil seal should not be the reason equipment damage or failure occurs.

***Chris Tindell**, CMRP, is a regional business manager for Sealing Equipment Products Co., Inc. (SEPCO). Chris has more than 20 years of experience in reliability consulting, training and troubleshooting equipment, and has worked in many manufacturing industries, auditing and optimizing PSM maintenance programs and providing training on RCM and lean manufacturing strategies. www.sepco.com*

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As told by Jim Hall, CRL, Exec. Dir., The Ultrasound Institute

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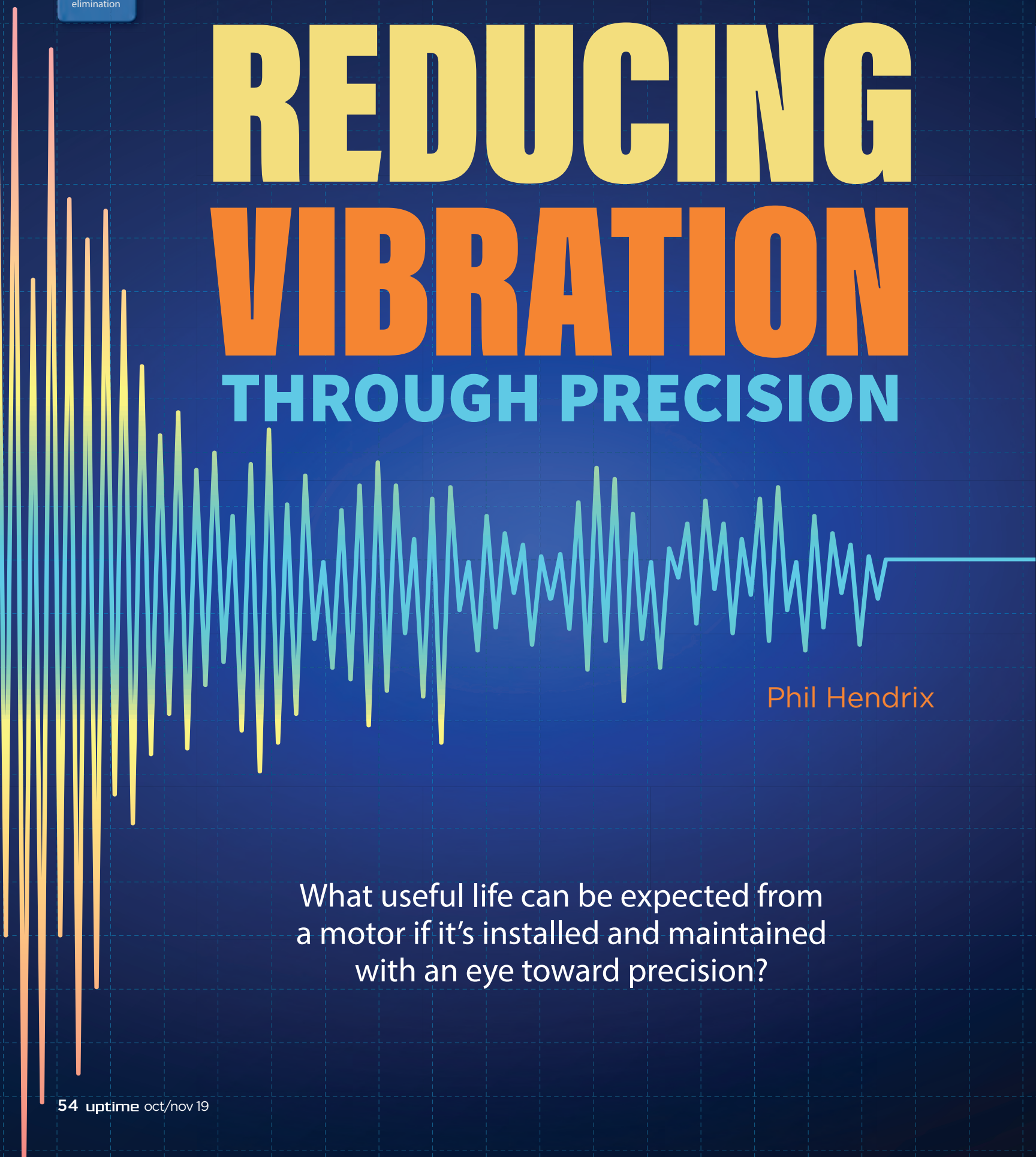
REDUCING VIBRATION THROUGH PRECISION



Phil Hendrix

What useful life can be expected from a motor if it's installed and maintained with an eye toward precision?

