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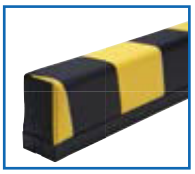

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Run your digital race

Even the toughest loads are easier to bear with a partner and a plan

If you're a regular reader of this column, you know that one of my hobbies is long-distance running. Two presentations this fall reminded me of what it took to run my best full marathon time 11 years ago.

In October 2011 I headed to Ohio for the Nationwide Children's Hospital Columbus Full and Half Marathon. This race had me excited, because the year prior I had completed my first full marathon, but had trained and run the race alone. In contrast, in Ohio I would be running with my close friends Pete and Alyssa, who each had trained to run the half. They also made things more fun by using a hand-clicker to keep tab of how many race supporters we would high-five along the way.

We started together, cheering at the starting line when Bruce Springsteen's "Born To Run" kicked off the race, and for first 5-6 miles we laughed and joked and high-fived a lot of people. Then around Mile 7, our different training routines for the full and half marathons kicked in. Pete and Alyssa pulled ahead and kept high-fiving people, running their race, and I slowed down to run mine and conserve energy for the next 19 miles.

Memories of this race came flooding back this year as I listened to the keynote address at the Rockwell Automation Fair in Chicago. Blake Moret, Chairman and CEO of Rockwell Automation, started his address by summing up the past few years:

"We saw 20 years of evolution in two, because we had to, but it's making us more resilient, more agile, and more sustainable," adding that "we were a little surprised that we could act as quickly as we needed to" given several years of pandemic-related challenges.

Now, with people and industry in general able to look back at what was learned during the worst of the COVID crisis, Moret noted that plant teams in general were bringing partners in earlier in the process of digital transformation in order to streamline their business processes, adding that he thought "simplification is going to sort out the winners and losers in this business over the next 10 years."

> "We saw twenty years of evolution in two, because we had to."

The second speaker was Kevin Laczkowski of McKinsey & Co., who discussed the Global Lighthouse Network, a project that McKinsey had developed with the World Economic Forum. The program is designed to showcase plants and facilities that have achieved measurable and sustainable success with digital transformation, and then share these "Lighthouse" case study examples with industry to help other plants in similar sectors. To date, of thousands of applicants, only 114 have made the cut as Lighthouses, but each of those reinforces that none of us are alone in this journey.

As for the 2011 marathon, it's no surprise to me that I ran my best time yet, powered by partners who shared much of the journey and even made it fun. Have a great holiday season, and all the best for a productive new year.

Thomas Wilk, Editor in Chief
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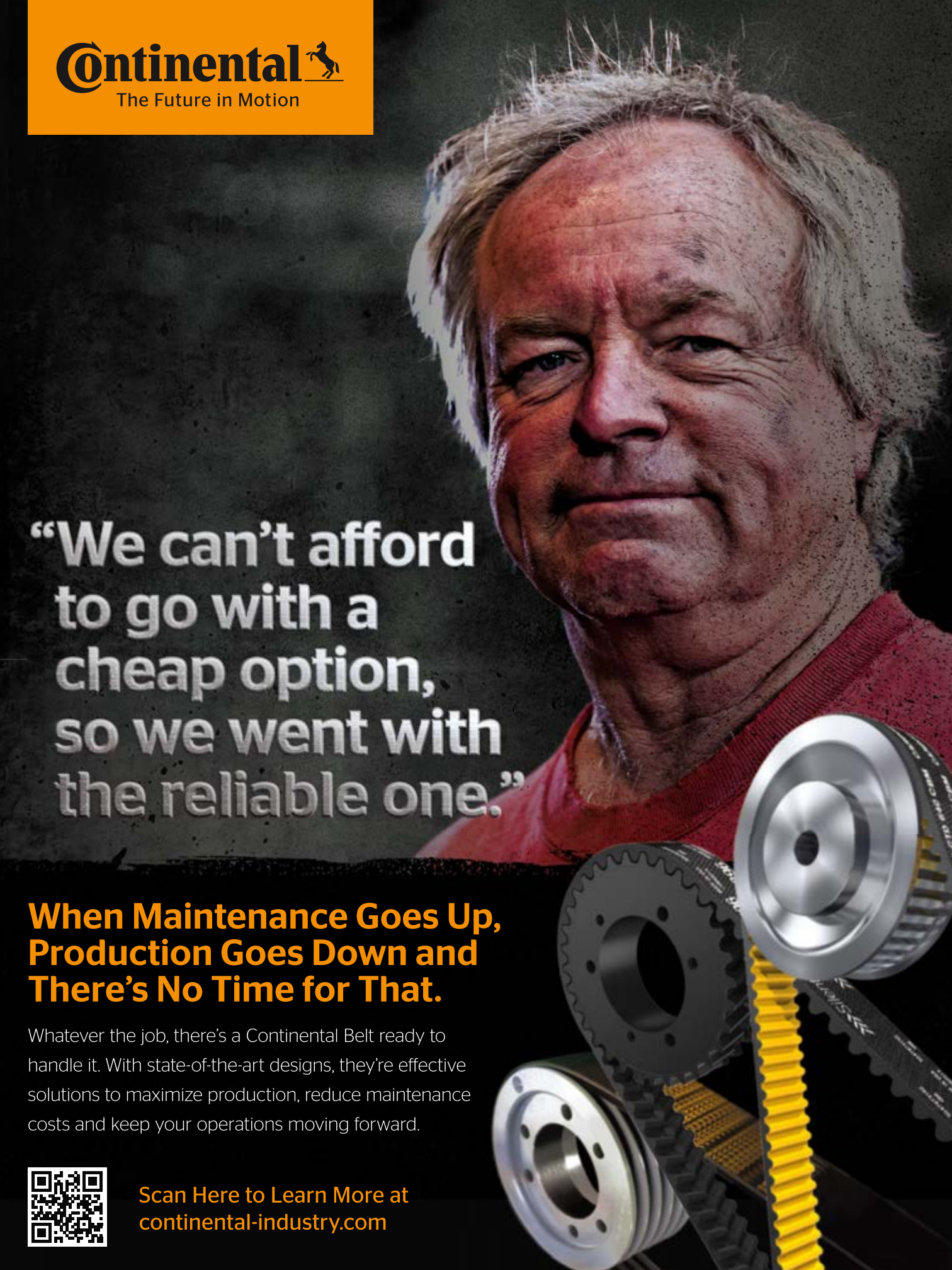

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Confidence conquers fear

Self-doubt or fear of failure can be the biggest deterrents to becoming a successful leader

Many of you know that I am an avid golfer. I have never played well enough to be considered in the top echelon in the sport, but I have a respectable game. One thing that I do about my game is constantly work on it and try to improve. I read books from experts, watch videos of golf instructors, and spend time on the practice range.

Some of the books I've read include Harvey Penick's *Little Red Book*, Jack Nicklaus's *Golf My Way*, and Bob Rotella's *Golf is Not a Game of Perfect*.

