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COMPETITION WITH A PURPOSE

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COMPETITION WITH A PURPOSE

BY DOUG PLUCKNETTE

"Competition with a purpose," Honda North America's Hugo Beltran smiles as he summarizes Honda's first Skills Olympics held at the Marysville, Ohio, site on March 6, 2014. "As a company, we recognized the need to focus some effort on our equipment service technicians (aka skilled tradespeople), how they are an integral part of our organization. On a daily basis, we depend on our equipment service technicians to communicate with our operations people, troubleshoot equipment, identify faults, and make repairs or modifications to keep our equipment up and running.

We also wanted to create an event that incorporated the teamwork from the executive level to the equipment technicians, while incorporating Honda's core philosophy of a challenging spirit," the associate chief engineer explained. "At the end of the day, while only one team went home with the gold medals, everyone who was involved came out a winner."

Sitting around a conference table with some of the creators of Honda's Skills Olympics, it is evident that each and every one is excited to elaborate on their piece of an event program that focused on three key areas:

1. Technical skills;
2. A predictive maintenance focused vendor fair;
3. Identification and sharing of best practices.

The concept of a Skills Olympics is an intriguing one. The idea of a company planning an event that would give its equipment service technicians a chance to demonstrate and be recognized for their technical knowledge and skills was something new. This author first heard about the event in a meeting last fall with Honda North America's reliability engineering team. While excited to hear about the event itself, it was fascinating to dig deeper to learn about the work that went into creating such a competition. Here's how it all came together.

Gary Cundiff was the Skills Olympics project team leader, Darrell Stafford headed up the best practice team, Gary Barr led the predictive maintenance vendor fair, and Mike Kibler was the team leader for the technical skills events. In planning this two-day event, the team worked together to create a schedule of events that focused on developing a proactive maintenance culture through employee development and exchanging best practices.

The theme for the event was "Predictive Technologies," the tools maintenance technicians can use to detect potential failures and correct defects before they shut down the manufacturing equipment. With the understanding that the maintenance technicians are Honda's equipment subject matter experts (SME), the team wanted to ensure that as Honda introduces new technologies, such as airborne ultrasound, it has a way to educate and exchange information to accelerate their use. The end result would be a maintenance tech who is not only a manufacturing equipment SME, but a predictive technologies SME as well.

Keeping to the theme, Barr and Stafford had their teams invite a number of vendor companies who specialize in predictive technologies or proactive maintenance techniques, asking each to showcase its equipment in a vendor fair. Seven of these companies were asked to give a one-hour breakout presentation in an effort to educate associates on how their companies would be working with Honda to implement proactive and predictive maintenance solutions.

Kibler's team focused on two separate events, the individual skills competitions and the team trivia competition.

KICKING OFF THE GAMES

The event kicked off with Cundiff welcoming the group to the first Skills Olympics and telling Honda associates that, "We believe our associates are the most important resources. We're investing in you. You may not win, but the knowledge you take away from this event will be invaluable."

Technical Skills Olympics team member Harry Wagner said, "You could feel both the excitement and nervousness of the participants as the event kicked off, and at the same time, you could see bonds of mutual respect being formed between team members."

Each participant was given a detailed schedule of events. The following two days were packed with presentations, a Genba tour (Japanese for factory floor in manufacturing) of the East Liberty Auto Plant, where associates were able to see fully assembled engines automatically installed into cars, and, of course, the team events.

TECHNICAL SKILLS COMPETITIONS

For individual skills competitions, teams selected from three different manufacturing areas of the Honda North America site. Each team would participate in one of the three selected technical skills events.

In these three events – robot mastering, PLC troubleshooting and logic troubleshooting – teams would each be given a goal to accomplish, a problem to resolve and a time limit. The technical skills events were held in a lab environment under the watchful eye of a judge and a closed-circuit camera that transmitted the teams' progress live to where all Honda executives, leaders and associates from each area could cheer them on.

The technical skills events were open to all Honda North America maintenance technicians. All one had to do to participate was to form a team for one of the three listed skills and attend the qualifying events. In the end, the three teams selected were the top three finishers in the qualifying events.

ROBOT MASTERING

In the robot mastering technical skills event, the teams were given a goal to restore the robot to operational status. Each team had a problem to troubleshoot on a FANUC S-430i RJ3 robot; the team had to identify the problem and master or re-teach the robot to return it to operation within a set degree of accuracy. Teams were required to verify the accuracy of the robot following mastering and penalties were assessed for each millimeter off location. The team with the fastest time after penalties to make the robot operational was the winner.

Figure 1: Skills Olympics participants Paul Sandrus and Mike Seif from the East Liberty Auto Plant work against the clock to troubleshoot a FANUC robot and make it functional to within a specified degree of accuracy.

PLC TROUBLESHOOTING

The PLC troubleshooting event teams were required to work through the following scenario:

- You are called out to a piece of manufacturing equipment where you have no experience.
- The machine operator informs you that his/her machine has stopped.
- In order for it to continue, he/she needs to see the "finish light" in the corner of the display screen.

The task here was to make the finish light come on without changing any programming or forcing any devices in the program. To accomplish this, each team was given the prints and program needed to determine the proper operation sequence and data register values required to turn on the finish light. Teams were timed for the event and the team that completed the task with the fewest steps in the least amount of time was declared the winner.

Figure 2: Delbert Lang from the Anna Engine Plant works with a PLC to identify a problem and restart the equipment.

LOGIC TROUBLESHOOTING

The logic troubleshooting event dealt with a simulated car wash. Each team was given a problem to troubleshoot and had to identify it, resolve it and complete a car wash. Like a real car wash, the system was automatic, but electromechanical problems were built into the event. Team members who identified their problems and completed a car wash in the least amount of time were the winners.

Figure 3: Honda Associate Mike Hall from the Anna Engine Plant working at the car wash to troubleshoot, locate, repair and restart.

Technical Skills Trivia

The final team competition, technical skills trivia, was led by Greg Williams. The event featured five categories: electrical, maintenance management, mechanical, predictive technology and general trivia. Participants used handheld devices to respond to each question, with live results tracked on the auditorium screen.

COMPETITION RESULTS

In the technical skills events, Matt Turner from MAP Weld brought home the gold medal and avoided a sweep of the podium in the PLC skills event by AEP competitors. Joining Turner on the podium was Joe Freeman from AEP FMD with the silver and Kyle Bailey from AEP ALMC with the bronze. In one of the shocking moments of this event, participants were very surprised when told by the event judge that the easiest way to have won this event would have been to click on the "Help" button. Had any team done this, a troubleshooting guide would have given them detailed steps on how to resolve the problem.

Jon Parks from MAP Forming was able to complete the car wash in the fastest time for the logic troubleshooting event, earning the gold medal. Bill Koch from AEP ALMC captured the silver and Steve Bates from ELP Paint secured the bronze.

The team of Derek Ivy from Weld and Brian Bays of Paint were able to give MAP a clean sweep of gold medals for the Skills Olympics event, with the fastest time in the robot mastering competition. Kevin Hale of FMD and Joe Souder of

ALDC took the silver for AEP. Another MAP team, Scott Fortner of Assembly and Bob Moser of Weld, were able to earn the bronze.

"My partner, Brian, and I had a blast," Ivy said of the event. "Our thanks go out to Mr. Iwata (retired HAM president and NAE leader) for his investment in all of us. I've always been proud to work here at MAP."

THE CLOSING CEREMONIES

Athletes who participated in the Olympic Games, when interviewed later in life, often reflect on one special moment that gave their participation meaning, or a lasting impression that, win or lose, they look back on and say it was all made worthwhile when they witnessed this specific event. For most at Honda's Skills Olympics, it was Hidenobu "Hide" Iwata's closing ceremony speech. Iwata spoke with passion about his career at Honda and the culture of challenging spirit and teamwork he experienced throughout his career.

Iwata began his career in weld maintenance, working with Honda's equipment service technicians to overhaul the sealer pumps to ensure they worked each day. He remembered how dirty he would get doing this job and, because of this, they worked to figure out how they could reduce the overhauls and keep the equipment reliable. He also worked to develop techniques where Honda could predict when kickless cables were about to fail so they could replace the cables at lunch or on weekends before the failure occurred, thus saving the company a significant amount of downtime.

Iwata stated: "I am glad to join you here today to celebrate the challenging spirit you have shown at the Skills Olympics. Your competitive spirit has added great excitement to this event and this is what drives us to be the best. You were selected by your management team to represent your department and your plant and you should be as proud of that as I am of you. Honda's continuing success depends upon the skills and knowledge of its associates to improve our daily job."

Participating and winning an event such as this is special, but in learning that your company president once worked in the same type of role as you, you get a sense of just how important it is to continue to learn everything you can about new equipment and the technologies available to detect potential failures.

Figure 4: Skills Olympics Gold Medal Winners

The event concluded with a special recognition luncheon where Iwata presented the award winners with limited edition Carhartt jackets and black hats.

Beltran is proud to say, "The black hats, like the black belt in martial arts, signify the mastery of an expert level of capability. No one else at Honda will ever have one of these jackets or hats, only the gold medal winners, Mr. Iwata and Mr. (James) Wehrman, (retired senior vice president). When these guys walk around their plant with those hats and jackets, people know they earned that special recognition by proving they are the best in our business.

ACRONYMS

MAP - Marysville Auto Plant
AEP - Anna Engine Plant
FMD - Ferrous Machining Department
ALMC - Aluminum Machining
ELP - East Liberty Auto Plant
ALDC - Aluminum Die Cast
HAM - Honda of America Manufacturing
NAE - North America Engineering

FEEDBACK AND KEY LEARNINGS

Always striving for continuous improvement, the Skills Olympics organizing team went to the games' participants looking for feedback on what the participants liked about the event and, just as important, they wanted to know about ways they could improve the event. Regarding the things that went well, the group thought the entire event was well planned. The actual event exceeded most people's expectations, specifically the technical skills events and the closing ceremony, where nearly everyone commented that Mr. Iwata's reflection on his career and the importance of equipment services was a highlight.

With regards to the things the group felt could be improved, they would like to see more technical skills events and more detailed presentations on predictive technologies at the vendor fair, as well as additional and longer Genba tours. While this might sound a bit strange to those who work outside the industry, it is quite rare for most employees to see the entire assembly process, so the Genba tour at the East Liberty Auto Plant was very popular.

PATH FORWARD

It is safe to say that after the success of the first Skills Olympics, it will not be the last. The organizing team already has its sights on setting up an event that will include teams at all the Honda plants in North America. But perhaps the largest bonus that comes from this event is the identification sharing of best practices.

In the past, Honda, like many other large companies, has struggled with silo mentality. Beltran states: "We have several departments that are doing some fantastic things with predictive technologies and reliability tools, such as root cause analysis and RCM Blitz®. With events like the technical skills competitions, we now have a forum where we can begin to share these best practices, along with new maintenance strategies that might come from these events."

PASSING THE TORCH

One challenge companies all have in common is dealing with an aging skilled trades workforce. The average age of today's skilled trades workforce is now over 50 and they have begun to retire at a rate that makes backfilling at a one for one rate extremely difficult. Companies just don't have the abundance of apprentice programs and technical schools that were available 30 years ago. Add to this issue the fact that companies are replacing people with three decades or more experience with those who have little or no experience. As a result, what you are looking at now if you are a company operations manager are some extended periods of downtime for often very simple failure modes.

This is what is so intriguing about the Skills Olympics. While most company leaders are crossing their fingers and hoping these skills and experience will magically transfer from one generation to the next, Honda has put its best equipment service technicians in the driver's seat by recognizing the best of the best.

It doesn't matter what job you're in, recognition goes a long way and those who are recognized are always willing to share information – in this case, passing the torch to the next generation!

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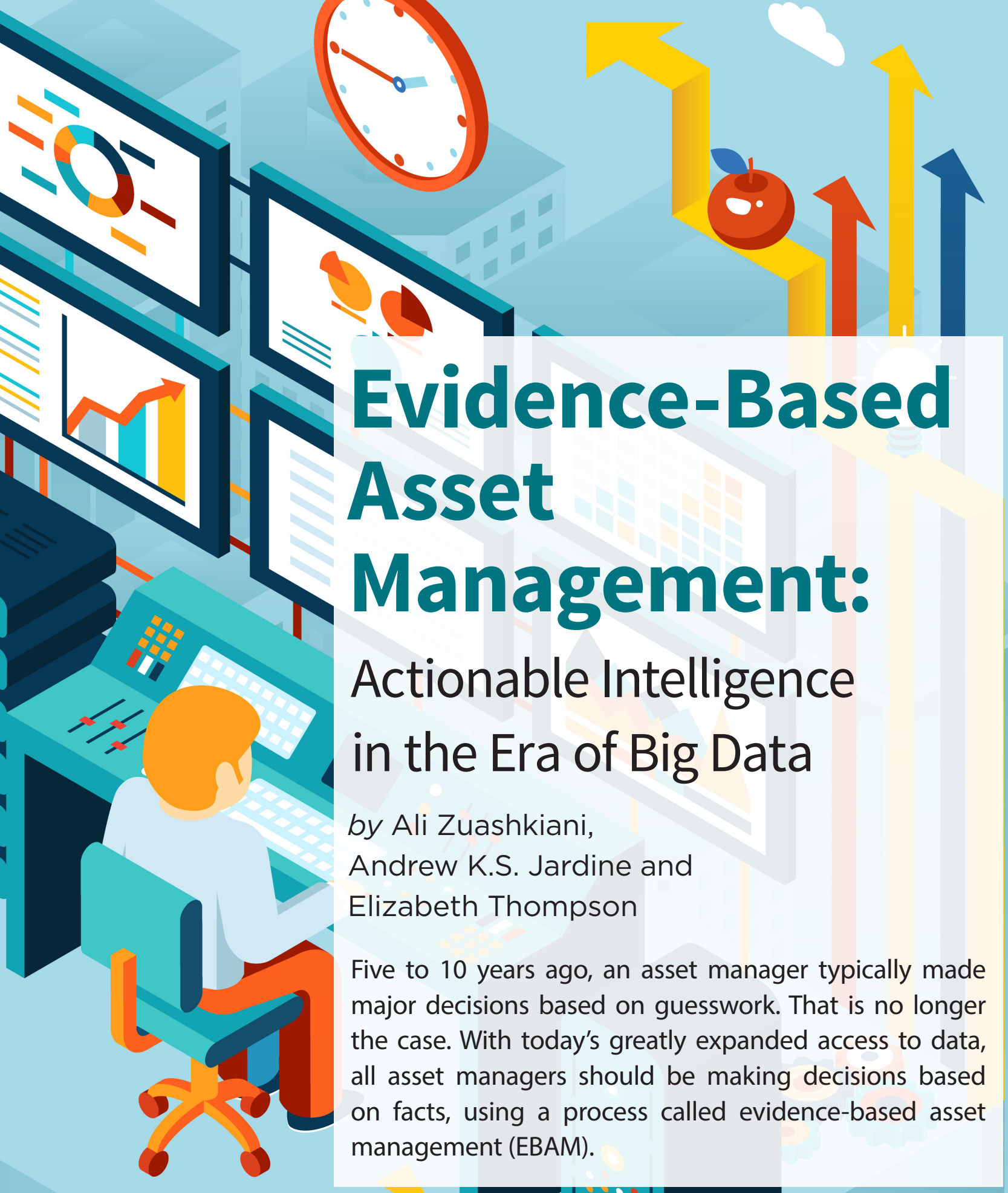

Evidence-Based Asset Management:

Actionable Intelligence in the Era of Big Data

by Ali Zuashkiani, Andrew K.S. Jardine and Elizabeth Thompson

Five to 10 years ago, an asset manager typically made major decisions based on guesswork. That is no longer the case. With today's greatly expanded access to data, all asset managers should be making decisions based on facts, using a process called evidence-based asset management (EBAM).