THE RULE OF THUMB IS:

Lower vibration by 20 percent and double the life of bearings

Reducing vibration no doubt reduces fatigue and failure, as proven by Dr. Wernher von Braun and leading reliability engineering schools, therefore increasing a component's life span. However, 80 to 90 percent of maintenance professionals pay little to no attention to this initially. Yet, it's the easiest path to lower costs, improved uptime and improved morale. Keeping an eye on precision through vibration reduction has a lasting effect on numerous mechanisms that play a large role in a company's success.

Figure 1 shows actual results obtained by implementing and **insisting** on precision installation and maintenance at the world's largest pulp and paper mill.

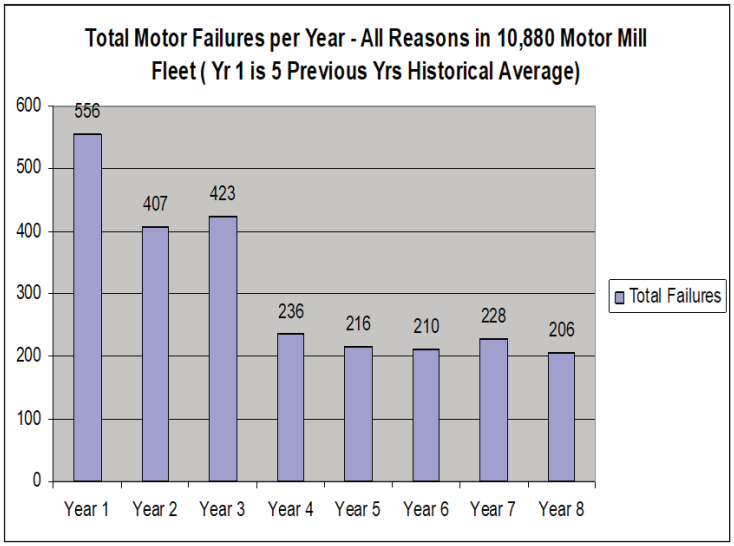
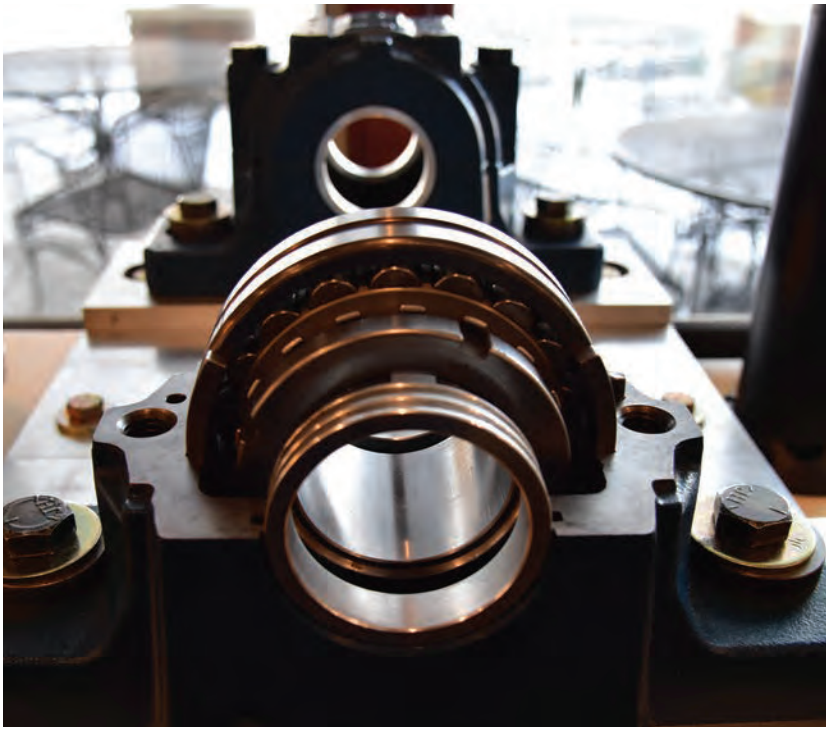


Figure 1: Results from precision installation and maintenance

Prior to precision state, the average life of the mill's motors was 19.6 years. Concentrating efforts on the troublesome and costly motor positions first, and insisting that the hundreds of others vibrating at higher than the newly established minimum acceptable levels be put into a "precision state," easily more than doubled the life of the electric motors to an average life of 46.1 years, or conversely, cut the failure rate in half in just four years. Some eight years later, the rate has been sustained and now reflects an even higher average motor life of 52.8 years.