Recently, I read a book that was published in 2005 by Dr. Gio Valiante called *Fearless Golf*. There were many passages in the book that I found interesting and helpful. One passage struck me as particularly interesting because it made me think of leadership. He wrote:

"If fear is the great enemy, its undefeated conqueror is confidence. Confidence does not ignore fear, it overcomes fear. Confidence starts with knowledge, understanding and accomplishment. As skill develops, so too does the potential for confidence. Each time we move past fear, we increase the likelihood for success. Confidence strengthens our resolve, even when success is not immediate. Confidence builds on itself, each new experience is fueled by the last and then goes on to fuel the next."

This passage struck me as something meaningful for people that are contemplating making the journey to become a leader, or for those already in leadership positions looking to improve. It can apply to anyone learning anything new.

We all have at some level a fear of making mistakes. Many men and women would make great leaders. But they may have self-doubt. They may be concerned that they might fail. Those already in leadership positions can also have doubts about making a wrong decision, learning a new task or taking on a new responsibility.

As background, consider McClelland's Needs Theory. The theory states that people have three needs:

1. The need for affiliation: having social interaction and friendships.
2. The need for achievement: being good at something and being recognized for it.
3. The need for power: being in charge.

Everyone has needs in each of these three areas. But most people have one dominant need among the three. People with a need for affiliation may shy away from leadership positions. They may feel that learning new things or taking on more responsibilities may upset their social network. They may have to correct or have difficult conversations with former peers. Friendships are very important to those with a dominant need for affiliation to risk them.

Those with a need for achievement may feel like it's "a bridge too far." They feel that they have mastered their current level and are now recognized experts. Achievement oriented people may feel they need more time and experience before they attempt a new level of responsibility. If they try and fail, it will set them back and diminish their sense of achievement.

We tend to not worry about those who have a need for power. They forge ahead. If they lack capabilities, they will fake it 'til they make it. If they don't know something, they will learn it. Power-driven people tend to have confidence and are not fearful.

Whatever your hesitation is, you can overcome that fear by accumulating experiences that reduce your fear. The same goes for a current leader that is trying to develop someone to prepare them for greater responsibilities.

Arrange experiences that will increase knowledge, feelings of success, and confidence. Set some goals for yourself. Venture out and try something new. Make it "bite-sized." That way if you fail, it won't damage your friendships nor your ability to demonstrate positive achievements. *"Confidence builds on itself, each new experience is fueled by the last and then goes on to fuel the next."*

With each win your confidence grows. More and more little steps will raise your confidence to the point that you know you can take on greater responsibilities, or that you can learn how to perform a process that demonstrates your higher skill level or greater knowledge. As confidence improves, your willingness try something new is increased.

Most organizations and the people in them do better when there is upward mobility. This only happens when people see a path for bigger and better things.

Go forth and do great things.

Tom Moriarty, P.E., CMRP is president of Alidade MER, Inc. (www.alidade-mer.com), and is author of the book The Productive Leadership System; Maximizing Organizational Reliability. To get an autographed copy of his book, visit https://alidade-mer.com/productive-leadership/book/. Contact him at tjmpe@alidade-mer.com, 321-773-3356 (office), or 321-961-4306 (cell), and find him at www.linkedin.com/in/alidade-mer.

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Young achievers find their calling in industry

Introducing the third annual Plant Services class of young professionals under 30

Machines make the world go 'round but only when they are well designed and maintained. Attracting candidates to these roles can be a challenge yet those who find a career in industry tend to thrive and grow. Nowhere was this more evident than at this year's 30th Annual Conference of the Society for Maintenance & Reliability Professionals (SMRP), where the enthusiasm and sense of purpose of the attendees, many with a lifetime of experience, was palpable.

We recently asked several industrial pros under age 30 where they are now, what enticed them to this vocation, and what they would like job seekers to know. Their responses are compelling.

Tanner Patrick, 25, is an area maintenance manager at an Amazon Fulfillment Center. "I love a lot of things about my job, first and foremost being the culture—not only within my team but within the entire organization," he says. "Rallying around and working together to accomplish the same goals, such as equipment uptime, improved safety, and high reliability, with a team of technicians who enjoy doing the same makes every day a fun and entertaining challenge."

"The importance of maintenance best practices and a reliability-centered maintenance approach to sustained success in a manufacturing environment clicked for me."

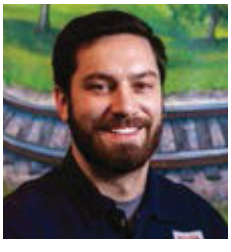
With an industrial engineering background in school focusing on process improvements and operating in a production environment, the idea of equipment reliability and optimizing production through various maintenance practices really appealed to him. "The importance of maintenance best practices and a reliability-centered maintenance approach to sustained success in a manufacturing environment clicked for me. That was what led me down this path in my career," observes Patrick.

Kelsey Hay, 27, is a reliability maintenance engineer at E. & J. Gallo Winery. A semester of college interning at a food manufacturing plant inspired her career path. "I worked with some wonderful people in the maintenance department who showed me the ropes and allowed me to work on the equipment myself," she explains. "It was there that I got to experience what it was like being a mechanic, and where I found a passion for helping to make equipment more reliable and more easily maintainable for those that work on equipment on a daily basis."

"So many students worry about trying to finish school in four years, but internships are really where you'll discover what you're interested in, what you're not interested in, as well as help you get a foot in the door with companies that could be your future employer."

For those seeking career direction, especially while in school, she highly recommends doing an internship—preferably multiple, if possible—even if it pushes out your graduation date.

"So many students worry about trying to finish school in four years, but internships are really where you'll discover what you're interested in, what you're not interested in, as well as help you get a foot in the door with companies that could be your future employer," she explains.



Nick Leineweber, a 27-year-old mechanical engineer at Novelis, an aluminum rolling and recycling company, credits his father for getting him into engineering. He grew up enjoying science and math and appreciates problem solving and working in a team environment. "It is really cool to identify an issue's root cause, design something from scratch, collaborate with others to have it built,

and then see the final product that started as nothing more than a little thought," he remarks.

One of the culture beliefs at Novelis is to "say anything" and while it can be intimidating at times, Leineweber recommends the practice to others. "There are some really intelligent people and people of all backgrounds, and you can't be reserved or scared to speak up. Always be eager to learn and to speak your mind, and never be afraid to challenge something—but always do it respectfully," he suggests.

At 27, **Kyle Runyan** is a mechanical reliability engineer for the Nonreactor Nuclear Facilities Division at Oak Ridge National Laboratory, where he is currently supporting the implementation and start-up of an asset management program.

"My favorite aspect of the reliability and maintainability field is the concept of continuous improvement and predictive technologies," says Runyan. "I enjoy the challenge of investigating the signs and warnings that equipment health can provide, analyzing the data to determine what issues are present, as well as how to fix and prevent those issues in the future."