Applying principles of EBAM to asset management decisions generates huge savings for companies, up to tens of millions of dollars annually

Admittedly, even with the recent explosion in available data, maintenance data may be thin or nonexistent for certain assets. For example, decades-old assets with a long lifetime may have no data from their early years of service. Fortunately, we can elicit knowledge from a wide variety of sources across an organization. Obviously, knowledge can be extracted from the maintenance department, but others may have useful information as well. Despite having poor data records, a company may be rich in tacit knowledge. It just requires knowing where to look and how to extract it.

In EBAM, theory and practice are joined to produce accurate outputs from statistical data and/or tacit knowledge through a process that includes state-of-the-art mathematical and statistical techniques that analyze, clean and process data. With data and knowing how to use it, maintenance managers can improve their standard maintenance practices.

To see how this works, consider what happens with original equipment manufacturer (OEM) recommendations in the real world. Manufacturers suggest the appropriate maintenance activities for an asset and it might seem logical to simply do as advised. However, these are often generic guidelines rather than case-specific instructions. For one thing, they do not consider the effect of a specific operating environment on the asset. Fortunately, companies with rich data will have access to this kind of information (e.g., weather or the conditions in which equipment is used and the consequences of failures of the asset in its current operating context) and by applying EBAM, they can modify the OEM's recommendations to suit their needs. In other words, the data is there if a company opts to look for and use it.

Applying principles of EBAM to asset management decisions generates huge savings for companies, up to tens of millions of dollars annually[4-7]. Such decisions include: finding the optimum retirement ages of expensive assets; calculating optimum inspection frequencies for protective devices; establishing the most economical preventive replacement intervals for critical components; buying expensive spare parts in the right quantity; determining the best repair versus replacement decision policy; and making optimum condition-based maintenance decisions. Four key decision areas are:

- Lifecycle costing decisions;
- Maintenance tactics, such as preventive replacement strategies;
- Inspection policies, such as predictive maintenance and failure finding intervals;
- Resource requirements, such as establishing maintenance crew sizes.

Of course, even ample data may be incorrectly used. The data or evidence alone will not create a solution and with missing or incomplete data, the problem is much greater. In short, EBAM tools are necessary to ensure optimal decision-making. The Centre for Maintenance Optimization and Reliability Engineering (C-MORE) at the University of Toronto has been leading the way in this type of research, developing software tools to help predict reliability and optimize condition-based maintenance. One such software tool is used to predict equipment failure, estimate the remaining useful life of equipment and define the optimal mix of preventive maintenance and run to failure in order to optimize costs and reliability, and achieve the optimum risk/cost/reliability balance. A basic schema of the software principle is shown in Figure 1.

Another option is a decision support tool for setting inventory levels for critical, slow-moving and high cost parts. This system forecasts inventory levels for in-house repair, subcontract repair and new purchases based on the required reliability, cost and equipment availability, and combining science and economics to set inventory levels according to operations and performance needs, not just budgets. A third software can be used to find the optimal replacement policy for assets.

Over the past 20 years, C-MORE has worked with a wide variety of companies around the world on a multitude of projects. Companies include transit, energy, pulp and paper, mining, etc. Past projects have determined: the economic life of a bus fleet; the optimum replacement age for underground steel mains; whether to repair or replace a gas meter; the optimal number of spare repairable electric motors to stock for a conveyor system in a mine; and an optimal inspection schedule with respect to availability for a mine's fleet of safety pressure valves, etc. Two ongoing projects demonstrate the applicability of EBAM across the maintenance spectrum. The first considers the optimal inspection frequency for medical devices, while the second is working on a scheduling problem with Bombardier Aerospace.

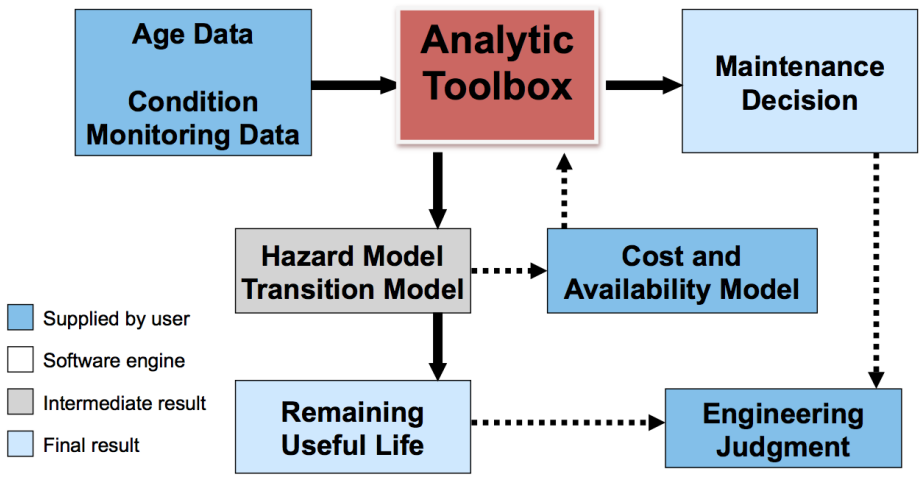

Figure 1: Analytic tool

1

Inspection Frequency for Medical Devices:

Hospitals deal with a large number of devices and depend on periodic inspections to ensure these devices are safe and reliable. Most follow the manufacturer's recommendations for inspection and maintenance, but as previously mentioned, these are not necessarily the best possible practices in their specific operating context. Dr. Sharareh Taghipour, formerly with C-MORE and now with Ryerson University, and Dr. Dragan Banjevic with C-MORE, developed a model to determine the optimal inspection interval for such medical devices. Taghipour and Banjevic are trying to close the gap between optimal and actual practices in periodic inspection of repairable systems by using available data, formulating models that best describe the data and recommending evidence-based policies based on the outcomes of the models.

2

Maintenance Scheduling:

Bombardier's Dr. Nima Safaei, formerly with C-MORE, has been working on a maintenance scheduling problem for Bombardier aircraft. He is trying to determine the schedule of preventive/corrective maintenance jobs (i.e., the sequence in which the maintenance jobs should be executed) during a short planning horizon, considering the available resources. Scheduling is essentially short-term decision-making, so encountering limited resources, such as skilled workforce, facility time capacity, tools, space and spare parts, is common. In the maintenance management field, the workforce is considered the highest priority resource because maintenance jobs are labor-intensive and the workforce performing these jobs is highly paid and extremely skilled in their area. Because of the nature of the problem, most companies encounter conflicting objectives. One objective is workforce cost/requirement minimization. Workforce costs include employment, subcontracting, training and transportation costs. Other objectives may be equipment/asset availability maximization, turnaround minimization, weighted completion time minimization, etc. A set of non-dominated alternative solutions addressing the trade-off between the workforce cost/requirement and other considered conflicting objectives are central to better decision-making. Safaei has formulated the problem as a mixed-integer mathematical programming model in which the network flow structure is used to simulate the flow of an aircraft between missions, hangar and repair shop. The model's validity can be tested using data from the company.

Conclusion

Evidence-based asset management is more than just a number obtained at the end of data analysis. It is a process asset managers can use to defend their decisions through the proper collection and analysis of data and the appropriate selection of decision criteria. The process comprises the following steps:

- Clearly identify the problem;
- Consider the optimization criteria (i.e., what the company hopes to achieve);
- Define a model;
- Extract data, including tacit data;
- Validate/revise the model;
- Solve the final model;
- Conduct proper sensitivity analysis of the recommended decision with respect to the model's key parameters;
- Recommend an asset management decision.

C-MORE researchers have barely scratched the surface of the kinds of practical asset management problems that could benefit from the EBAM application. Optimizing asset management decisions covers component replacement, including the choice of optimal replacement time and spare parts provisioning. EBAM addresses inspection decisions, including optimizing condition-based maintenance, inspection frequencies for a system and failure finding intervals for protective devices. Other main areas are capital equipment replacement decisions, maintenance resources requirements and scheduling.

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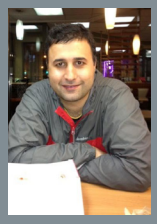

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Implementing ISO14224 Enabled EAM Systems

by Neeraj Gupta

Applying ISO14224 taxonomy and coding to your enterprise asset management (EAM) system is of utmost importance to ensure that reliability and maintenance (RM) data is collected and reported correctly. Standardization of RM data collected further helps in bringing different stakeholders together to understand and utilize this data for various analyses performed by each party. In today's competitive world, organizations need a way to benchmark themselves with best in the industry and ISO14224 provides that.

With every EAM implementation, the biggest challenge is defining a right data structure that can fulfill the business need relevant to the industry. Be it location/asset hierarchy that aligns with your maintenance strategy or asset classification for effective asset management and reporting, collecting the right failure data for future analysis and decision-making is dependent on this data structure.

This article outlines ISO14224 objectives, provides guidance for collecting RM data and presents important aspects for configuring your EAM system to comply with ISO14224.

What Is ISO14224?

In the petroleum, natural gas and petrochemical industries, great attention is being paid to safety, reliability and maintainability of equipment. In this respect, data on failures, failure mechanisms and maintenance related to these industrial facilities and their operations have become of increased importance. Standardization of data collection practices facilitates the exchange of information between relevant parties, such as plants, owners, manufacturers and contractors throughout the world.

ISO14224 describes data collection principles and associated terms and definitions that constitute a reliability language that can be useful for communicating operational experience. A major objective of this international standard is to make it possible to exchange RM data in a common format between owners, operators, original equipment manufacturers (OEMs) and other relevant vendors and contractors.

This international standard does not apply to the following:

- Data on direct cost issues;
- Data from laboratory testing and manufacturing;
- Complete equipment data sheets;
- Additional on-service data;
- Methods for analyzing and applying RM data.

Benefits of RM Data Collection and Exchange

There are several aspects of benefits that can be realized by properly collecting and analyzing quality RM data. Some of them are:

Economic

- Cost-effective design to optimize capital expenditure (CAPEX);
- Cost-effective operation to optimize operational expenditure (OPEX);
- Improved profitability through reduced revenue loss.

General

- Being able to operate (operator license);
- Life extension of capital equipment;
- Improved product quality.

Safety and Environmental

- Improved personnel safety;
- Reduced catastrophic failures;
- Reduced environmental impact.

Analytical

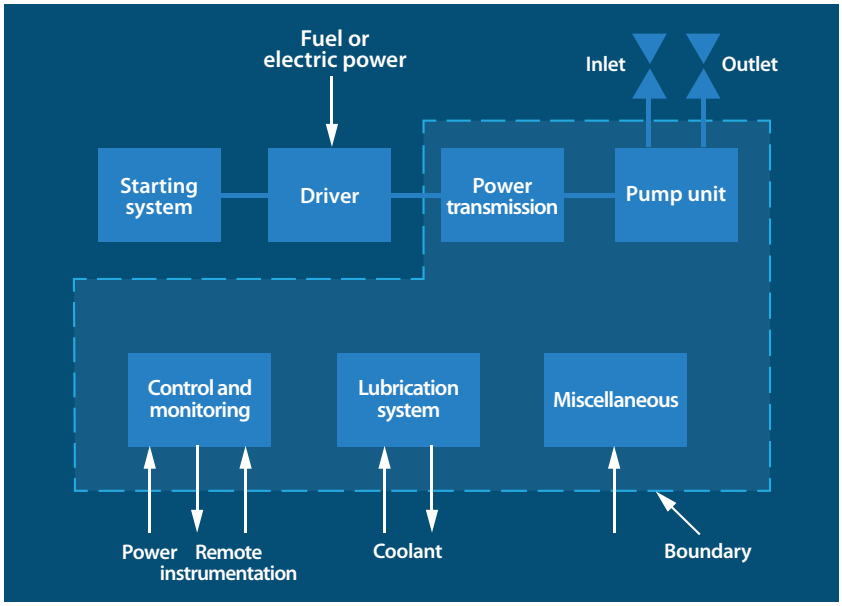
- Improved decision-making;
- Qualified benchmarking;
- Better predictability.