Reducing vibration will exponentially improve bearing life. Additionally, since bearing clearances control most of rotating equipment component life, by association, rotating equipment life is increased. For every 20 percent that you lower vibration, you easily double the life of the bearings. Do this on a systematic basis across the plant and you will not believe the other costs that will go down and the uptime that will go up. You accomplish this by applying vibration and precision as follows and using similar plant fleet vibration/downtime/cost metrics.

1. Identify the Top 10 vibrators in each area. Assign the responsibility of putting them in precision state to individual mechanics. Review with each mechanic the proper expectation setting of what the precision state is and how to get it without spending more than a few hours of mechanical downtime.
2. Some plants make the mistake of only working on the Top 10. This is a huge mistake.
3. Set expectations for crew leads to put an additional number of equipment in a precise state each month or quarter. Audit the results (i.e., no pencils or keyboards "whipping up the number").
4. Mechanics with set precision expectations can eliminate common assembly errors made every day in every plant by mechanics and construction workers.
5. Work to establish **strict** precision measurements for fit and tolerance in plant repair shops. Conduct an audit with the mechanics and one engineer outside the repair shops to ensure the mechanics are working to your standards and not theirs, unless their standards are better.
6. All installations in the field must have zero pipe strain, no soft foot and be aligned for thermal growth and precision alignment expectations.
7. New and rebuilt rotating equipment should be purchased to G 1.0 balance specs.



De
defect elimination

8. It is vitally important for mechanics to fill out and turn in to the planner a precision field maintenance worksheet stating whether or not the equipment was left in a precision state. No one should be scolded if the equipment is not left in a precision state. Mechanics simply need to make notes on why they weren't able to do so. (i.e., pipe strain; no time to correct; bearing housing wore out and none in storage, need to order bearing housing; or precision alignment not possible because 60-year-old base corroded away).
9. Follow-up is also of vital importance. Follow-up on all the problems turned in by mechanics and those on the first line of emergencies. It is vital for the planner, superintendent, or whoever knows they have the responsibility to order parts and get back on schedule for repair.

It has been proven that vibration significantly decreases the overall life of all rotating equipment, including, but not limited to, bearings. Lowering the overall vibration of your plant's equipment will cut your rotating equipment and overall maintenance cost dramatically, while increasing uptime and profits.

***Phil Hendrix**, is Co-Founder and Owner of Hendrix Precision Maintenance. Phil has 47 years of successful experience performing and leading heavy industrial maintenance in all industries, and has been a reliability consultant and trainer at over 250 companies. His passion for the last 15 years has been teaching these skills to younger maintenance people.*
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Practice What You Preach with Your Equipment Support Systems: It's FREE Money

Mark Pipher

More than 40 percent of the allocated electrical costs in an industrial environment is attributed to equipment support systems, including heating, ventilation and air conditioning (HVAC), compressed air, chilled water, boilers, and more. While equipment optimization and visibility are often things that many facility managers take great care in providing, it is not as often considered for these support systems, which product line equipment often depends on to maximize uptime. To ensure all systems are optimized and operating efficiently, more facilities are introducing a process and technology, better known as monitoring-based commissioning, which provides complete transparency and real-time updates on these various systems.

Monitoring-based commissioning systems use advanced fault detection (i.e., analytics) to shift facility management from a reactive structure, where support systems are fixed after an equipment issue or malfunction occurs, to a proactive approach, where it's possible to identify and eliminate potential issues before they occur. These analytics, which can be viewed anywhere through cloud-based platforms, are able to diagnose equipment faults, prevent failures, and increase operational efficiency through faster time to resolution.

These systems are proven to save upwards of 10 percent of the overall electric bill, with a simple payback time of less than nine months. In many cases, it's even possible to double these savings by working with your utility company to gain incentives for corrective action costs or even equipment replacement with higher energy ratings. Over the course of time, facility managers can experience exponential savings year over year, both in costs and energy, if continuously monitored by these systems.