He recommends finding someone who will not only act as a mentor but build a relationship and truly invest in you, help you find a path forward that suits you and your personal goals.

He had attended a study abroad program in Munich, Germany, that concentrated on reliability and lean manufacturing after his freshman year of college, while still trying to determine what path in engineering to pursue. "I found a passion and never looked back," Runyan explains. He recommends finding someone who will not only act as a mentor but build a relationship and truly invest in you, help you find a path forward that suits you and your personal goals, and will help you along that path to achieving them.

Aaron Lord is a wind turbine technician at Vestas, a wind energy solution provider. Now 28, he has always been a hands-on person. "I like building and fixing things and taking stuff apart," he explains.

When he started college, he wasn't sure what he wanted to do, and his uncle who worked at a nuclear plant told him about a nuclear engineering program in Augusta. "I thought it would be cool to learn about how power is generated at a nuclear plant and get to work in the energy field," says Lord.

"I especially like that I can finish my day and see what I've accomplished and know that the turbines are going to continue to produce power."

Now in the wind industry, he has a more physically active role. "I get to climb towers and work more with my hands, which I like because it keeps me in shape," he explains. He also gained much more experience in troubleshooting electrical, mechanical, and hydraulic components and systems. "I especially like that I can finish my day and see what I've accomplished and know that the turbines are going to continue to produce power."

Trey Twickler, 29, is a furnace engineer at Owens Corning. "I have always been fascinated with the idea of working in manufacturing. It offers many different types of challenges and the ability to always improve. I enjoy that each day is different with a new challenge to solve," he notes.

Twickler earned his BS in Mechanical Engineering and MS in Reliability & Maintainability Engineering at the University of Tennessee, Knoxville (UTK) (https://utk.edu), and also participated in an internship/co-op program through UTK's Reliability and Maintainability Center (RMC).

"I enjoy that each day is different with a new challenge to solve."

"I encourage students to take advantage of internship opportunities and get experience working in manufacturing," he says. "I also believe it is very important to be attentive and learn the process, but equally important to learn how to communicate and work with different groups of people in the plant."

Email Contributing Editor Sheila Kennedy, CMRP, managing director of Additive Communications, at sheila@addcomm.com.

How to apply planning to reactive work

Reactive maintenance that isn't an emergency will benefit from a quick plan and a bit of a head start

Don't let reactive work bypass planning and scheduling to a fault. The fear of not quickly dealing with urgent work keeps some of us from gaining the full value of both planning and scheduling. Yet, we can apply some of the simple planning and scheduling principles to reactive work without compromising rapid response. We can quickly plan some of the urgent work without making supervisors wait, as well as create more credible schedules for next week.

REACTIVE VS. PROACTIVE MAINTENANCE

What is reactive maintenance? Reactive maintenance is work to remedy a newly discovered situation that should not wait until next week. The emergency or urgent plant situation is already (or will imminently be) compromising plant performance for profitability, safety, or the environment. Most plants let reactive work bypass planning and scheduling because there is little or no time for delay. The plants see the possible inefficiency of unplanned work execution as much smaller than the possible impact of the crisis. This risk evaluation might be appropriate for plants with only, say, 10% of their work being reactive. However, many plants have 20% to 50% or even more of their work being reactive. In contrast to reactive work, proactive maintenance is work to prevent reactive situations from developing in the first place. (Technically, proactive work "maintains" a system's proper function, and reactive work is not even maintenance, per se, but work to restore a system's proper function.)

The real management issues are (1) the plant could be more competitive if it had less reactive work in the first place, (2) the plant could reduce reactive work if it did more proactive work, and (3) planning and scheduling could help a plant complete more proactive work while it has its hands full of reactive work. In effect, if we do have a lot of reactive work, we really need planning and scheduling to help us dig out of the pit.

SOME URGENT WORK CAN WAIT

Let's consider handling reactive maintenance. First, not all reactive work is an emergency needing immediate response today. Some of it is urgent that might start today but could start tomorrow or perhaps later in the week. The urgent work that does not start today could benefit from a planner checking on the job to provide a head start. Perhaps the planner could quickly attach a plan from the growing job plan library. The head start might remind the craftsperson to take a certain gasket this time because not knowing it was needed caused a delay last year. The head start could also help the supervisor assign the work, e.g., one mechanic for five hours.

The key to planning such reactive work is never telling a supervisor to wait on planning. Planners abide by this rule by checking with the supervisors as new urgent work requests show up in the backlog. The planner simply calls the supervisor and asks, "Are you going to start this job today?" If "Yes," then don't bother planning the job. If "No," plan quickly, today. This quick, but helpful, planning is possible because of Planning Principles 2, 3, 4, and 5. The planner does not try to make a perfect plan, but simply gives a head start (PP2). The planner might already have a plan for that exact asset and problem from the library (PP3). The planner does not have to take long making a labor estimate (PP4). And the planner does not have to plan the job with excruciating detail (PP5).

In effect, if we do have a lot of reactive work, we really need planning and scheduling to help us dig out of the pit.

Second, not all urgent work even starts this week. Most companies have "urgent" work that is over a week old. Let's not say that the requesters abused the priority system, but rather that sometimes it is difficult to determine the plant risk: Does the situation really need addressing this week or could it possibly wait? The requestor declares it to be urgent to be on the safe side. But later as the week unfolds, that urgent work order ends up not being started after all. Let's accept that this scenario plays out every week. The declared urgent work that does not start this week can be included in the schedule for next week, but only if it was planned! Planning Principle 1 and Scheduling Principles 1, 2, 3, 4, 5, and 6 all help schedule this leftover urgent work for next week. The planners can plan some of the urgent work because they are protected from too many other non-planning duties (PP1). The plans might simply have craft skill and estimated hours, but that allows them to be scheduled (SP1). The priority system helps the planner quickly identify any urgent requests (SP2). The bundling inherent in the scheduling process is amazingly effective if we can bundle some non-urgent proactive work with reac-

tive work on the same asset or in the same system (SP3). The schedule must be fully loaded to 100% with as credible a schedule as possible. Don't break the schedule next week for something that was known about this week (SP4). Supervisors are the on-the-spot resource to handle the daily schedule. If they want to start a new urgent job today, let them (SP5). And finally, we are not looking for greater than 90% schedule compliance. We are expecting that supervisors break the 100% fully-loaded weekly schedule. Planners should simply check with them to see if they plan to break it today for a new urgent job before wasting time planning something about to start.

NO BLANKET WORK ORDERS

A final note is that we must use work orders for nearly all work. Do not allow blanket or standing work orders for small requests for two reasons. One reason is that people abuse the privilege. They do not write work orders for work on assets where later we need the history. The other reason is that blanket work order usage makes scheduling ineffective. Such schedulers leave an "allowance" for blanket work and, hence, under-schedule crews.