The application of this standard is recommended for collecting data during the whole lifecycle of an asset, including installation, start-up, operation, maintenance and modification, until the asset is decommissioned or retired.

Some important aspects for creating the data structure are:

- **Defining Equipment Boundary:** For each equipment class, a boundary should be defined indicating what RM data is to be collected under each equipment class. Boundaries should avoid overlapping among different equipment classes.

Figure 1: *Equipment boundary*



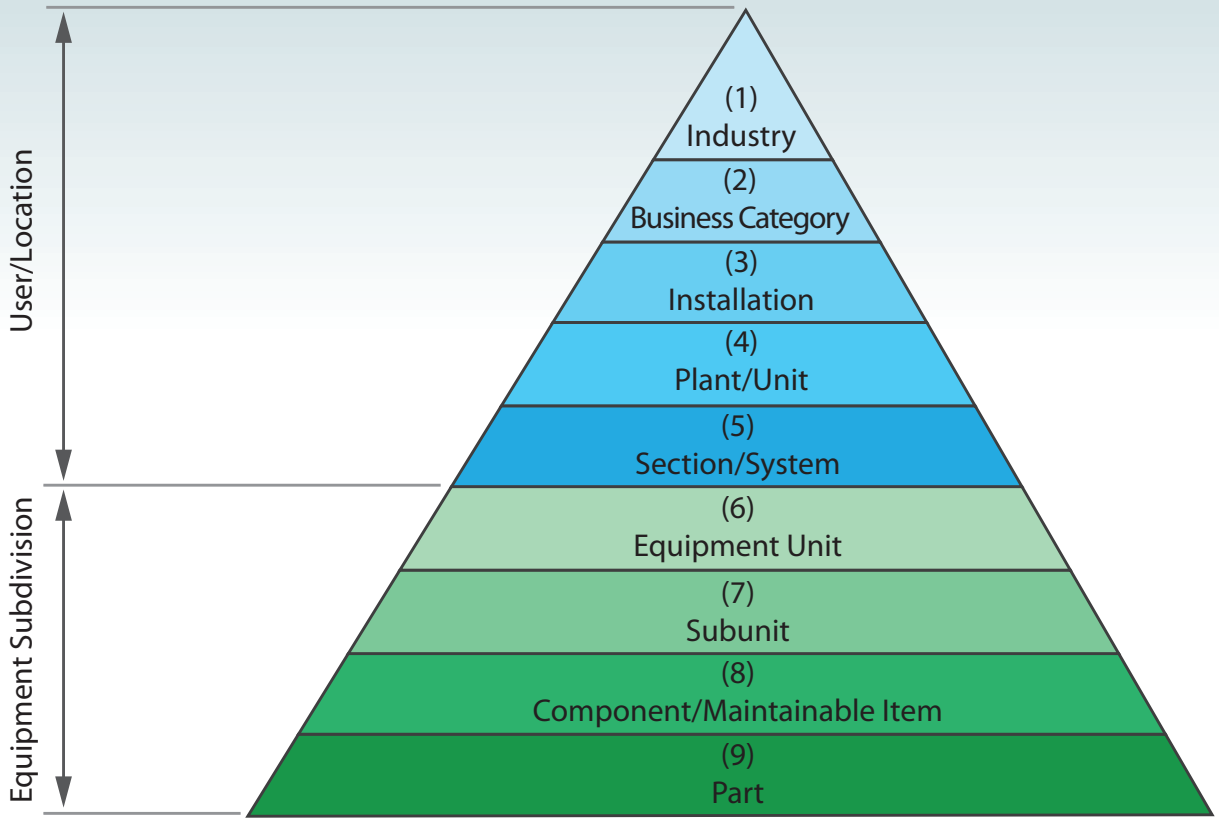


Figure 2: *ISO14224 taxonomy*

The ISO14224 taxonomy defines different levels at which data needs to be collected.

Levels 1 through 5 represent a high-level categorization that relates to industries, plants and their sections, regardless of the equipment units involved. It is necessary to have the operating context of each location/equipment to make the analyses more meaningful.

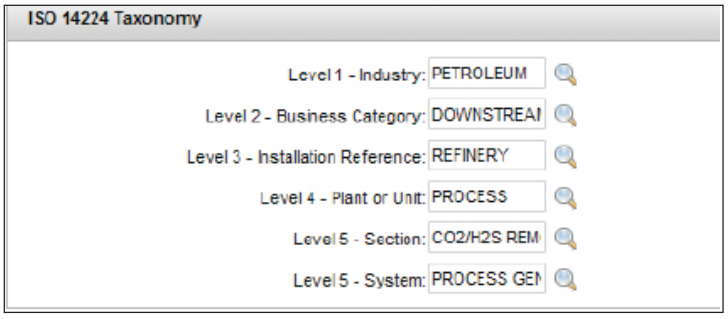


Figure 3: *Location operating context*

Levels 6 through 9 are related to the equipment unit, with the subdivision in lower indenture levels corresponding to a parent-child relationship. The number of subdivision levels for the collection of RM data depends on the complexity of the equipment and the use of this data.

For effective collection and utilization of RM data, these data categories should be used:

a) Equipment data

- Classification data (e.g., industry, plant, location, system);
- Equipment attribute (e.g., manufacturer's data, design characteristics);
- Operation data (e.g., operating mode, operating power, environment).

DATA TO BE RECORDED
Equipment Class
Equipment Type
Equipment identification/Location (e.g., tag number)
Equipment Description
Unique equipment identification number
Manufacturer's name
Manufacturer's model
Design data relevant for each equipment class and sub-unit/component as applicable

Table 1: *Equipment Data*

b) Failure data

- Identification data (e.g., failure record number and related equipment that has failed);
- Failure data for characterizing a failure (e.g., failure date, items failed, failure impact, failure mode, failure cause, failure detection method).

Table 2: *Failure Data*

DATA TO BE RECORDED
Failure record
Equipment identification/Location
Failure date
Failure mode
Failure impact on plant safety (e.g., personnel, environment, assets)
Failure impact on plant operations (e.g., production, drilling, etc.)
Failure impact on equipment function
Failure mechanism
Failure cause
Sub-unit failed
Detection method
Operating condition at failure
Additional information

c) Maintenance data

- Identification data (e.g., maintenance record number);
- Maintenance data (e.g., date of maintenance, maintenance category, etc.);
- Maintenance resources (e.g., labor, spares, tools/other services);
- Maintenance times (e.g., active maintenance time, downtime).

Table 3: *Maintenance Data*

DATA TO BE RECORDED
Maintenance record
Equipment identification/Location
Date of maintenance
Maintenance category
Maintenance priority
Interval (planned maintenance only)
Maintenance activity
Maintenance impact on plant operations
Maintenance man-hours, per discipline
Maintenance man-hours, total
Maintenance equipment resources
Active maintenance time
Downtime
Maintenance delays/problems
Additional information

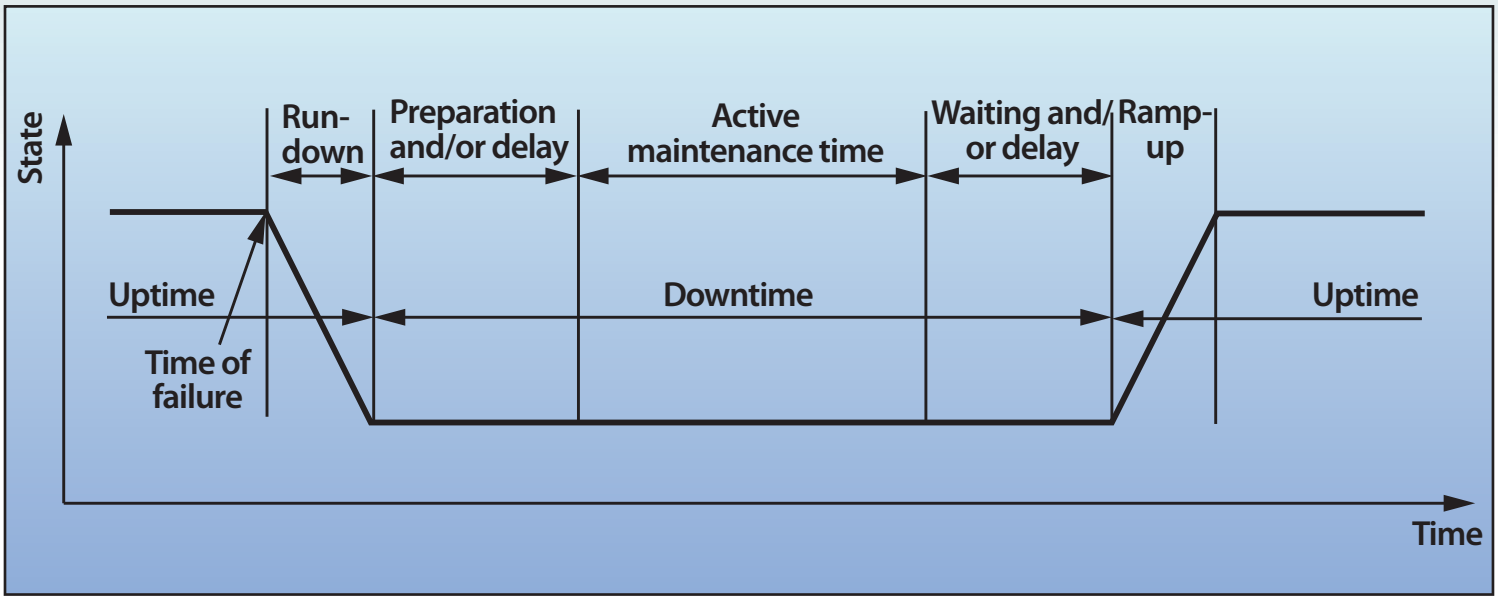


Figure 4: *Maintenance times*

- **Maintenance Times:** The standard recommends collecting two main calendar times – downtime and active repair time – during maintenance.

It has been observed that many companies ignore the importance of collecting RM data during the initial project stage and, hence, their EAM system lacks this data for future use when the owner/operator needs it badly to make important decisions. Many times, the EAM system is designed by the engineering, procurement and construction (EPC) contractor to meet contractual obligations. Modifying the system at a later stage requires more effort and is never cost effective. Moreover, by the time the client realizes the consequences, a lot of useful data is already lost.

There are several challenges that keep companies away from what they should be doing:

- Contractual complexities;
- No direct involvement from the owner/operators at an early stage, the EPC manages the show;
- Conflict of interest within involved parties during plant commissioning;
- Lack of advisory skills in the team and/or subject matter experts (SMEs) involved;
- Non-availability of the right resources on the implementation partner's team.

The result of this problem is an inefficient EAM system. Companies either create a bunch of systems struggling to operate in a cohesive way, or look for some point solutions to fill these gaps at a later stage. This increased complexity leads to a reduced adoption of such solutions and a high cost for system maintenance. In such a situation, it's difficult to make the right decisions and/or analysis from the implemented system.

Therefore, choosing the right package, the right implementation partner with the right domain skills at the right time is very important to a successful EAM implementation, especially in the oil and gas industry.

Above all else, the most important thing is to inculcate discipline in the workforce to collect the right quality data. Merely having a system in place won't help until you capture the right quality data at the appropriate time.

Remember, data gathering is an investment. You can perform better analysis with quality data only. As such, you need to ensure that you have the right checks and controls built into your business process to capture this data.

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Disclaimer: The viewpoints made in this article are based on the experience and opinions of the author and do not represent the views of IBM.

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BREAKING THE RELIABILITY CYCLE OF DESPAIR

Part 2

The Application of Strategic Reliability Principles

by Jay Shellogg

This article is a follow-up to one the author wrote for the **December/January 2014** issue of Uptime magazine that explained some of the fundamental reasons North American manufacturing has not been able to sustain reliable asset performance. The author stated, ***"Since the discovery of modern asset reliability principles (first detailed by Nowlan and Heap in the mid-1960s) and up until the latest evolution in the 1990s by John Moubray, some 30 odd years have passed, but with little rigorous adoption of these principles into the asset management strategies of North American industry."*** In that article, the author explained why the adoption of these reliability principles has been so difficult and what he thinks is required for the adoption of these reliability principles. In this article, the author will expound on those ideas, but warns that sacred cows are going to be slaughtered and it will be messy.

Most of North America is unaware of the principles of reliability. During two speaking presentations to groups of maintenance reliability professionals, the six failure patterns shown in Figure 1 were drawn and the audience was asked if they had ever seen them before. On both occasions, only half of the audience members raised their hands. The half that had never seen the failure patterns before were stunned to learn that most assets fail randomly with respect to time. If these leaders of North American manufacturing and reliability do not understand the basic principles of reliability, how can they hope to sustain improvements? It can be summed up this way: *Most leaders within North American industry today do not understand, or even know about, these principles of reliability, how the principles were derived and how to implement them into a strategic plan. Most of North America's industrial leadership is ignorant of what is required to achieve meaningful reliable asset performance.*

So what would motivate our industrial leadership to learn and embrace these principles and a new paradigm? First, what motivates them in general needs to be answered. Based on firsthand experience, most of industrial leadership is motivated by results, tangible, measurable results. The problem is, you are measuring for the sake of reporting so you can document that you are doing something. Even if that something is not really benefiting the organization in any real way. Far too often, leadership from the top begins to apply pressure to an organization to improve and, as part of that pressure, demands that the results be measured and communicated back to them. This, then, drives management at the next hierarchical levels and below to begin to look for solutions that are what they believe to be measurable and beneficial. The assessment of whether an endeavor is beneficial is often only explored on the surface by asking the question, "Does the endeavor sound like a good idea?" More importantly, the measure of whether or not something is beneficial may simply boil down to asking the next question, "Is anyone else doing it?" What this gives management is cover. Management is measuring results that can be reported and even if real improvements are not achieved, they can say that everyone else is doing it so how can it be wrong.