Turning System Transparency into Savings

Monitoring-based commissioning systems are able to identify a number of areas and systems across a facility that are wasting energy and costs. Consider, for example, HVAC contribution, which on its own presents a significant opportunity for cost savings. Your typical building management system (BMS) does not drive utility costs down, for its primary job is to manage the control system. It takes manual intervention, hours of analysis, and a senior facilities BMS on staff professional to determine optimization and energy reduction opportunities. Often times, the control vendor is paid to take a look intermittently, but with no clear incentive to look at energy reduction or justify the change.

> "Over the course of time, facility managers can experience exponential savings year over year, both in costs and energy…"

The new generation of monitoring-based commissioning systems look at the complex issues, like simultaneous heating and cooling, baseline optimization, economizer failures, and airflow equipment interactions, all of which impact environment, health and safety (EHS) of a facility. These issues are incorporated into intelligent fault detection findings, providing energy reduction savings and process optimization opportunities that drive less wear and tear to increase equipment life. This same type of analysis is applied across the plant, precisely analyzing data from the numerous systems and pieces of equipment. As long as there are sensors and data to be gathered from the machine, controller, or the BMS, they will all be connected and detected.

With compressed air and chilled water support equipment, utility savings can soar up to as much as 25 percent. Compressed air systems are used

> Monitoring-based commissioning acts like a 24/7 technician…

in every industrial environment and are typically key in product delivery. A monitoring-based commissioning system looks at the entire supply and demand process to drive not only equipment faults, but sequencing, scheduling and optimization. Some equipment vendors supply optimization software for these systems, but to determine the biggest opportunity for savings, you need to justify those optimizations. Monitoring-based commissioning systems not only amplify optimization and fault detection, but offer savings calculations that justify the changes to these complex systems.

One of the biggest benefits derived from incorporating these types of systems into your facility is increased reliability. For example, determining the optimization of blow off is typically not easy to begin with. Factoring in energy savings based on system demand is a tough task and usually requires the expertise of a technical consultant. In one real-world environment of 10 compressed air systems, a monitoring-based commissioning system, within four days of run time, determined that by adjusting blow off without compromising demand could save over $100,000 in electrical costs.

Getting the Most Out of Your Data

The question, "Do I even have the data to find these issues?" is often asked within the industrial space. The truth is, most building management systems have enough data to do your analysis manually. Some provide trends and others do not. Monitoring-based commissioning systems provide the trends and then use the history to determine the faults and conditions that contributed to the fault. This not only saves money, but helps improve operational efficiency and creates longevity in equipment life by proactively addressing maintenance issues through fault detection analytics. Monitoring-based commissioning acts like a 24/7 technician, instantly analyzing when the fault occurred, what caused the fault, and alerting staff to faults, even when no one is around. It also uses this history for determining the prediction of failure.

Picture a simple supply fan running constantly at 75 percent. What if you could take this fan down to 50 percent or 30 percent on average and still maintain the temperature and humidity requirements? This is one application of a monitoring-based commissioning system. You would not only save money, but also extend the life of the fan.

In labs and clean rooms, utility costs are high and a balance needs to occur between air turns, temperature, pressure and humidity. A monitoring-based commissioning system alerts you to savings and, more importantly, addresses EHS concerns immediately in these complex environments. When time to resolution is critical in a safety environment, casual analysis is key to the facility engineer, rather than spending hours on the BMS analyzing the issue.

The efficiency of your building's energy consuming systems slowly deteriorates over time. Similar to how your vehicle needs a regular tune-up to run optimally, so does your building. Monitoring-based commissioning is a comprehensive study that serves to enhance the efficiency of an existing building's equipment and processes through the identification of low to no cost operational improvements. These operational improvements are designed to decrease the amount of energy used by your building and reduce its overall carbon footprint.

Monitoring-based commissioning systems are the next generation of Industrial Internet of Things (IIoT) technology. They provide the facility director, energy/sustainability manager, and engineer with the tools to make better decisions. These are decisions that impact the comfort of people, the production of product and the sustainability goals of the company. These systems ensure the changes are permanent by continuing to watch them over time. And finally, the savings are not just allocated costs, they are pure profit to the company.