By planning some of the reactive work, we get the great job quality improvements possible through continuous improvement on some of the reactive work and we better support scheduling. It greatly helps the credibility and acceptance of fully loaded schedules if we include the un-started reactive work from last week. From the first week of fully loaded schedules, we see an increase in work order completion rate. We complete more proactive work when we had our hands full of reactive work. Best of all, we can do it without making supervisors wait! Just plan the ones they are not about to start. Success!

Doc Palmer, PE, MBA, CMRP is the author of McGraw-Hill's Maintenance Planning and Scheduling Handbook and as managing partner of Richard Palmer and Associates helps companies worldwide with planning and scheduling success. For more information including on-line help and currently scheduled public workshops, visit www.palmerplanning.com or email Doc at docpalmer@palmerplanning.com.

Lack of Preventive Maintenance Got You Down?

Joe Limbaugh, Motion

Does the lack of preventive maintenance have you feeling the blues because of unacceptably low production rates?

I remember when most North American manufacturers performed preventive maintenance routines on various lines/equipment once or twice a year: one in July and perhaps another towards the end of December. These "PMs" would start by disassembling known trouble spots and replacing bearings, seals, gears, couplings—you name it. Even if some of the components looked fine, they got replaced anyway. The idea was that the PM cost was a fraction of the downtime cost.

An automated goods-to-person system, like this one at Motion, helps fulfill demand by increasing efficiency exponentially for on-time delivery to customers.

Through time, this practice has changed for a couple of reasons. First, manufacturing in general—specifically, MRO products—has improved in reliability. Secondly, the availability of skilled maintenance workers makes it harder to perform preventive maintenance for those lines and processes that would benefit from it.

Consider the numbers: In 2014, there were roughly 4.3 million unfilled job openings. In 2018, that number increased to 6.6 million. Today, that number sits at roughly 11.4 million.[1] No doubt, some openings are for plant maintenance and planning roles.

This is where a good supplier partner can help. At Motion, we understand that over 50% of all customer orders are unplanned. In other words, when our customers begin production, they may not know that a part will fail. Accordingly, our inventories are determined by using a scientific approach to understanding "demand," then placing that inventory at the closest point of potential usage.

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So, the next time you're feeling down, give us a call. We understand the pressures of keeping it moving and are standing by to help. At Motion, we know that having the part is important, and having an understanding partner who can help you optimize the technical aspect of products and processes is crucial.

Partners. The best part of all.

Joe Limbaugh is Executive Vice President – Supply Chain / Operations Support / Marketing / Enterprise Excellence at Motion in Birmingham, Alabama. Serving the Company since 1983, he is currently responsible for product procurement and inventory, distribution and fulfillment centers, branch operations support, headquarters campus operations, marketing, productivity improvement, conveyance and repairs/services, and company-wide lease management.

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[1] Organization for Economic Co-operation and Development, Total Unfilled Job Vacancies for the United States [LMJVTTUVUSQ647S], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/LMJVTTUVUSQ647S, July 5, 2022

Why we naturally resist change

Implement these tactics to create a tipping point in your change leadership approach

At the recent Society for Maintenance and Reliability Professionals (SMRP) conference, I had the opportunity to lead a workshop on change management. In this month's column, I wanted to share some of the highlights of the workshop to help you with leading change in your organization.

While there are many change models, I frequently reference John Kotter's approach, which can be found in his book, *Leading Change*. With Kotter's model, there are eight points to the process.

For creating urgency and developing the change vision, Simon Sinek in his TED Talk, *Start with Why,* provides details of what differentiates inspiring leaders and organizations. He shares that "all the great inspiring leaders and organizations in the world, they all think, act, and communicate the exact same way. And it's the complete opposite to everyone else."

In his work, Sinek came upon a discovery that he calls the Golden Circle, a series of three nested circles, each progressively larger. The inner circle contains the "Why?" the slightly larger circle contains the "How?" and the last circle contains the "What?" Recognize 100% of the people within an organization know *what* they do; less understand *how* they do it; and very few get the purpose, the *why*. You might think the Why is to generate a profit, but Sinek notes that is a result. The Why is the purpose, the belief, or the cause.

With his discovery, he found that most organizations go from the outside in with the circles, from What to How to Why. Conversely, the organizations and leaders that inspire people to believe begin with the purpose, from the inside out, from Why to How to What. Get people to believe in the need for change by focusing on the Why.

Getting the first followers to join in believing means that we need to help them overcome their fears and establish trust. To illustrate this concept, refer to the matrix graphic below. Typically, leaders talk about the benefits of making the change from their perspective. In the upper left quadrant, a person may be encouraged to take a promotion that will yield a higher salary. Yet, status and money will not encourage everyone to make the change. We must answer the "What's in it for me?" (WIIFM) question by addressing all four quadrants.

KOTTER'S EIGHT-STAGE PROCESS	
1	Establishing a Sense of Urgency
2	Creating the Guiding Coalition
3	Developing a Vision and Strategy
4	Communicating the Change Vision
5	Empowering Employees for Broad-Based Action
6	Generating Short-Term Wins
7	Consolidating Gains and Producing More Change
8	Anchoring New Approaches in the Culture

FOUR QUADRANTS OF CHANGE		
	PRO	CON
CHANGE	Receive a promotion and a salary increase	Required to move the family to a different state or province
NO CHANGE	Everything remains the same, no move for the family	Plant may close and the opportunity is lost

In the workshop, we leveraged a one-hour exercise to help the attendees understand some of the reasons that people resist change. The attendees were divided into employee and manager groups. Employees were randomly seated in rows of chairs. The management group attempted to create a compelling reason for the change and cast their vision of the future state. Then, each employee was asked to align to the new structure by moving to a sequentially numbered chair. While the employees would have been compensated to move chairs, about one-half of the employees chose not to move. They voiced fears of the unknown and apprehension with the way the management group approached the change. A lack of trust was a factor. The exercise was quite telling and surprised the workshop attendees.

Interestingly, Heraclitus, around 500 B.C., was quoted as saying, "Change is the only constant." Yet, 70% of all change implementations fail, often due to errors in implementing change. No doubt, people resist change they don't understand or believe in. In addition to providing an inspiring vision, change leaders must become marketers. Studies show that the typical employee receives more than 2 million words across a three-month period. The typical communication regarding the change vision across that same period is less than 20,000 words. Doing the math, less than 1% of the communication is dedicated to inspiring change. Kotter notes that we under-communicate by a factor of 10 times or more. Constantly reinforce communication in all forms. The messaging includes talks, articles, newsletters, presentations, storyboards, and so on.

The typical employee receives more than 2 million words across a three-month period. However, communication across that same period regarding a change vision is less than 20,000 words.

Focus on creating small wins that compound to build bigger wins. Start with the first followers that are inspired. Use the wins to create momentum, which becomes the tipping point. Empower people for broad-based change. Use metrics. Every point in a process can provide the ability to leverage metrics that drive behaviors with the goal of changing the culture.