You can see evidence of this tangible and beneficial belief system by listening to the folks in your plants, or when visiting other locations. The first clue is when you hear someone say, "We've tried this before and it finally went away." This means the effort was not sustained. To be sure, the effort was measured and advocated by management as beneficial, but if it did not sustain itself, the most likely reason is because it was not truly beneficial. The second indication is when you ask management to tell you about the efforts they have underway and they immediately point to some key performance indicators (KPIs). KPIs are great, but when management points to them first or second, it is probably because the KPI is the focus and not true improvement. For your money, you want to talk to the folks who are turning valves and wrenches. These are the people who know what efforts are truly beneficial.

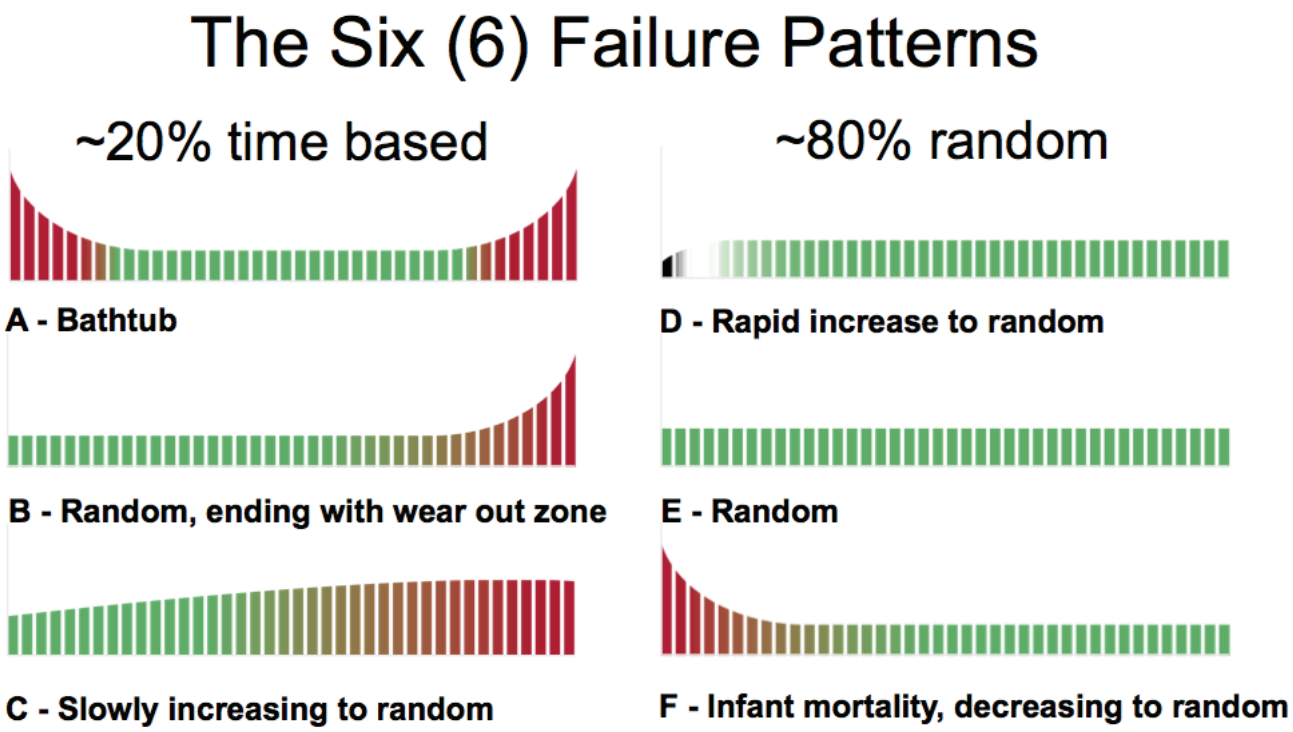

Figure 1: The six failure patterns

THE BASIC PRINCIPLES OF RELIABILITY ARE THESE:

1. Eighty percent (±) of all equipment failures occur randomly with respect to time.
2. Indications of pending functional failure (the failed states) follow a predictable degradation curve known as the P-F interval.
3. The human senses are capable of detecting 80 percent (±) of failed states.
4. Those working closest to a problem are the best equipped to solve the problem.
5. There is no need for the collection of data first to achieve asset reliability.
6. There must be an understanding of the meaning of failure consequences (safety, environmental, operational and non-operational). Further, there must be an understanding that 30 percent of the failure consequences occur hidden under normal operating conditions.
7. Risk is inherent in everything we do.
8. Assets can only perform as well as they are designed, installed, operated and maintained.
9. Failure mode identification must be categorized into three categories:

   a. Suddenly,
   b. Over a period of time,
   c. Hidden.

HERE ARE SOME EXAMPLES OF THESE TANGIBLE, YET BENEFICIALLY QUESTIONABLE ENDEAVORS, AND THERE ARE MANY MORE THAN JUST THESE:

1. **Planning and Scheduling** – For decades, employees have been trained and retrained on how to plan and schedule work. Rare is a mature organization that is unable to adequately plan and schedule its work. Granted, there is often infighting between maintenance and operations about what work needs to be planned and scheduled, but the knowledge of how to plan and schedule is there. The reason this infighting exists is because there is no universal understanding of what maintenance's function is and, in many cases, neither department understands the principles of reliability. This is what causes the infighting and drives management to mistakenly believe that planning and scheduling training is the solution. You can plan and schedule work until all the sacred cows come home, but if the decision makers do not understand the principles of reliability and are not aligned to follow them, you will just get a lot of good planning and scheduling of work that is not worth doing.

2. **Criticality Analysis** – This is another favorite because it is tangible and it must be beneficial since everyone is doing it. The truth is, unless you are a greenfield plant, or you have a high degree of employee turnover, formal criticality analysis is not necessary. Salaried and hourly workers alike know the criticality of the equipment. They do not need a detailed procedure to tell them that one particular pump is more critical to the operation than another; they know. If you don't believe this, then go ask them. You'll be surprised at how much they do know. So why do criticality analysis? Two reasons:

   I. It sounds good and everyone else is doing it, so it must be beneficial.
   II. To try and stop the infighting between maintenance and operation during planning and scheduling. But does it work with lasting affects? Experience shows it does not because maintenance and operations are fighting over unfounded and/or emotional ideas.

   If your organization understands the principles of reliability and will listen to the workforce, criticality analysis becomes a moot point. But with anything, there are exceptions: If an organization does not have or has lost its institutional knowledge about which assets are more critical to the operation than others, then criticality analysis may be warranted to determine which assets need reliability efforts. Criticality is also often used incorrectly to determine how often maintenance is performed, as in, "we do maintenance more often because that piece of equipment is critical." Criticality does not determine how often to perform maintenance. Criticality should be used to determine whether to consider maintenance at all. The six failure patterns, life and P-F curve (failure characteristics) determine the type and frequency of maintenance and not the equipment criticality.

3. **Root Cause Failure Analysis (RCFA)** – Many hours are wasted each year in North American industry in pursuit of a single or even the top four or five likely root causes. Like criticality analysis and planning and scheduling training, this is a subject that industry likes to focus on because it is easily taught and measured, and everyone else is doing it. Probably most everyone reading this article can tell of RCFAs that lasted over a protracted period with little or no results. Most likely, the lack of a result was due to the fact that the principles of reliability were not understood at the beginning. For the best results, RCFA should be a replaced by comprehensive failure mode and effects analysis (FMEA) that looks at operating contexts, function, functional failure, failure modes and failure effects, and is followed by action plan development. *Why waste your time finding just one root cause of failure in a RCFA, when in the same amount of time, you can find all the failure modes with a FMEA and develop pro-active tasks to inspect for those failure modes?*

On the surface, this subject will strike a raw nerve with a lot of folks, but ask yourself these questions:

- **How many years** have you've been doing this type of work?
- **How many times have** you trained your teams to do this type of work?
- **How many times** have you done this type of work and training repeatedly in the same facilities?

The answers are decades, decades and several times over. So why would you continue to do this type of work when you know it did not achieve a lasting, sustainable result in the past? The answer must be because you don't know of anything better to try. The truth is, you do have something better. Spend your time and efforts understanding the principles of reliability and teaching these principles within your organization. You must educate everyone from the shop floor to the CEO boardroom on these principles. The principles are the foundation to asset reliability.

So what is needed to motivate your industrial leadership to learn and embrace these principles and new paradigm? For those who are seasoned to an organization or industry, the need for a compelling reason to change is required to motivate action. A little pressure from the competition or a need to improve performance, like safety, environmental, quality, or productivity, always helps. For those new to an organization or industry, a compelling reason is not required. They only need an explanation of the methodology, taught in a manner in which they can grasp, apply and see real results.

It is critical to understand that reliability principles set up the cultural aspects of how an organization should view reliability. Culture is a shared system of beliefs that an organization uses to solve its problems. This system of beliefs has worked well enough in the past to be taught to others as the correct way to think and act. The principles of reliability set out a new paradigm of reliability, a new way to think and act. Adoption of these principles is not easy, but the steps are basic.

The first step is learning the nine principles and then teaching them to others. Once the nine principles are understood, the organization must commit to the proposition that the principles of reliability shall govern the way an organization makes its decision about asset management. When questions arise, the organization should look to these principles to solve its problems and improve asset performance. Far too often, organizations fall into the trap of tactile application of reliability elements, rather than embracing a strategic approach utilizing the principles of reliability.

Organizations are often tempted to focus on an element of reliability, such as planning and scheduling, equipment history, predictive tools and many others, rather than focusing keen attention to the principles of reliability. It is the tactile application of these elements without a strategic understanding of the principles that has lead the industry to the endless reliability cycle of despair. The principles of reliability are foundational to all the elements of reliability.

Another way to look at this concept is with the Model of Manufacturing Excellence, shown in Figure 2. The model sets out the nine principles of reliability at the foundation, with the four pillars of manufacturing (safety, environmental, quality and productivity) atop them and the tactile elements of reliability atop the four pillars. Woven among the architecture is the concept that every decision must satisfy three primary stakeholders: the employee, the shareholder and the customer. You can add others to the stakeholder's list, such as the community, but it can be argued that a disgruntled community where the employees live will displease shareholders and drive away customers. Therefore, the model sets out the framework of meeting the triple bottom line.

In Part 1, the article ended with this closing paragraph, which is also appropriate to conclude Part 2.

Our task is to educate ourselves on what the principles of reliability are and then we must educate everyone else. The work begun by Nowlan and Heap and carried forward by John Moubray is now in our hands. It is the duty of today's reliability leaders to move the work through to its next phase – the education of the business and engineering professionals, as well as the trade/crafts, on these principles of reliability. Not until everyone from the shop floor to the boardroom understands these principles of reliability can the work of the next phase begin. That is, the work of establishing proactive asset management plans with lasting effects.

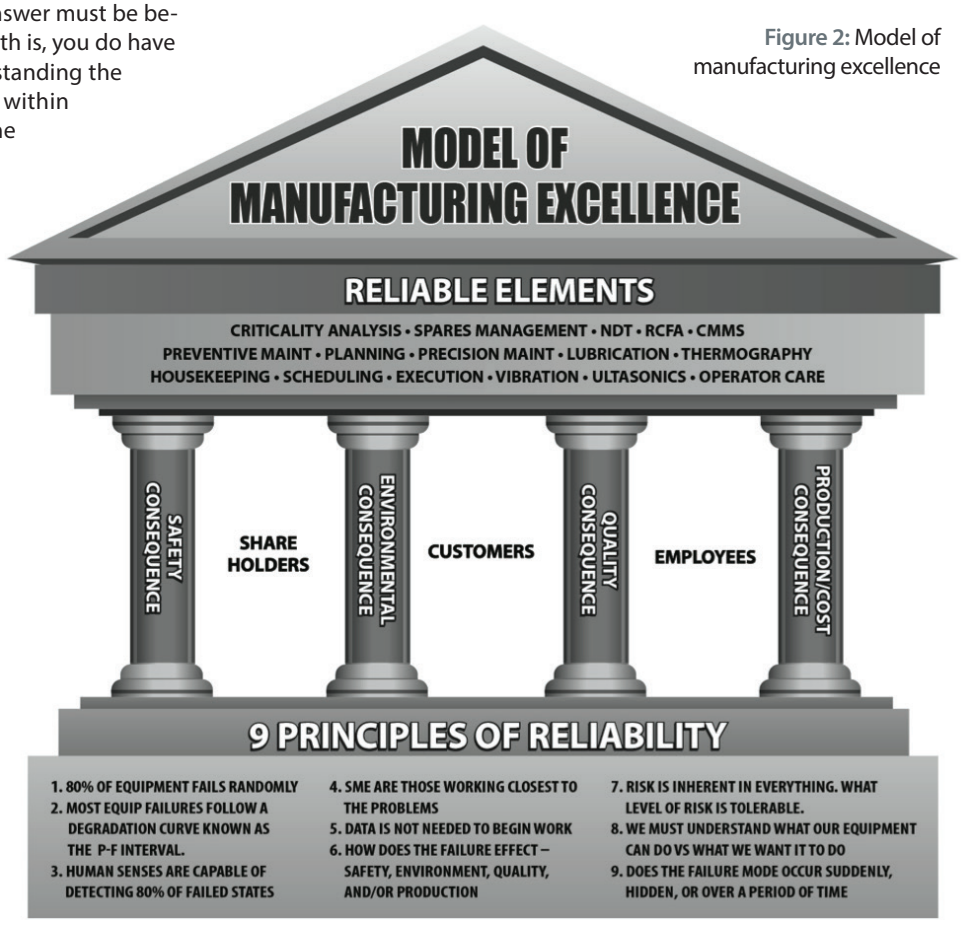

Figure 2: Model of manufacturing excellence

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Not a Buzzword but a Great Opportunity!

by Enrique Mora

A good number of global organizations are now pursuing an ambitious goal: **Operational Excellence** (OE), triggering overwhelming anxiety in some of their surprised plant populations.