Mark Pipher *is the Vice President and General Manager of FacilityConnex. With over 20 years of experience, Mark has worked as the General Manager for GE's Intelligent Platform division, COO for SQMWorks, Founder and VP of Engineering for West Ridge networks and VP of Engineering for Celox. www.facilityconnex.com*


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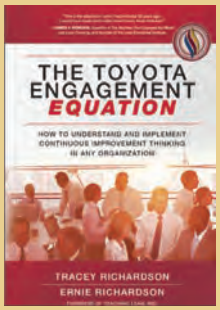

TRACEY RICHARDSON

President and Co-owner • Teaching Lean Inc.
Author • *The Toyota Engagement Equation – Understanding and Implementing a Continuous Thinking Environment for Any Organization*

Prior to starting Teaching Lean Inc., Tracey Richardson was in management in the plastics department at Toyota Motor Manufacturing Kentucky from 1988-1998. Tracey was one of the first team members hired with the fortunate opportunity to learn from the Japanese trainers, getting hands-on experience from the experts. As a group leader, she was tasked to oversee all team members in safety, quality, productivity, cost, and training and development goals for her groups.

Tracey is passionate about assisting organizations who are on the "lean learning journey." With over 31 years of experience in Toyota methodologies, Tracey supports companies by implementing key elements for success.

Q. You have been involved with the Toyota organization for a number of years and hold several certifications related to the Toyota Production System that you earned while working in Japan. Will you please explain the Toyota Production System?

The Toyota Production System (TPS) evolved from Sakichi Toyoda from the Textile era, along with his son Kiichiro Toyoda, to create a framework for people to have common language for effective business practices around just-in-time thinking, jidoka (build in quality), standardization, continuous improvement and respect for people in a macro viewpoint (there are many infrastructural nuances that support TPS). Over the years, TPS evolved from the Gen 1 version to Gen 2 – the Thinking Production System, meaning the deeper thinking of this system can be translated external to Toyota – and lastly Gen 3 TPS, which is the Thinking People System, meaning it can translate to any genre of industry centered around the 4Ps: People, Process, Purpose and Problem-Solving.

Q. In organizations in the United States and other Western countries, maintenance departments are being held responsible for equipment reliability and unexpected breakdowns; however, when breakdown causes are investigated, very few relate to maintenance. How do organizations like Toyota deal with cross-functional issues and problem-solving?

During my time at Toyota working in the plastics department, I worked along with maintenance and tool and die departments to understand their expectations of me in regard to the equipment as the supervisor in the area, as well as machine and process capabilities of my equipment. If those standards weren't developed, known and trained to, they can create the discrepancies that we tend to react to. Our trainers would say, "don't blame a person for a badly designed process," so we would have cross-functional quality circles or training sessions to ensure great standards were in place for preventive maintenance (PM) that were team member related and those that were maintenance related and visualize that at the process.

Q. ***Uptime*** **and Reliabilityweb.com focus on reliability. Reliability has a technical side and a people side. The technical side focuses on understanding the nature and causes of failure so they can design the failure out or create tasks to eliminate or avoid suffering from them. How does this relate to the type of continuous improvement and problem-solving in the Toyota Production System?**

We used a term internally called primary process owner (PPO), which involved the people and technical side of each process we had. We looked at it as understanding the "process diagnostics" side of things and change point management. Toyota is a standard-driven company and won't operate the process without someone with accountability to follow it. The standard is designed to incorporate "problem awareness" through our Andon pull system for the team member and team leader to see abnormality at a glance and stop the line, if necessary. This sets up for effective and efficient problem-solving (PDCA method) to find any opportunities for continuous improvement. We try to equip the team members (PPO model) with all the knowledge of the process from a maintenance, productivity, quality and cost perspective so they can make certain decisions based on their essential job function without always relying on the team leader. For Toyota's success and others, it results from E3, meaning Everybody, Everyday Engaged in correctly framing problems.

Q. Does the Toyota Production System take culture into account? Do companies in Japan have an advantage because of the natural cultural instinct to collaborate, comply and be part of the whole? In the United States and other Western cultures, individual innovation and performance are emphasized and rewarded. How did you make the Toyota Production System work in the U.S. plants?

Not all Japanese companies embedded specific TPS thinking in their organizations; it was very specific to Toyota plants, although many have tried to replicate it. I think the culture in Japan, in general, is a bit different, but I feel overall there are commonalities—they do tend to invest time in predictive problem-solving versus reactive. At Toyota North America, I was introduced to the Quality Circle Program and Suggestion System. The Quality Circle Program was created to allow team members to have an avenue to problem solve within their team, working on specific scoped issues in their area and giving them a platform for self/team development supported by their supervisor, with assistance from maintenance and tool and die to help with the idea. It's a part of team member and team leader development for their succession planning and to lead and learn together as an organization heading toward the same true north.