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Assets Anonymous

From morning meetings to the plant floor, use these steps to get your team better grounded in reliability basics

by George Williams, CMRP, CRL, and Joe Anderson, CMRP, CRL, ReliabilityX

Plant Services Editor in Chief Thomas Wilk hatched a plan with George Williams and Joe Anderson to create a podcast series titled "Assets Anonymous." Each monthly episode addresses one of 12 aspects on how to gain better control over your maintenance processes and ultimately drive improved throughout and greater profitability.

***All episodes are now available at www.plantservices.com/the-tool-belt**, and this month's cover story draws from each episode to deliver an extended sample of the advice shared by Joe and George.*

STEP 1: UNDERSTANDING REACTIVITY

What should plant teams know about what reactivity can do for them, and the ways it may work against them?

George: Reactivity for me is a really large topic and a misunderstood topic. What's interesting is, what we see in industry today is, "we've got to not be reactive, not be reactive, not be reactive." In reality, what we have to do is eliminate unnecessary reactivity and manage the reactivity that remains. And people are so focused on "how do I become proactive?" that they're not understanding that even if you are in that state, part of proactivity is managing reactivity well.

Joe: To understand proactivity and reactivity, it's like a sliding scale. It's not one or the other. You can be more proactive or more reactive, depending on the tasks that you're doing. It's kind of a sliding scale. It's not this black or white, you're either this or you're that.

The way that I look at it is people get confused with run to failure. I think the problem is that run to failure is a business decision, whether it was come to strategically through an equipment maintenance strategy, or that's the culture and it's taken over anyway. But run to failure is a domain, and then you have your preventive domain, your predictive domain, where all of those are reactive at some point, but some are more proactive than others. Distinguishing between a domain and the sliding scale of reactivity and productivity, understanding that first I think is key.

STEP 2: UNDERSTANDING PROACTIVITY

What does making progress look like then when it comes to proactive maintenance? What are some of the signs that you're on the right track?

George: Less reactive maintenance.

Joe: The goal is to give yourself more time. For example, if I wasn't planning and scheduling before, and I'm now planning and scheduling, and I'm getting my work orders, I'm getting more work done, I'm restoring my equipment, eliminating more defects which leads to less breakdowns, less calls out on the floor, and I have more time to invest in things like my PdM inspections while my equipment is running so that I can spend my planned downtime doing corrective maintenance.

You also have more time when you're finding defects early on in their initiated state versus farther down the P-F curve. You're giving yourself more time to order the parts, wait on the parts to come, and you start gaining control over your assets instead of your assets controlling you. You know you're in a very reactive state when the asset determines when you get to go to bed at night, versus you determining when you get to go to bed at night because you are in control over the machines. As I start to see more time, and I can start putting people out doing other tasks, that's a gauge for me, knowing that I'm on the right track.

George: Even just the culture, your folks will be less stressed. You'll have a better safety record. As you move in maturity in a space, the benefits are substantial, but they all boil down to profitability of the organization.

STEP 3: THE CIRCLE OF FIRE

George: The Circle Of Fire is an analogy for the reactive state. Imagine this circle: we can't PM it because operations wouldn't give us the equipment, operations wouldn't give us the equipment because we're behind schedule, we're behind schedule because this conveyor failed earlier in the week, and the conveyor failed earlier in the week because we couldn't do the PM. Then the circle just keeps going and going: we couldn't do that PM because something else on the line wasn't right and they had to run a line, and we've got this continuous reactivity that takes place.

What is interesting to me is that the Circle Of Fire is made up of smaller circles. And so inside "why we didn't do the PM" is another circle. Why the conveyor breaks down is not only the PM wasn't appropriate, but we've got the wrong type of gearbox, we don't have a breather on it, we don't align things appropriately, the shaft has been bent for three years, and the whole gearbox wobbles while the conveyor is going around.

Often the approach to trying to put out the fire is symptomatic. We throw a cup of water on it, but we can't do anything more than that because we have to go put out another fire. *Someone* has to make a fire go away and reduce its likelihood of coming back.

Joe: We do that through a series of defect elimination techniques, but you have to understand, to get out of these cycles, there's other types of failures that have to become more important than the catastrophic failure. The potential to failures are your opportunity to address things at the cheapest possible point of overcoming a defect. You're looking at 10 to 40 times the cost to do maintenance in the catastrophically failed state versus, "I found a bearing defect, and I need to replace a $300 bearing." Understanding those types of failures and addressing them with as much urgency, if not more, as you would a catastrophic failure is how you start to break those little cycles down.

STEP 4: BECOMING A FIRE MARSHAL

Can you talk about the two levels of what it means to become a fire marshal, and combat the Circle Of Fire?

George: One is the advocacy piece, right? The "How do I engage with operations with senior leadership" and we're saying from the perspective of the maintenance manager, and even with the technicians, "How do I manage the change of looking at defects as early as possible to mitigate them before they become a risk to the business or even a catastrophic event that has a business impact?"

And then the other side of that is, "Well, what steps do I take as a fire marshal? How do I actually become one in terms of my actions? What do I have to do to mitigate defects as early as possible?"

Joe: It's like eating an elephant with a spoon. You take one bite at a time, eventually you'll get through it. You take one problem and make it go away forever. Just one, right? But if you can do that every day, those things start adding up, and now a week later, you've put away five different problems. By the end of the year, all that really starts adding up and you start putting out these little circles of fire and you start to break that cycle. Now you can introduce a new cycle which is on the more proactive side of the scale, in which you're addressing issues before they lead to catastrophic failure.

STEP 5: KNOWING WHERE YOU STAND

You've both published articles with Plant Services about the importance of knowing the maturity and skill set of your plant team. Why is "knowing where you stand" the fifth step in this process, rather than an earlier step?

George: The first four steps really focus on a broader understanding of reactivity and proactivity, and I think this step is the first one in taking some action. This step and Step 6, "Knowing Where You're Going," really help create the strategy and the direction for you to move into a more proactive state.

For me, knowing where you stand is a never-ending cycle. In my previous life, we had lots of sites that varied in their maturity, and I used to explain to them that the goal was not that everybody necessarily be at the same level. The winner is not who is further along in maturity. The winner is who closes the gap the most, who takes effort and puts knowledge to action. And so for me, knowing where you stand is the start of all of those things. It's really a slap in the face sometimes but we need that.

Joe: You can't begin a journey if you don't know where you are, right? The hardest thing for people is to understand first what "right" looks like; and then second, where they compare to what right looks like so they can begin the journey towards that direction. Being honest is difficult for some people because the mentality today is to look green, not red. But your goal is to find the red and go after the red, and typically in most organizations that red is low-hanging fruit. So it's quick wins, it's an easy driver to get people engaged in the success and get them off the fence and getting them to jump in. So understanding that and assessing honestly, I think, is the key to this whole thing.