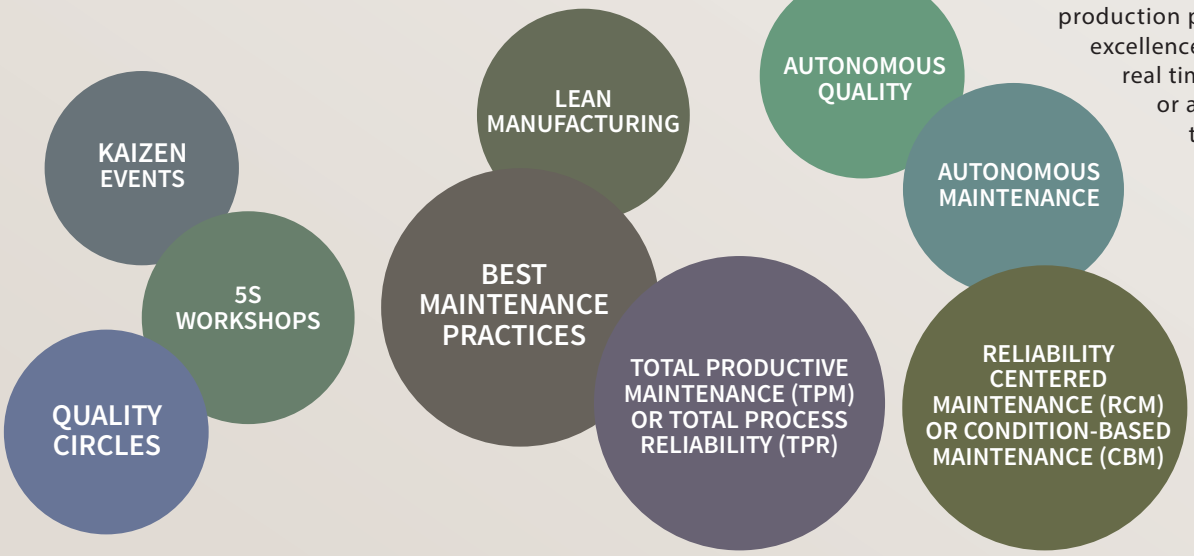
Of course, there is a good reason for setting such an ambitious goal: **Competition.** There is some scarcity of information on the subject and some people may feel threatened because they easily confuse excellence with perfection. The good news is there is research and development that takes this concept into application in everyday operations.

> "Perfection is not attainable, but if we chase perfection we can catch excellence."
>
> Vince Lombardi

CLARIFYING

The first step is clarification. You've probably already done something like it without calling it by its official name. You might have actually done some groundwork toward it. You have been driving in the right direction, so you are closer to the achievement than you thought.

If you have done any of the following:



Great News! You are aware of all you need to establish operational excellence.

INCLUSIVITY OF THE WHOLE POPULATION AND TRUE EMPOWERMENT

All the associates can now freely bring up their goodwilled creativity and objectivity to enrich processes, products and infrastructures. This contributes to operational excellence.

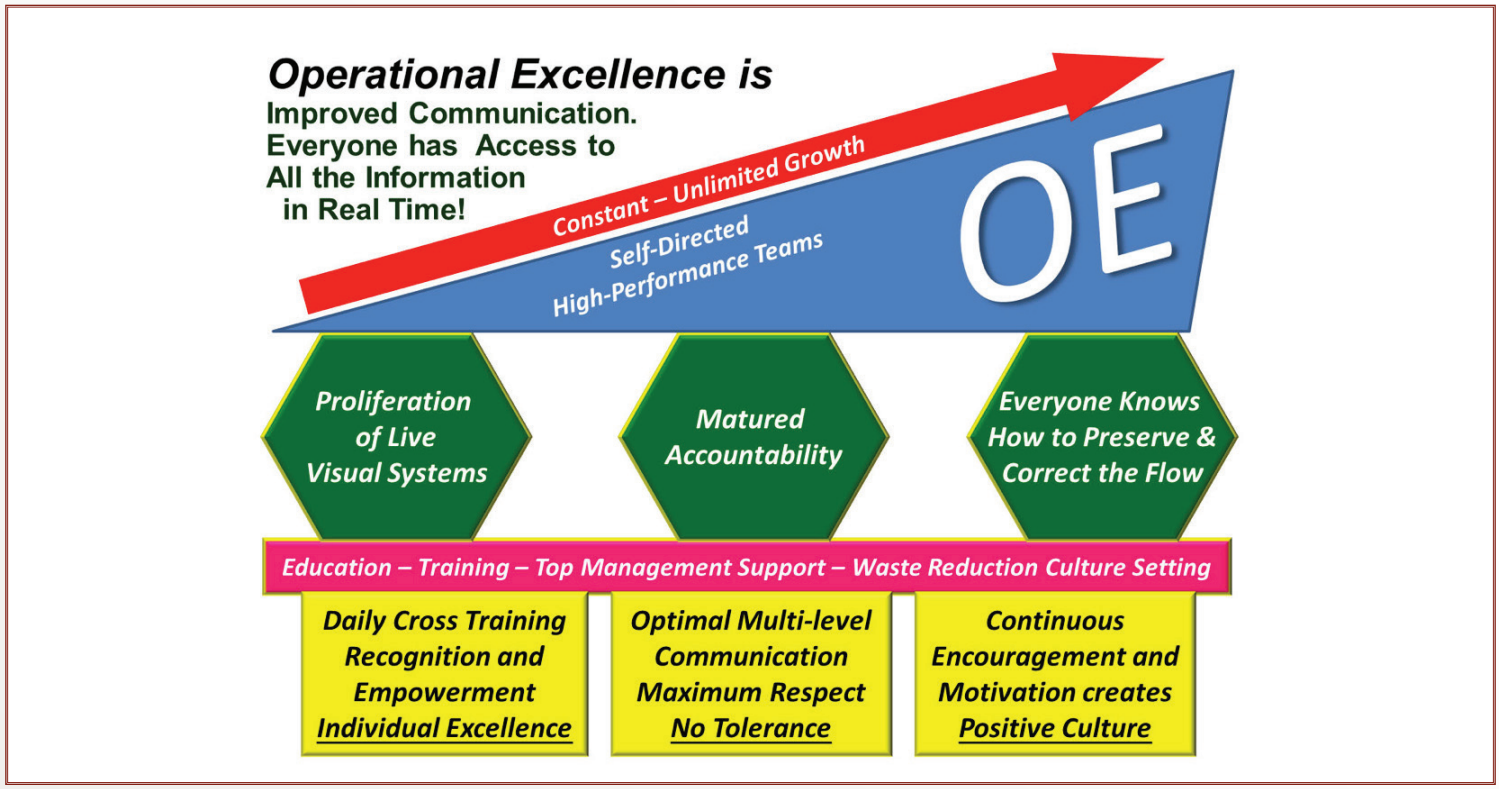
One vital sign in the new environment is that associates at all levels are not only listened to, but also are daily trained, equipped and empowered to do their duties in an autonomous manner. Leaders can now focus on the big picture and the challenges of the future. Everyone becomes aware of the co-responsibility of watching for any possible losses. They all feel the ownership of the business.

ENHANCED VISUAL SYSTEMS

Each day brings improvement in technologies. With the advantage of these continuously improving technologies, everyone now can be clearly and timely informed of the process flow. This is happening for administrative and production processes. With operational excellence, all associates are aware in real time of the possible obstacles or alterations that might affect their flow. They can now develop standard processes to ease and help with informed timely corrections. They are empowered and able to act this way without having to wait around for any authorizations. This prevents delays and stoppages that today still plague trditional administration and manufacturing processes.

MANAGEMENT DEVELOPMENT

Leaders at all levels have an important task in front of them to help operational excellence happen. To take advantage of this opportunity, they will need to go into overdrive in their process of strongly educating and training their teams. The great advantage is that all these efforts result in true operational excellence empowerment. The leaders will benefit from:



- Fewer micromanagement tasks;
- More effective and responsible teams;
- True accountability from all;
- Better team-wide attitudes;
- Higher levels of cooperation;
- Excellent working environment;
- Higher quality of everything they do;
- Longer tenure of their best people.

Once they achieve this, minor tasks that usually consume and, at times, waste leaders' time are lifted from their shoulders by team members so the leaders now have the time to better see the big picture.

This enhanced vision is perhaps the most important benefit of operational excellence.

> In operational excellence, however, the key ingredient is commitment.

Managers will be in a position to help their operation not only survive, but compete and grow beyond the traditional expectations!

OE STRENGTHENS YOUR EFFORTS

All these features of operational excellence are aligned with all previous efforts, such as kaizen events, TPM, RCM and lean, and bond them into a strong, structured and solid discipline with higher standards of performance, accountability and ownership by everyone. The population gradually matures and enjoys the cultural improvement.

WHERE AND WHEN CAN YOU GET STARTED?

One of the most noticeable differences of operational excellence is the criticality of the initial approach. That is actually the main ingredient that, unfortunately, is missing in many poor implementations of any discipline or strategy. In some cases, though, even with that flaw, some satisfactory results can be obtained. In operational excellence, however, the key ingredient is commitment. Commitment is paramount when you need improvements to become a real breakthrough. As you work toward excellence, it becomes evident that the main technique to achieve the culture needed is example. This means that top management must be the source of inspiration, the engine of change, the exemplary behavior to be followed by everyone.

While most other strategies produce a certain amount of improvement even if the commitment is low, operational excellence will not fly without the fuel produced by that kind of commitment from the top. Many companies fail in their intention simply because there are some top managers who still believe that they are immune to any new disciplines. Their idea is, "Everybody should abide….. but me."

Where to begin is clear: You must start at the top.

When is also clear: When the organization is ready. It will happen when you decide to do away with traditional tolerances and conformity behaviors.

It has been proven in many cases. One switch of mind-sets was established a few years ago when Bill Ford, executive chairman of Ford Motor Company, faced criticism for bringing in the CEO who has turned things around for the important automobile manufacturer. Alan Mulally came to Ford to work hard in changing the culture and in the last few years he succeeded big time at that.

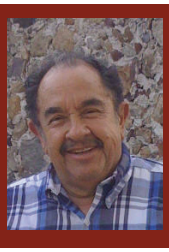
Another example of that kind of adventurous determination is doubtlessly Jack Welch, who in a few years turned GE's destiny into the brightest ever for the giant. A good number of other enterprises have followed these great champions.

START AT THE HEAD OF THE ORGANIZATION; CREDIBILITY WILL FOLLOW, RESULTS WILL BE UNSTOPPABLE!

What needs to change first? Attitude! The goal is to get everyone in the organization to understand that they all own the success or the failure. Hierarchies are gradually blurred as the common knowledge, responsibility and accountability grow.

For the most part, everything will fall in place when you achieve such an atmosphere. Each individual in every area of responsibility will deliver if they are adequately motivated. This, of course, demands an unusual assignment of effort and attention to fundamental education and training. Any investment in this regard will have spectacular returns.

Operational excellence is not something you implement because it is a healthy and fashionable trend. Rather, it is a priceless status that everyone will all live and enjoy!



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THE LOST ART OF SCHEDULING

By John Reeve

PRIMAL FEAR:

"Schedules have due dates. And, management will hold us to these dates. We could get in trouble if these dates are missed."

ASSET MANAGEMENT SYSTEM (AMS) IMPLEMENTATION

AMS implementations are usually quite involved. Software is installed and configured, processes are documented and improved, and roles and responsibilities are clarified. The project team will identify as-is and to-be processes. More importantly, the project manager must facilitate these workshops, coordinate resources and communicate change. With so much at stake, why aren't AMS project managers making full use of the project management tools, such as scheduling software?

DIFFERENT SCHEDULES	DEFINITION
Daily Plan	A power plant's operation and maintenance (O&M) daily schedule of events and work
Weekly Schedule	Weekly maintenance schedule
Outage/Shutdown	Power plant's scheduled shutdown (4 to 8 weeks)
Major Modification	Major work (e.g., modification or overhaul; redesign)
Software Implementation Projects	Large software projects that can last for months. Therein this type of project can benefit from activity and resource coordination.

Table 1 – Different Schedule Types

SCHEDULES: OFTEN PERCEIVED AS A NECESSARY EVIL

Most software implementations have a high-level schedule at the start of the project. However, the creation of the schedule is commonly believed to be a one-time effort. Usually, this high-level schedule resides in non-scheduling tools (e.g., Microsoft Excel®) and is never expanded in detail or progressed. Unfortunately, this means many of the benefits of using a critical path methodology (CPM) tool are never realized. The project manager (PM) should welcome technology that forecasts activities and resources based on activity progress.

ROLLING WAVE SCHEDULE

The software implementation may be a four-phase approach:

1. Establish requirements,
2. Design,
3. Build,
4. Test/train.

Because of the many unknowns early in the project, there is often a hesitation to build a detailed schedule. I agree that there can be many unknowns. But the way around this is as follows: state your assumptions; outline the scope; build details where known; insert logic ties; and create a critical path. It is quite common to have a rolling-wave such that activities close to the data date (where progress is reported "as of") are more detailed and activities in the future are high-level.

WHAT DEFINES FAILURE OF A PROJECT?

AMS implementations can fail before or after going live. But, a properly built implementation schedule can help prevent failure by providing visibility to problems before they occur. Table 2 defines symptoms encountered before and after the go-live.