Q. How does the Toyota Production System ensure that the best solutions are advanced? So many times, decisions come down to the personal preference of the middle manager, who may not have the knowledge or breadth of perspective to make the most informed choice. Is there a system that encourages an open mind, wider questioning, or other method of discovery?

Toyota resides in Toyota Business Practices (TBP), eight steps to problem-solving thinking. This thinking drives more fact-/gemba-based thinking versus tribal knowledge, assumptions, or even opinions at times when results are important to attain. It encourages framing the problem correctly on the left side of the A3 in order to ensure the proper countermeasures are implemented to get past the symptom. We also think tribal knowledge is great, but must be shared (wisdom) in order to develop best practices and standards, which are learned at the gemba at all levels.

Q. What is a sensei?

This wasn't a term I personally used to describe my Japanese trainers, but to most, it was what they were. Today, I prefer the term "influencer," because you don't have to be a leader or trainer to influence people by your actions each day. The role of an influencer or sensei is to lead and learn with people through gemba interactions and asking questions with process owners to help team members manage problems versus problems managing them and differentiating leading and lagging KPI tracking. For example, How is it going and how can I help remove the barriers and constraints to improve the work with you (not for you), and how do we know (measurability)?

Q. Lean is often taken to mean that management is reducing headcount and cutting costs. Why did it get that reputation? How can lean be applied to equipment reliability?

Lean in some companies, unfortunately, has morphed or has been misused over the years to create a negative perception that's not about developing people, but rather reducing headcount, but in all reality, the intent is quite the opposite. If folks weren't exposed to the creation of how lean was coined, it can lend itself to the "reduction of people" mentality versus reducing "process waste" to add value in their daily work and for the customer. Lean thinking was used at Toyota in many ways to level load equipment time for model change trials, cross-training and ergonomic studies. Working with maintenance and understanding capacity and capability were a must for accuracy, fit and people development during changeovers to maintain KPIs.

Q. What role does leadership play in creating a successful culture of engagement and continuous improvement (the act of leadership, not leadership from the plant manager)?

When I was promoted into my leadership role at Toyota, my Japanese trainer asked me if I understood the expectation of my role as a servant leader. I replied "yes" and he said, "Do you realize 50 percent of your time is to develop people?" I have to admit, that was going to be challenging. His intention was to ensure I would be spending time at the gemba present with their team, supporting standardized work creation and auditing (SDCA), problem-solving, A3, visual management, 5S and quality circle theme work for their area. It is a leader's role to develop people beyond what they thought they were capable of. Leaders need to understand learning styles and preferences to be able to nudge their team members past their comfort zone in order to learn and share wisdom.

Q. How do you develop leaders on the floor?

Leaders must understand the servant leadership model in order to say and bring to life the "I work for you" model. A leader must give their team members the proper space to think versus firefighting or reacting. In order to do that, leaders must have the discipline and accountability to practice effective lean thinking, even then, the drive to get the results is strong. The difference between a good versus extraordinary company practicing lean and evolving its culture is the ability to say, "We are a company that develops people first that just happens to produce (X)." People must be the focus and leaders need to make those actions tangible on a daily basis. The Toyota Way 2001 was founded on respect for people and continuous improvement, so leaders leading and learning simultaneously should be an expectation of their role to ensure long-term sustainability and growth for any company.

Q. What advice do you have for those who want to get started on a similar career journey as yours?

I'm 32 years into my learning journey inside and outside of Toyota. I've always tried to be a sponge, soaking in all I can from the folks I'm blessed to work with, as well as my leaders and trainers who never stopped pushing me past my comfort zone. My trainers would say, "The moment you stop learning, your value begins to go down," so I try to stay true to learning and finding new ways to explain lean in our everyday lives to help folks learn much faster than I did. Sharing wisdom with the next generation is our responsibility, so the paradigm of tribal knowledge isn't a hindrance, but rather constantly renewing the norm through our collective ideas to meet the ever-changing market demands. So, never stop learning from others and, as Mr. Cho says, "Go See, Ask Why and Show Respect."

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