STEP 6: KNOWING WHERE YOU ARE GOING

George: If you're still cloudy about where you're at, understanding where you're going gets a little more complicated, but it is a complex issue. It's more than the tactical pieces of asset management and operational performance. Knowing where you're going also involves: How do you align to the overall organizational objectives? Does the language of where you're going align to that in such a way that you will gain support versus gain friction? And what am I going to do today to take one step closer to that goal?

Joe: I'll tell you for a lot of organizations, if you could just focus on tomorrow, that would be great. But it should be more a five-year type plan: What is that vision of the future state? And it depends on the industry. In some industries, things move very, very, very slow. You have red tape and procedures and all this stuff that you have to get through to make movements. And in other industries, it's not so much, where tomorrow I could go out, write a PO, have a PO on my desk in five minutes, and already be initiating something. And in some organizations, it could take me six months to get that PO.

It's about having a vision and setting goals that align to that vision – that's just the strategic part. Then the tactical part is setting objectives and tasks that align to the goals and the vision, and making sure that it all aligns with the organizational objectives.

STEP 7: INVESTING IN PEOPLE

This may be the next action step, but is it really necessary?

George: You are not obligated to invest in people. There is no statute, law, or regulating body that will require you to invest in your people. Maybe OSHA. However, the keys to success all lie in this space, and I think the downfall we see in industry is not having a focused effort on this.

Joe: There are two pieces to this, right? One is the chicken and the egg syndrome, and the other is the fact that we operate in silos. I'm not even sure, for example, a maintenance manager understands what budget lies out there for training through HR to use it to their advantage. That's one piece.

The chicken and the egg piece is, companies now are going, "well, to invest in people, it requires a cost" but again, if you don't invest in people, you'll never get better. So it's kind of this dilemma that they're in. Of course, when things start going south, the first thing that gets eliminated from every space is the training program, and then right behind that is their reliability program. And so you lose knowledge, skill, development, that type of thing, as well as the overall reliability of your facility.

George: Think about what's happening right now. You have all these companies that are in dire need of people, and if they've had a long-standing history of not investing in their people, they've probably are on the worst end of that spectrum where people are leaving the organization to go elsewhere. It's not always about pay.

STEP 8: WHAT DO I OWN, AND HOW CRITICAL IS IT?

When people are looking to determine what their critical assets are, what should they look for?

George: First, for us, is defining what an asset is, and there's two approaches to that. One is your typical ISO standard approach. ISO 55000 says if it adds value, realistic or potential, it's an asset. The standard canned answer I like to give is, if I intend to replace parts on it, it's an asset. If I plan on throwing it out and just replacing it, it's a spare part. Now, that's a high level definition and there's some caveats to that, regarding if it is required from a regulatory agency or if it's a calibrated instrument, then it's still an asset and goes in the system. But generally speaking, we start with that definition.

From there we move into defining criticality, and criticality is based on severity factors, and likelihood of failure factors or occurrence factors. Severity is everything that sits inside the business, from profit goals to commitments to safety, to the environment, to the community. Any asset that can impact any of those goals has a severity factor, so when you're going through severity, you're looking at all those types of factors, and you identify those impacts.

Ultimately you end up at an occurrence score, which is how often does this asset fail? That can use either history you already have, or a general mean time to failure that may exist in industry. That's a product score, and you end up with some criticality factor, and then that criticality factor typically has a much broader number range than what sits inside your CMMS. So then you convert it to either A-B-C or 1-2-3, or 1-2-3-4-5 based on how it sits inside your CMMS. Yay! Criticality!

STEP 9: IF CRITICAL, HOW DOES IT FAIL?

George: At this point when an asset is considered critical, you're trying to understand exactly how it fails: in what ways, what component failures, and what will cause failure of this asset that I have to make sure I mitigate.

Even these scenarios are not perfect, and I'm going to probably get lots of feedback on this, but when you do an FMEA or an RCM, and you're getting down to those component levels in deciding what the failure modes are and assessing those failure modes, and then coming up with a risk priority number and all that fun stuff that you follow in the process. We've had a failure where we tried to convince a manager of a plant that they needed training in how to properly torque and use precision tools. There was a pump whose electrical connections were on a ceramic block for the motor, and they almost lit this thing on fire because the ceramic block was cracked because they over tightened it. No PM; no FMEA; it's unlikely that the ceramic block terminal connection being over tightened and causing the crack – which eventually creates an arc and heat and melts all my insulation and creates a fire – is being identified in the FMEA.

So it's not only the formal process, it has to be what happens in the field feeding back into that system. Your failure modes have to be a living entity that include not only what you brainstorm in a room, and hopefully you have all the right people and identify a bunch of stuff, but it's unrealistic to think you will identify 100% of the potential failure modes when you sit in a room and do this exercise. If anybody does believe that, it's probably foolish, you know, the probability is slim and none. It has to be a living list of failure modes that are recurringly looked at and that your CMMS feeds back.

Assets Anonymous: The 12 Steps

1. Understanding Reactivity
2. Understanding Proactivity
3. The Circle of Fire
4. Becoming a Fire Marshal
5. Knowing Where You Stand
6. Knowing Where You Are Going
7. Investing in People
8. What Do I Own and How Critical Is It
9. If Critical, How Does It Fail
10. What Will Maintenance Do About It
11. What Will Operations Do About It
12. Continuous Improvement

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STEP 10: WHAT WILL MAINTENANCE DO ABOUT IT?

What does maintenance do about the things they are identifying with their criticality analyses and the failure modes?

George: The first step is to identify your risk mitigation strategy, right? So the short term of that is, what's my PM or PdM strategy to help either understand that a failure mode is about to have a catastrophic event on my P-F interval, or that I need to replace wear components at some interval of time based on duty cycle or time, or however that may shake out.

Now, there's all kinds of standards around that, then questions associated with that: "Can I engineer it out? If I can't engineer it out, can I predict it? If I can't predict it, do I do some scheduled intervention, whether that is a preventive maintenance activity for wear components or a scheduled restoration, or a failure finding task?" So, a failure finding task – something against the hidden failure mode, like a generator transfer switch, something you'd never know if it's going to work until you actually need it. You're testing it to see if it already failed. You are not testing it to see if it will work when you need it.

So all of those things, and then eventually run to failure and the development of a spare stocking strategy, all of those things get vetted out based on cost. What does it cost if I run this at this failure mode? The failure, what does it cost?

If I can predict it, what does it cost? And then the most cost effective strategy gets implemented.

Joe: And then you can develop a maintenance budget around all of those tasks because you have a cost, and that's zero-based budgeting. But yeah, you have to be really good to get to that point.

STEP 11: WHAT WILL OPERATIONS DO ABOUT IT?

What are you seeing operators step up and do, either what they were doing before the pandemic or the special tasks you're seeing them take on?

Joe: That's the main point, right? Defect elimination starts with cleaning. You clean to inspect. It's kind of like having a dirty engine in your car and you have an oil leak. You have no idea where that oil leak's coming from. You just know that it's leaking. Where if I had a clean engine, I had a piece of my head gasket missing, I would know immediately where that piece of the head gasket was missing due to the oil leak. And it allows you to get a little deeper into where the issue is occurring.