BEFORE GO-LIVE	AFTER GO-LIVE
Cost overrun	Return on investment (ROI) never realized
Project finish delayed	Processes lack clarity; no business rules
Product quality inferior	Users complain of lack of training or system complexity
Misunderstood scope	Management complains about lack of value-added reports
Improper expectations	Lack of core team

Table 2 – Trouble Indicators

The above issues won't necessarily stop implementation, but when schedule and cost overruns occur this can introduce a negative connotation about the overall product.

A COMMON FEAR

Clients and consultants seem to misinterpret the purpose and benefit of scheduling. Their primary concern is normally around the dates, in particular, what happens if a date is not met? Upper management may be influencing this thinking. At project initialization, their primary focus is often the overall finish date - and total cost. They may have said, "Make sure nothing changes!" Unfortunately, this type of guidance from upper management conveys the wrong message, meaning "no activities or dates should ever change." In the scheduling world, it is generally understood that a progressed schedule will have activities that move around and details added.

However, some see a project schedule as something that must exist only on day one and should not be updated. Perhaps the project manager made one because they needed it to win the job. It could have shown high-level activities, but otherwise has minimal value. In absence of day-to-day scheduling, the PM resorts to managing staff and actions from a punch list.

PROGRESSING THE SCHEDULE

Anyone can build a schedule, but a lot fewer can successfully update one. This doesn't mean it can't or shouldn't be done. A special skill set is usually required. The scheduling role requires someone to bird-dog individuals for status updates. Typically, there is a weekly AMS status meeting. Although the

> The definition of progressing is not only percent complete, estimate to complete and expected restart or finish, but also, the addition of new details, deletion of incorrect data, alteration of durations/ constraints, calendars, assignments and logic ties.

scheduler may not be running the meeting, he or she must glean the necessary information during each update cycle to properly reset the schedule. This individual needs to know what work is completed, what work is underway (and when it will finish), if it's on hold (and expected restart) and future starts. A schedule may have 1,000 activities, but the scheduler only has to focus on the work straddling the data date, which is a much smaller subset.

WHAT TO DO IF THE PROJECT FINISH SLIPS?

Note: The scheduling tools provide a baseline tool. This means it is possible to compare current schedule to a frozen baseline.

The project finish can and will move around each time updates are performed. Any unusual slips, however, should be evaluated. The recommended procedure is to go through a checklist of actions:

1. Is the updated schedule correct? Did we get bad or missing input from a worker? Was the recent progress updated incorrectly?
2. Ascertain what changed on the critical path. What was the main driver? (Note: Some activities can slip without impacting the critical path.)
3. Reference your previously frozen schedule or baseline taken before the update.
4. If all the data is valid, then ask the team how to manage the critical path to bring it back. Should we:
   a. Increase staff on current and subsequent tasks? Is that even possible?
   b. Change activities from working only on day shift to around-the-clock?
   c. Identify what is slowing them down and delaying the critical path? How can the impediment be removed?

SCHEDULES ARE INTENDED TO BE REFINED

It is fully expected that any schedule will change. You may be expanding detail or you may be adding new scope. Using a rolling wave concept, it is quite common to expand details as the data date moves forward. These actions are usually combined with periodic status updates. The update frequency might occur weekly for a six-month software implementation, whereas a nuclear power plant outage lasting three to six weeks might gather progress daily. This updated information is intended to provide the entire team with accurate forecasts to aid in work coordination. Yes, the dates will change, but the focus should be on content, critical path and resource management. It should be noted that the only time you will ever have a perfect schedule is once a project is finished.

BENEFITS OF FORMAL SCHEDULING

A detailed schedule should be your number one communication tool. A bar chart can show activities under a calendar strip, which means you can see other work being performed at the same time. This graphical display also provides visual reference to all departments showing upcoming activities and prerequisites. It tells management when they will need certain resources during the project and where they are overloaded. The scheduler could also perform what-if calculations to evaluate impacts by:

- Adding/subtracting resources;
- Changing activity calendars;
- Global edit durations (e.g., multiply by .90).

Once the schedule is flowed, it needs to be printed out so other team members can then comment or critique. Input from others is always wel-

TABLE 3 – ONE-SIDED COMPARISON

BENEFITS COMPARISON	NON-SCHEDULING TOOL	FORMAL SCHEDULING SOFTWARE
A basic list of work – tabular listing	●	●
Start and finish dates with automatic float calculations		●
Entry of predecessor and successor (logic ties)		●
Activity progressing against a data date (e.g., remaining duration = 4)		●
Program evaluation review technique (PERT) chart graphically displayed and printed; Ability to insert new activities in PERT mode		●
Logic bar graphically displayed and printed		●
Critical path determination		●
Resource leveling, manual or automatic		●
Able to create a frozen baseline and make comparisons		●
Activity schedules can be linked to work breakdown structures		●
Activity schedules can be linked to AMS systems		●
Multiple schedules can be pulled together into a master schedule		●

comed to validate accuracy of the critical path. In summary, a properly built schedule helps to minimize mistakes and reduce risk.

The spreadsheet tool may be made to *appear like a schedule* (e.g., bar chart display), but other than that, it lacks significant functionality. And a simple list tool also does not manage prerequisites or create date forecasts. The scheduling software, however, provides a list of prerequisites, critical path and cost forecasts. In some scheduling products, the user can follow the critical path backwards and quickly find the driver. A schedule can also be linked to a work breakdown structure (WBS), where scope and cost are closely managed. Tip: it is best to create the WBS before the schedule is created.

IT'S OKAY TO GUESS

Planning and scheduling as a profession is hard for some to wrap their head around. It is not an exact science. The planner/scheduler has to provide estimates, also called guessing. Sometimes, you have to state your assumptions to explain why certain activities were created. In the maintenance department, a planner must routinely estimate work that has not started in terms of task steps, duration, craft code, number of personnel, estimated hours, materials and tools. The planner could guess wrong, but what's worse is to have no guess at all.

SCHEDULES HELP REDUCE RISK

Scheduling is a form of communication. Wouldn't you rather know if the project finish is in trouble before the last minute? As a project manager, you have a lot of areas to manage, including scope creep, change management, resource management and regular updates to the stakeholders. The project manager is responsible for maintaining the master schedule. The schedule helps you to remember what, when and who. Ask the question: Which is better, a list of activities or a logic bar chart with critical path and projected finish? In the end, having a detailed schedule in place can help the team anticipate problems and, therefore, reduce the probability of failure.

AGILE IMPLEMENTATIONS NEED DETAILED SCHEDULES

Because agile strategies make use of cross-functional teams, including contractors/consultants, it is extremely important to have a detailed sched-

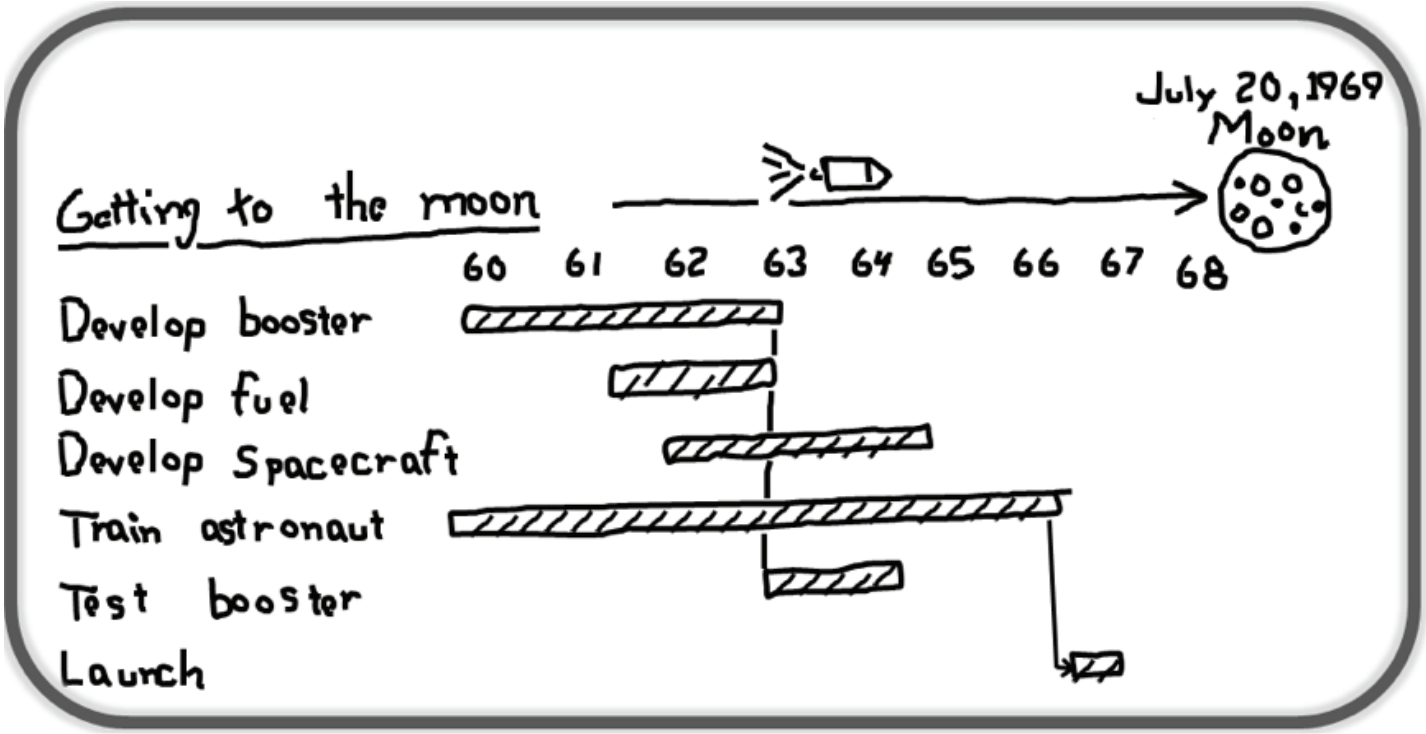

Figure 1: Even if a schedule is hand drawn, it is better than having no schedule at all

ule that shows resource assignments and expected delivery dates. There is also a chance that intermediate milestones may overlap due to progress. The scheduling tool helps provide clarity and visibility.

> **Definition:** There is a new implementation methodology called agile. This style of implementation uses a series of mini development projects that are all combined at final go-live. This phased development benefits from early involvement of users to gain acceptance and design approval.

WHY DO FEARS REMAIN OVER SCHEDULING?

With all these benefits, why do fears remain? Most likely, the reason is as simple as training. Many believe they know the purpose of a scheduling tool, but they do not. Scheduling software is one of those products that may be quickly installed and self-taught, but more often the users are not aware of best practice techniques for managing/updating the schedule. Or, they may be missing conceptual knowledge relating to scope control, time management, cost, job quality and risk management. Here are some other points to remember:

- When updating a schedule, dates can and will change, not only on the activity being updated, but also on all downstream activities. Thus, the project finish date may move around.
- Even if the project manager doesn't want to show each update to the executive level, it is still to the benefit of the team to regularly update the schedule to get realistic dates.
- It is helpful to have a team member, usually the PM, perform the scheduling role. This requires that person to own the master schedule.

CONCLUSION

Bad things happen when a schedule is not properly utilized. Good project managers depend on this medium to manage the unknown. A master schedule helps staff to focus on the critical path. People often build small schedules on a whiteboard when they are talking. It is a natural way of communicating. The act of scheduling helps the entire team focus on the path forward and provides assurances that everything has been thought of. Forecasting the future is not easy, but it sure beats not having any forecast at all. And by managing the schedule, you increase the odds of success.

John Reeve is a seasoned professional and consultant with over 25 years of diverse industry experience, with expertise in work, asset and reliability management system design. Mr. Reeve obtained United States Patent 7421372 for maintenance scheduling involving unique order of fire routine in support of resource leveling. www.cohesivesolutions.com

Increasing Uptime Through Filtration

Rare earth magnetic technology can save your maintenance budget thousands of dollars

by Roger Simonson

Contamination is the leading cause of downtime in fleets. It increases the need for fluid and filtration change out and results in increased wear to integral system components. Industry research states that iron, steel and silica particles below 10 microns in size are the most damaging contaminants in lubrication, hydraulic fluid, coolant and fuel systems.

Ferrous metal contamination in fluids results in premature wear, accounting for 90 percent of equipment failure. The sources for the majority of these hard wear materials are caused by manufacturing and assembly processes, break-in wear, air breathers and contaminated new oils/fluids. The contamination found suspended in new oils and fluids is the result of corrosion and erosion of the carbon steel storage reservoirs and piping systems used for transport.

New fluids introduced into equipment contain contamination particles that flow throughout the system, accelerating the wear cycle. New fluids maintain this degree of contamination, even when prefiltered by traditional filtration, because the particles, which are below ten microns in size, are missed. This contamination is not all removed during normal oil or fluid change out, as it hangs up on the components and builds up over time, increasing the wear cycle. The result is downtime for repairs, increased operational expenses and loss of productivity.

Traditional depth media filters are made of paper, polymer, or fiberglass, which allow worm holing or channeling to occur. This occurs when the contamination cuts a hole through the media and the residual contamination follows the path of least resistance, traveling through the hole and reducing the filter's efficiency.

Over the past 18 years, new magnet technology has been developed to remove the ferrous and non-ferrous contamination to sub-micron levels with minimal flow restriction. This rare earth magnetic filtration incorporates a powerful magnetic radial field design. The non-ferrous contamination is attracted to the magnetic field through static adhesion. A dual filtration design incorporates a stainless cloth, a depth media filter element and magnetic filter for engine oil, and fuel and hydraulic applications. These filtration systems are cleanable, reusable and offer a long life of 10-plus years.

Based on the performance of magnetic filtration technology, it is becoming clear that this technology is part of the solution to end downtime caused by contamination.