The other piece is that cleaning prevents breakdowns. And this is what people don't understand. I always give an example of a motor. A motor has a fan on the back of it and all of these fins, and that fan actually blows air over the fins to cool the motor so that you keep it at a certain temperature so that you don't start destroying the insulation. Well, they say 1/10 of an inch of dust on a motor reduces its life by half, which is next to nothing when it comes to dirt, and yet all we have to do is take our little ShamWow and wipe it off every now and then, and we can extend the life of the motor.

Picture in some of these facilities how filthy some of this equipment is, and you want to know why your motors are going out every three months or every six months, why your bearings are contaminated and destroyed all the time? All that starts with cleanliness, and that prevents further events from occurring as well as a lot of the little minor stops that happen.

The principles and practices are very simple. The complexity comes in, in that people thinking that there's no way it could be this easy, so we over-think things, we over-engineer things, and we over-complicate things through a series of red tape and get away from the simple basics that need to take place.

STEP 12: CONTINUOUS IMPROVEMENT

The final step is continuous improvement. Completing the first 11 steps does not guarantee that you will be efficient going forward.

Joe: Effectiveness by definition is doing the right things. We've talked about all those foundational elements that you need in order to have the right things. Efficiency is just improving upon current practices and driving out more waste, making them better.

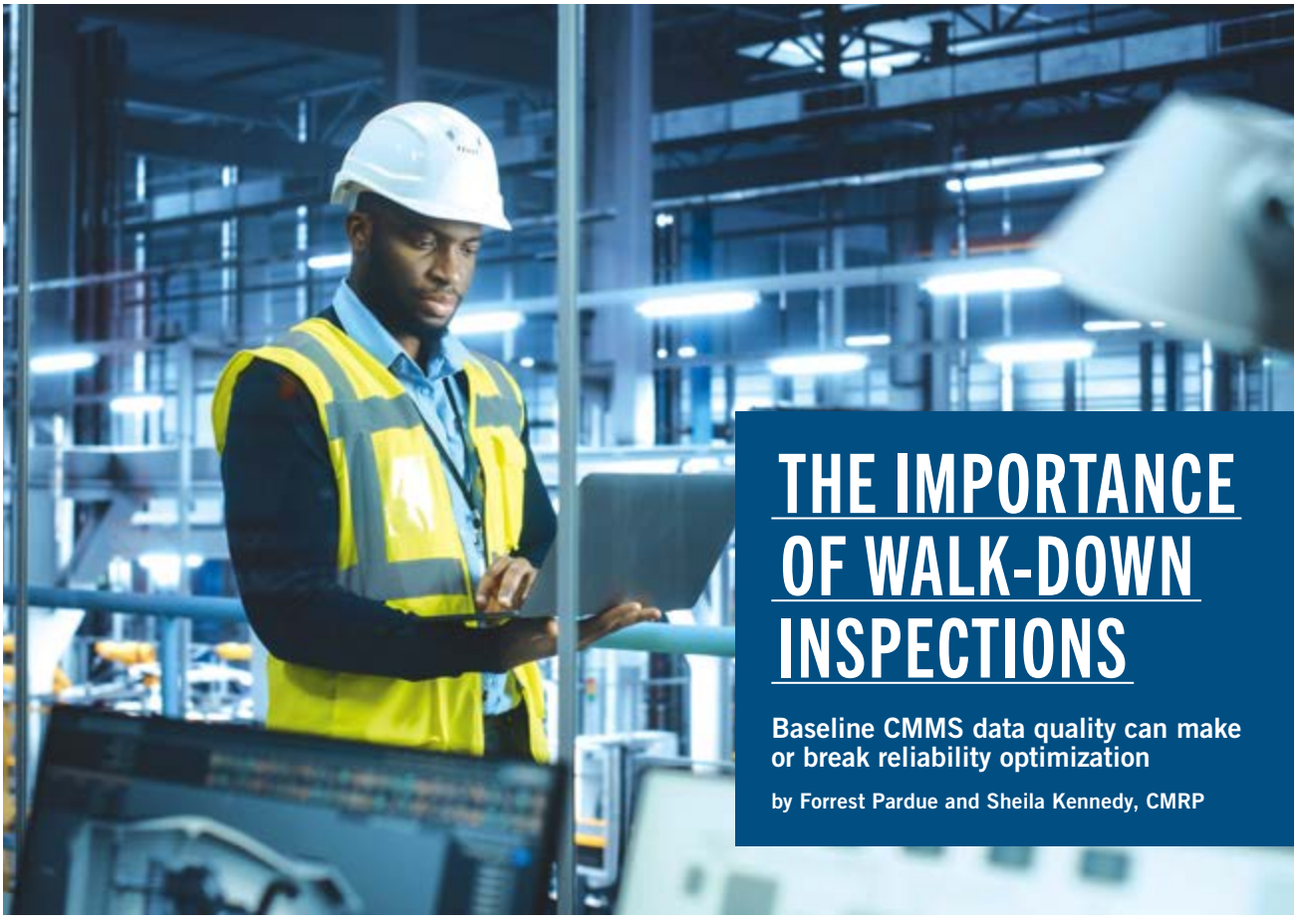
How can we make those processes more efficient? Things like planning and scheduling, things like executing work and setting up routes and using your PdM technologies, even on the operator end, focusing more on quality issues like incoming raw materials, making those processes more efficient. That's your continuous improvement phase and continuous improvement focuses on efficiency.

George: In the earlier steps, we talked about things like operator inspections and things of that kind, so previously we weren't doing anything. We try to reduce the change over time by saying do it faster, and so what that leads to is skipped steps. In the effectiveness approach we're saying, ok, you need to inspect this part of the machine to make sure it's going to operate well, make sure the settings and gaps are right.

In the continuous improvement phase, we're trying to see how we can do the right things more efficiently. And so we create a jig for the person to do the setup and make sure that yes, they no longer have to take a measurement, they put this piece in place, slide something over, tighten it, it's going to be perfect because the jig is perfect. We've made their ability to do it faster, and created more efficiency, which can in turn reduce the changeover time, but it didn't change the effectiveness of the changeover.

George Williams, CRL, CMRP, is the founder and CEO of ReliabilityX and is a blackbelt in reliability. He has a master's degree in reliability engineering from Monash University. Williams spent 16 years with a major pharmaceutical company, where he began as a technician and worked his way up to global asset management. In 2015, Williams' global team won the Uptime Award for Best Maintenance and Reliability Program. In 2016, he earned recognition by SMRP as CMRP of the Year. He has earned certifications in vibration analysis, infrared thermography, ultrasound, motion amplification, and plant maintenance management. Williams is a published author and a recognized leader in reliability. He can be contacted at ask@reliabilityx.com.