CASE STUDY

In August 2012, STEP Energy Services began having inherent problems with fluids being used in its fleet maintenance. Contaminated oil, glycol, fuel and hydraulic fluid were causing premature component wear, resulting in downtime. The contamination could potentially cause premature failure if not properly filtered.

Traditional depth media filtration was unable to filter contamination under five microns in size efficiently, while tolerances on hydraulic components and bearings were below three microns to sub-micron in size. Contamination, if left in the system, would cause premature wear of the components and reduce the oil and fluid life.

In the fuel line, contamination can cause premature wear to the injectors, pistons and even the fuel line, resulting in increased expenses to replace these system components prior to the anticipated maintenance interval.

Coolant contamination is the cause of more than 70 percent of engine failures, yet most original equipment manufacturers still do not install any filtration on their coolant lines. The small number of those who do, install filtration that is efficient to 30 microns, while the majority of contamination is below 10 microns to sub-micron levels. This contamination wears through the walls of the coolant jacket, contaminating the oil and causing hydraulic lock, acid formation, bearing damage, oil balls, oxidation and filter plugging, all of which can lead to engine seizure.

Cold start-ups is one area where STEP Energy Services realized the advantage of magnetic filtration over traditional filtration. Traditional filters are in bypass during cold start-ups, thereby the system has no protection. On the other hand, magnetic filtration has minimal flow restriction and will filter the fluid or oil to sub-micron levels on cold start-ups, thereby protecting the equipment's integrity.

STEP Maintenance Manager Dale Constantine tested and now employs magnetic filtration systems as the standard for all equipment. The twin pumpers employ heavy-duty reusable stainless screen filters in the lube circuit on the quintuplex pump, while the coiled tubing units use a hydraulic suction manifold filter (scrubber). In addition, y-strainers are installed on many circuits, including the hydraulic, coolant and fuel circuits.

Figures 1 through 4 show the trapped contamination, ranging from 100+ microns to sub-micron levels, that protects the equipment from premature wear and failure. The magnetic filtration technology never goes into bypass, even when traditional filter elements are unable to filter the oil, it still passes the magnetic filter, never losing filtration efficiency.

Figures 1 and 2 highlight the magnetic filters' ability to remove non-ferrous and ferrous contamination. In **Figure 1**, the filters trapped copper and in **Figure 2**, rubber flakes.

"The amount of contamination found in the twin pumpers oil circuit (Figure 3) would have clogged off between 15 and 20 traditional filters and caused component failure," states Constantine.

Figure 4 shows the contamination removed from a hydraulic suction manifold after the traditional five micron filter (one year service interval).

By employing magnetic filtration on every possible application and analyzing the contamination trapped on the magnetic filters as part of its maintenance program, STEP Energy Services is enjoying the highest level of equipment reliability in the industry.

Figure 1

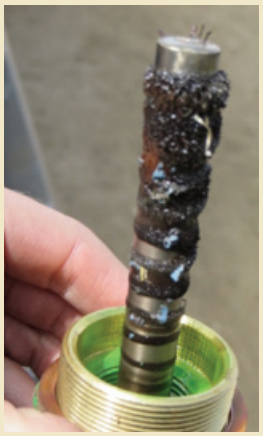

Figure 2

Figure 3

Figure 4

With the predictive maintenance program STEP Energy Services has in place, the company has seen tremendous savings over the course of its existence. "A comparison of industry standards versus STEP's in relation to the number of oil changes and barrels used on the twin pumper CAT engines, twin pumper tractor engines and coil units showed a cost savings in excess of $78,000 in maintenance up to March 2014," says Constantine.

Roger Simonson is the President and founder of Black Powder Solutions, a company that designs and manufactures black powder separation solutions, and One Eye Industries Inc., a company that designs and manufactures magnetic filtration products. Mr. Simonson designs and is the patent holder of the filtration technology and has 17 years in the industrial filtration market.
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Induction Heating and Safe Operations in the Industrial Workplace

by Jack Rubinger

So many people rely on induction heating every day, possibly without even knowing it. Induction heating is used to seal the caps of food containers and pharmaceuticals. A layer of aluminum foil is placed over the bottle or jar opening and induction heating machines fuse it to the container. This provides a tamper-resistant seal, since altering the contents requires breaking the foil.

According to Ambrell, a cap to container seal is made with the aid of a laminated disc composed of a wax layer, aluminum layer and a polyethylene (PE) layer. The aluminum layer acts as a susceptor, heating to about 125 to 150 degrees C in the electromagnetic field produced by the induction coil. It then heats up the wax and PE layer sufficiently to produce a hermetic seal between the cap and container. Heating time is less than a second in this high-speed, low energy consuming automated process.

Sealing caps on food containers and medications are pretty much taken for granted, but imagine the health and safety dangers, as well as the nasty molds, consumers would be subject to if these caps weren't properly sealed. The most extended induction application in this industry is the high-speed hermetic sealing in tamperproof packages, cap sealing and aseptic packaging. This technique guarantees the integrity of the seal, as well as the preservation of the product for longer periods of time.

Benefits of induction heating include:

- Rapid, efficient heating,
- Precise, repeatable heating,
- No flame.

One of the major benefits of induction heating is its energy efficiency. "Reduced energy usage in the manufacturing process is a win-win for developing a competitive advantage," says Mark Davis, Inside Sales Manager of Eldec Induction LLC. "Going green in manufacturing is more than a philosophy, a strategy, or a responsibility. It just makes good 'cents' to reduce and conserve. Induction hardening or heating releases less internal residual stresses as a result of the lowest possible energy input – measured in kilowatt seconds – and, therefore, only a small fraction compared to the total mass that has to be quenched during the final heat treatment. The lowest possible energy input and resulting reduced energy consumption translates directly into improved environmental benefits."

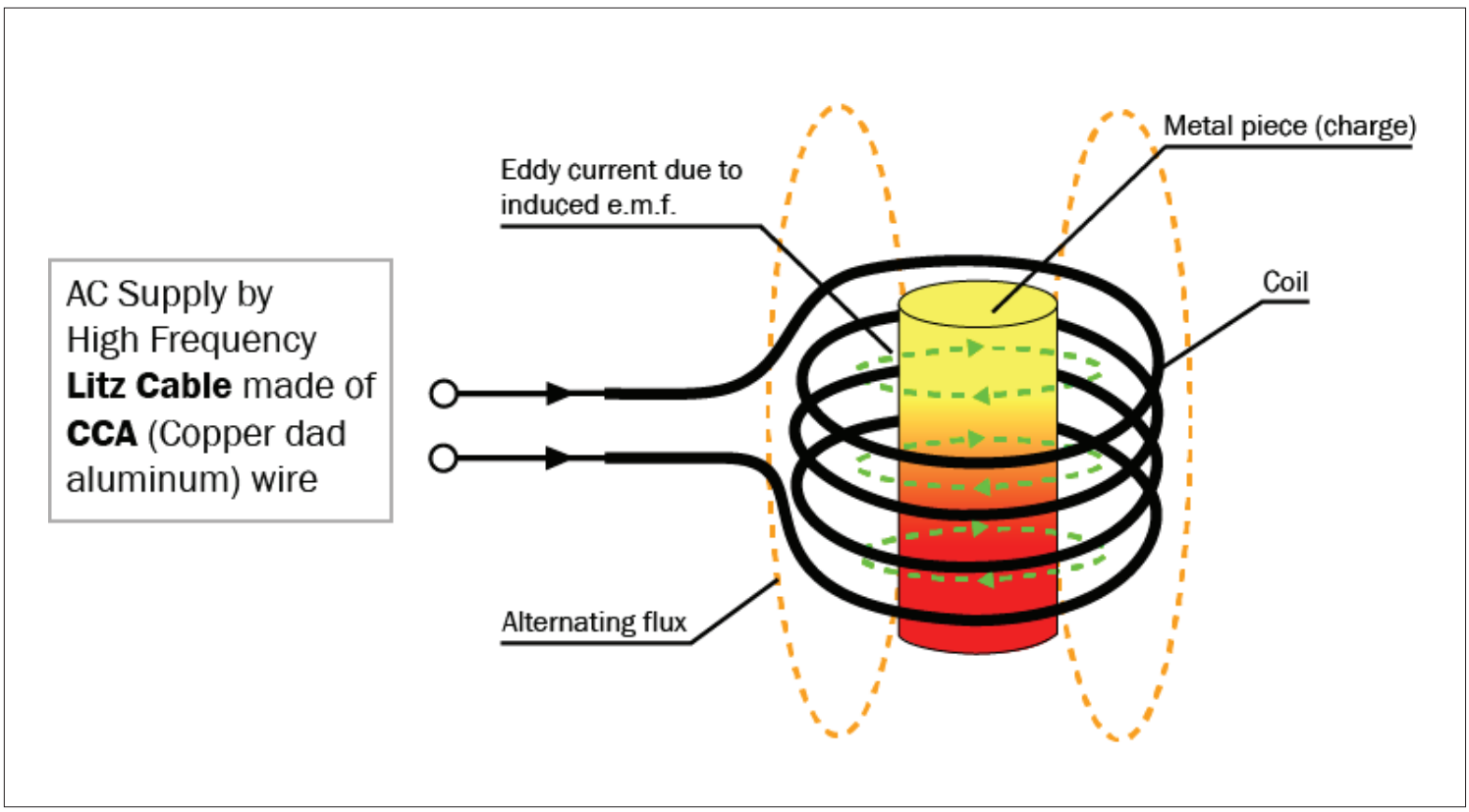
Induction heating is an environmentally friendly alternative to traditional heating methods, such as blowtorches, oil baths, ovens and hot plates. These expensive methods produce smoke, fumes and oil waste, and are hazardous to personal safety and working environments.

But there are dangers associated with the induction method of heating. Fortunately, the 2014 edition of the National Fire Protection Association's NFPA 70: National Electric Code addresses these concerns with specific guidelines for warning labels, signs and equipment marking.

Warning labels or signs that read, "Danger – High Voltage – Keep Out" shall be attached to the equipment and be plainly visible where persons might come in contact with energized parts when doors are opened or closed, or when panels are removed from compartments containing 150 volts, AC or DC.

In addition, a nameplate must be affixed to the heating equipment, providing the manufacturer's name, model identification and the following input data: line volts, frequency, number of phases, maximum current, full load kilovolt-amperes (kVAs) and full load power factor. Additional data is permitted.

Incorporating best safety practices involving induction heating can be accomplished with advice from suppliers who uses induction heating techniques for new product development, process evaluation and troubleshooting. Consultants work primarily with operators and line forepersons who are responsible for day-to day-equipment operations. Best practices include using lockout devices when servicing equipment.



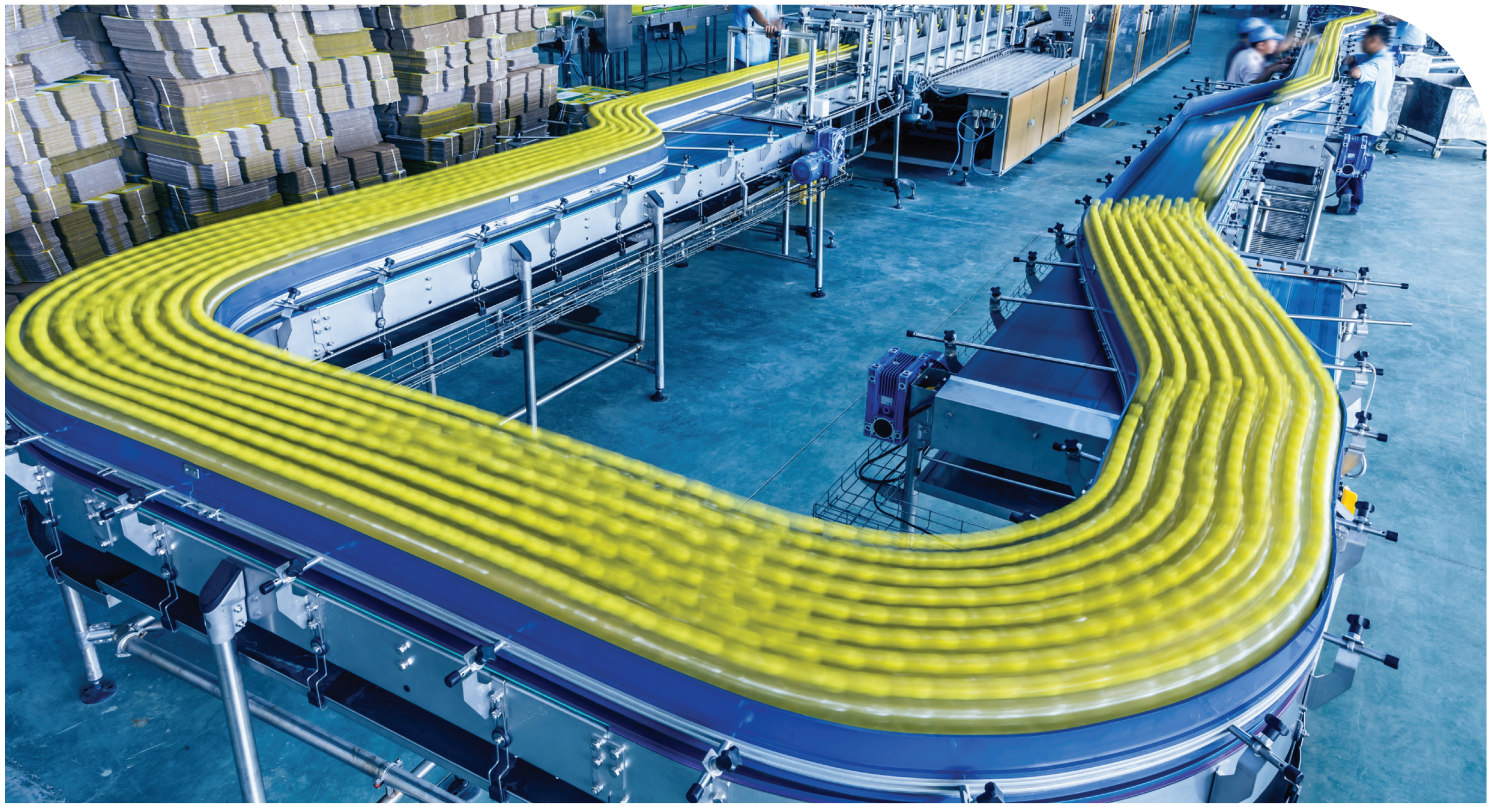


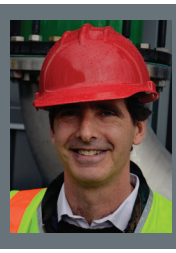
Figure 1: Lockout labels indicate that equipment has been disabled for maintenance or some other reason

Signs and labels should be used in facilities to warn workers about the dangers of working with induction heating on power supplies and coils that utilize high voltage. Another recommendation is the use of personal protective equipment (PPE) associated with working with induction heating. All equipment should utilize light guards or similar protective devices to prevent both contact with the coil and moving mechanical assemblies that might harm the operator during automatic operations.

Induction heating is also used for all types of:

- Forging and melting;
- Brazing;
- Soldering;
- Heat treating;
- Semiconductor and optical fiber applications.

New technology, even green technology, poses potential hazards to the modern workforce. Ensure that your number one assets - your workers - are well informed of workplace dangers with aid from safety signs, labels and PPE indicators throughout your entire heating induction system.



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Get Ready, Here Comes the Ultimate Multi-Skilled Worker

by Jeff Owens

It seems like everyone is talking about the skilled labor shortage. From the New York Times to the National Association of Manufacturers (NAM), people are debating the issue of whether there really is a skills shortage or a lack of people with the right technical skills to work in today's manufacturing. Many, including the New York Times, blame the problem on what they refer to as mismatched skills. Or, in other words, the workers have skills, just not the ones they need for the growing complexity of manufacturing.

Adding more fuel to the debate, manufacturers have laid off more than two million workers since 2007. So how can an industry that so many are disappearing from suddenly need more workers? It is a paradigm that only can be explained by supply and demand. There is a large supply of workers available, but the demand from today's manufacturers is for workers with the highest technical skills in the history of modern manufacturing.

It's no secret manufacturing has changed. In 1950, 60 percent of all manufacturing jobs could be handled by unskilled labor. By 2005, less than 15 percent of all manufacturing positions were unskilled, according to the Employment Policy Foundation.

EMPLOYMENT POLICY FOUNDATION

As manufacturing has continued to automate and reduce its workforce through the elimination of low-skilled employees, a new elite manufacturing technician is beginning to surface. A worker armed with reading, writing and math skills, plus advanced problem-solving capabilities. But where is this new elite worker to be found? The search continues to weigh on manufacturers. In fact, 83 percent of U.S. manufacturers surveyed in 2005 for NAM's Skills Gap Report indicated a shortage of skilled manpower already affecting their ability to serve customers. And the problem is growing, as the Washington Post indicates that baby boomers are retiring at an alarming rate of 10,000 per day. According to the U.S. Bureau of Labor Statistics, by 2030, the last of the baby boomers will have reached retirement age and 77 million baby boomers will have left the workforce.

SO HOW DO WE FILL THIS GAP?

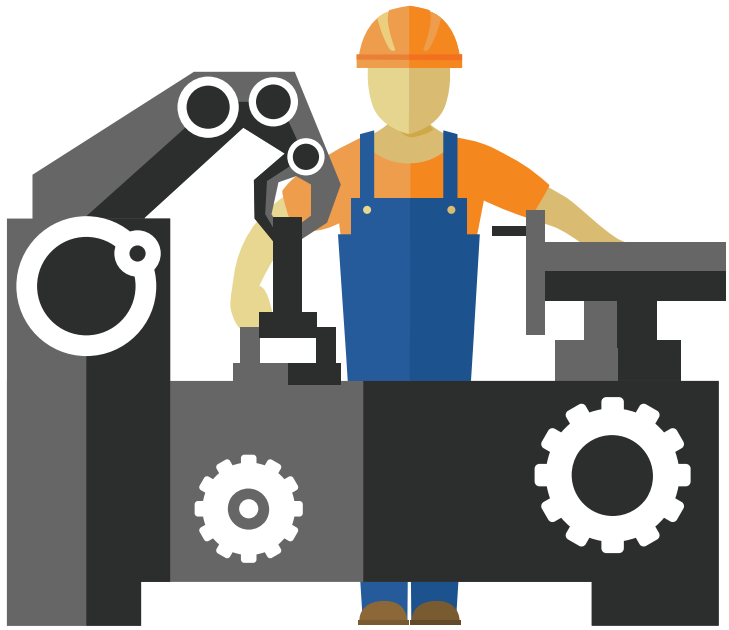
In some companies, such as professional maintenance organizations that provide production maintenance services for highly complex manufacturing assets, training employees to become this elite, multi-skilled technician has been ongoing since as far back as the mid-1980s. But, multi-skilled maintenance technicians don't grow on trees. All the numbers support the fact that maintenance professionals are in short supply, but the reasons for the shortage go deeper.

Never has there been more emphasis on asset productivity than in today's global manufacturing environment. Many manufacturers have identified production maintenance as one of the top contributors to increased productivity. And with the rising cost of downtime, manufacturers don't need wrench turners. They need proactive technicians who can head off problems before they create chaos.

So the logical question would be, is there a skills shortage or a training shortage? It's more of a question of what comes first. Without proper training, workers are not able to obtain the skills they need to be employed in today's high-tech manufacturing. And without a large number of these elite masters of manufacturing, there will continue to be a skills shortage.

In the past, manufacturing companies invested in apprentice programs and provided ongoing training to their employees. Then came the rise of increased competition and globalization, and apprentice programs became a cost cutting casualty, at least at most companies.

Training for manufacturing used to start at an early age. "When shop classes began seeing a decline in the 1970s, coinciding with a push toward college-bound classes, so did the number of young people entering skilled trades. Shop classes were largely eliminated from American high schools in the 1990s because they were expensive to run and sometimes dangerous. Now, industries facing a worker shortage are pushing for the classes' return," according to Alexandra R. Moses' book, "Shop Classes Return—with a 21st Century Twist."



Some companies have also established scholarship programs to ensure that U.S. manufacturing continues to thrive. The programs seek to prepare students for a fast-track career as a leader in manufacturing. Recipients receive tuition assistance and an opportunity for a paid summer internship with the company. The opportunity provides real-world, hands-on experiences, as well as leadership training, preparing students to compete for top jobs after graduation. This customized, well-rounded approach to technical training has helped companies identify and promote new leaders for their business.

The U.S. military has provided an excellent source for finding and recruiting skilled workers. The culture and sense of mission and discipline these returning veterans and former military personnel embody allow companies to hire for culture and train up for skills. And companies with over 25 percent of its employees having military experience find these veterans are very much at home working together.

Another approach used by companies is to tap into businesses that teach the skills needed for production maintenance on the technically complex manufacturing assets seen in today's manufacturing. Their courses teach students everything from basic electric to advanced power line communication (PLC) and computer numerical control (CNC) technology. And just as important, the training is used to advance the careers of the more senior technicians, which forms a bond to increase the retention of these valuable employees.

So as manufacturing is faced with a skills gap crisis, it must be creative and resourceful to find tangible solutions. According to NAM, the skills gap will only get worse. In fact, NAM predicts that 40 percent of factory jobs would require post-secondary education. That's why any current training offered should have an emphasis on post-secondary skills, including hydraulic theory, advanced electrical applications and more.

It's a new era in manufacturing. An era that requires a new kind of worker. Until this elite worker is available in ample supply, there will continue to be a skills gap of mismatched workers attempting to do today's work with yesterday's tools.

NAM predicts that 40 percent of factory jobs would require post-secondary education.

For companies that employ the highest skilled technicians, it has always been important for them to recognize the importance of training early on. Reaching out at the high school level has been a strategy used to introduce talented young students to their training programs. Through a thorough assessment program and customized training, students get both classroom and on-the-job training under the watchful eye of a veteran manufacturing professional.

Jeff Owens *has been the Chief Operating Officer and President for Advanced Technology Services, Inc. (ATS) since 2004. Mr. Owens has over 25 years at ATS and has been responsible for operations, strategic planning and implementation of ATS' major growth initiatives. He is a graduate from Westminster College with a Bachelor of Arts degree, majoring in business administration.*
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Turning the Oil Tanker

– Don't Get Locked into Your Performance Management System

by Daniël A. Lachman
and Roy O. F. Tjoen A Choy

This article highlights the hidden trap of performance management systems. Though the idea behind such systems is usually sound, getting bogged down in those systems can cause an organization to be slow in responding to driving factors from the environment that require it to change. This article draws parallels with concepts and theories from thermodynamics and recent insights from economics and applies them to the organizational setting. Performance management systems that govern the drive toward reliability excellence and organizational leadership must have reflection points built in and require continuous scanning of the external environment that influences organizational requirements.

ENTROPY OF ORGANIZATIONS

Many people are familiar with the first law of thermodynamics: Energy can't be created, nor can it be destroyed (though there are some, especially those hailing from quantum physics, who contest this). Less familiar is the second law, which doesn't have a fixed definition, but is characterized through a series of phenomena, such as energy flows automatically from a body with a high temperature to a body with a low temperature, or during the conversion of energy, a portion is always removed in the form of low temperature heat. An important thermodynamic property of materials related to this second law is entropy, which is associated with the notion of disorder and the second law statement that the entropy of a system undergoing a spontaneous process tends to increase. The more processes a system undergoes, the more its entropy increases and the more disorder it has. This entropy has both a reversible and irreversible part, of which the latter ensues that energy exits the system, for instance, heat losses to the environment and friction. The more processes a system undergoes, the greater its entropy and the more energy the system loses. Entropy assessment can be used to indicate the effectiveness of systems by, for example, assessing how much irreversible entropy has been created[1].

Recently, the entropy concept has been applied in economics to explain the unequal spread of wealth across nations. In this article, the concept of entropy will be applied to organizations. More specifically, entropy will be used in the context of performance management systems in organizations that strive though these systems for excellence.

CO-EVOLUTION AND MOMENTUM OF PERFORMANCE MANAGEMENT SYSTEMS AND ORGANIZATIONS

In Schumpeterian economics, the notions of variation, selection and retention are very important in selecting and amassing the right tools to fit within the organizational context. However, as stipulated by the so-called consistency condition, which states that the first prevailing theory supersedes all contradictory theories that follow,[2] many organizations make the mistake of not questioning the basics of their performance management system. This coincides with the concept of the multi-level perspective, discussed in earlier articles published in Uptime Magazine[3, 4], that the rule set or regime sits on top, while various niches or alternative ideas try to break through to the mainstream. Once a performance management system is conceived, the organization tends to grow the system further by incorporating various critical success factors and key performance indicators in an attempt to cover as much ground as possible and make the entire organization transparent.

With co-evolution, the organization builds the performance management system and consequently changes its behavior in such a way that it serves the system. In the case of momentum, the more the performance management system is expanded and used, and the more the organization adapts to the system, the more difficult it is to change that organization to an extent that reaches outside the parameters permitted by the performance management system.

TURNING THE OIL TANKER

So, what does this all mean? The proliferation of performance management systems in organizations and the ongoing co-evolution between the system and the organization causing further momentum renders the organization to be less flexible. As such, the organization is unable to change or think outside the box. This is where the entropy concept comes into play. Theoretically, an automobile that consists of processes that produce only irreversible entropy won't get anywhere; any energy that is converted is lost to the environment through heat losses and friction. One could say that organizations that have fully proliferated their performance management systems throughout all aspects of the organization without questioning its components and even its underlying assumptions have rendered themselves fragile in this continuously changing business environment. To draw parallels with the entropy concept, these organizations achieve full, irreversible entropy and don't get anywhere because they are too vested in their current performance management systems to make swift and sound changes in reaction to the changing environment.

Performance management systems make the organizational dynamics more transparent to higher management and give them more sense of control. It is understandable that these levels within the organization would be unwilling to question the very system that enables them to manage the organization. However, these organizations are hard-pressed to change. Changing them is like changing the course of an oil tanker. Change is the rule now and organizations need to be able to respond to these changing external influences. The 21st century is more about the competitive advantage to change faster than others and to jump on profitable options before your competitors.

RECOMMENDATIONS

Organizations need to accept that the 21st century is all about change. Therefore, they must be willing to question, confront and alter the foundation of their performance management systems. They need to create a culture of continuous change and improvement; whereas the latter frequently refers to improvements in processes, the first is more encompassing and can refer to complete makeovers of companies. To prevent organizations from getting too vested in and dependent on their performance management systems, it is advisable that they adopt these measures as common practices:

- Allow bottom-up feedback/critique regarding the performance management system without perceiving it as an attack on efforts to make the organization more transparent and controllable.
- The performance management system is not set in stone. Be willing to question its underlying assumptions and don't be afraid of the consequences when it appears that the system requires change, or even a complete overhaul.
- When expanding on the existing performance management system, always do it from a cost benefit point of view. Bottom-up feedback is important for this one!
- Regularly scan the future and get engaged in scenario planning in order to be able to anticipate looming and sudden changes in the environment that might impact the organization5.
- By assessing potential futures, design your performance management system in such a way that it is future-proof. Your performance management system will hold up well in each of the different futures, for example, by testing critical success factors and key performance indicators in each future scenario.

These measures will prevent an organization from getting stuck in its own performance management system, thus creating only irreversible entropy, while not being able to respond to changing external influences. The common practice measures will enable the organization to steer its oil tanker in a timely fashion.

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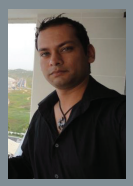

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