Joe Anderson is a partner and chief operating officer for ReliabilityX. Joe helps companies reach their full potential through improvement gains and lowering costs, giving them a competitive advantage on their journey to excellence. As an active columnist in Plant Services magazine, Joe shares his over 25 years of experience in maintenance, reliability and management excellence in various industries with the world through his writing. He is a CMRP, CRL, CARO, MLT2, MLA1, LSSGB, IAM-55k, CRL Black Belt and was recognized as one of the top 50 leaders in the country by the United States Congress, being awarded the National Leadership Award. He has also brought humor to the world through his experiences, and it can be seen in the character creation of Captain Unreliability.



THE IMPORTANCE OF WALK-DOWN INSPECTIONS

Baseline CMMS data quality can make or break reliability optimization

by Forrest Pardue and Sheila Kennedy, CMRP

Companies starting reliability improvement programs commonly hit an early roadblock: deficient data quality in their computerized maintenance management system (CMMS). The functional location structure and asset registry information in the system is a natural starting point for any vibration, lubrication, or other preventive maintenance (PM) or predictive maintenance (PdM) initiative, but in many plants a good percentage of this data is either absent, outdated, or simply erroneous.

If the foundations of reliability and maintenance programs are built on bad CMMS information, it will negatively impact the ability to meet reliability goals and unnecessarily waste troubleshooting time and money. Even facilities that try to follow a management of change (MOC) process may fail to keep their CMMS data up to date.

Often, the information is invalid because:

- It was brought in from an old system.
- It was never fully implemented.
- The people who set up the structure were inadequately qualified.
- The components no longer match the structure.
- New areas have not been added or kept up to date.
- MOC processes were inadequate or not followed.
- Area supervisors keep the information in spreadsheets.

But there is a simple yet underappreciated way to optimize the program: walk-down inspections. Visually verifying the accuracy and completeness of location and asset data by periodically walking around and auditing the plant—or at least critical equipment and areas—and correcting missing or invalid CMMS information is the best way to remedy discrepancies.

CONSEQUENCES OF BAD DATA

When what is in the plant does not match what is in the CMMS, the consequences can be costly. Joyce Blom, a senior electrical reliability engineer at a major gas production facility, has seen examples firsthand.

"We had a case where a 15kV switch for a critical load was not in the CMMS system and was missed for its five-year maintenance. The switch eventually failed with an arcing short, causing a plant-wide power outage for a couple hours while the second of our dual feeders picked up the load," says Blom. "It took over two months to repair the damage caused by the failed feeder switch. The associated costs were significant."

Missing CMMS information also affects parts planning. "Motors without adequate information in our CMMS cannot be included in our critical spares plan as there are no motor suppliers willing to bid on a motor specification with missing key components," explains Blom.

Bill Slygh, a reliability and maintenance consultant at Hendrix Precision Maintenance Services (Hendrix PM), has seen deficient information waste time for customers due to "garbage in, garbage out." An example is running vibration on a fan that has a different bearing number than expected and the fault frequencies don't quite line up. Or inspecting equipment that is said to be carbon steel but discovering it was replaced with stainless steel equipment.

Verifying the accuracy and completeness of location and asset data via walk-down inspections is the best way to remedy data discrepancies in your CMMS.

"When walking down the equipment, you're either going to validate what the CMMS says or validate that you're looking at something different. These errors in the CMMS make troubleshooting slower and less efficient," he explains, adding that it also creates spare parts identification and acquisition problems. If an equipment changeout doesn't get run through the MOC process, or there is no MOC process, the issues will add up and reduce productivity and extend downtime.

Scott Yenchik, a director of predictive technology and reliability services for B&D Industrial, recalls an incident in a prior role when a critical asset was down for an extended time because of incorrect data from not having a holistic process to review the CMMS, what changed in the field, and what was in the warehouse. "I don't know what the total cost of the failure ended up being, but it was enough of a pain point for them to pay for a maintenance improvement project," he says.

One of the main production pumps had inconsistencies in the bill of materials (BOM) in the CMMS, creating a "major expediting issue" to find repair parts. "There should have been a kit for the pump and that kit should have been a controllable item, but it wasn't. This led to a whole CMMS review and installed-base evaluation walk-down, gathering nameplate data, looking at the assets and BOMs, and matching up all the technical information of what was in the CMMS and inventory," he explains.

On the inventory control side, they looked for discrepancies between the CMMS's BOM and the inventory warehouse, comparing what was in the bins and doing cycle counting. Then, they updated everything from the CMMS parts to the BOM to the criticality ranking of equipment and ABC analysis of MRO parts. "One of the biggest glaring holes was the lack of control of the warehouse, because the kits were basically getting robbed via 'free shopping' without capturing the documentation of requisitions," Yenchik observes. "It was a tough lesson learned."

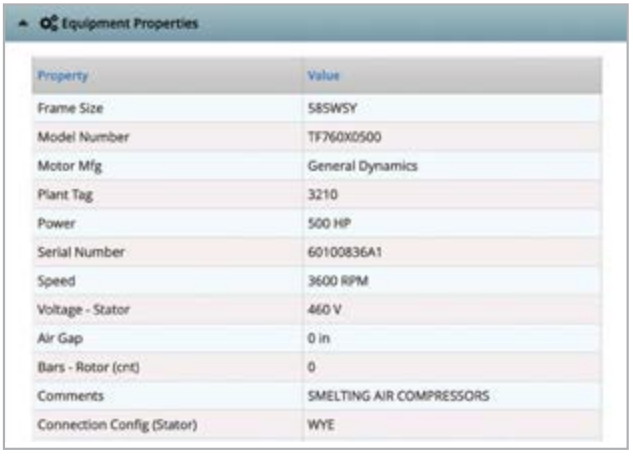
WHY WALK-DOWN INSPECTIONS MATTER

The system only knows what gets put into it, reminds Yenchik. "It increases uptime and wrench time when you have the right parts when you need them. And there are ancillary benefits such as scheduling compliance and reduced overtime—it all adds up," he adds.

Walk-down programs help to get your arms around particular groups of equipment, such as motors, electrical panels, or types of valves. "Once you have a sense of the scale, then you can work with your purchasing team and suppliers to develop spares and repair strategies for that particular group or type of equipment," says Blom. "That is a huge advantage over tackling the component identification on a one-by-one basis."

She notes that all walk-downs and audits generate money and time savings provided the learnings are documented in the CMMS system. For example, to purchase replacement parts these days, every supplier for parts asks for the model and serial number of the unit being replaced. Also, any contractor brought in to repair a system wants the model and serial number for the part they need to replace.

"Additional time-savings are that our maintenance planners prepare scopes of work to make clear the work requirements, beginning with indicating the model number of the parts to be worked on and context such as piping and instrumentation diagrams (P&IDs), location plans, equipment plan outlines, IOM manuals, and wiring diagrams," Blom adds.


Equipment Properties

Property	Value
Frame Size	58SWSY
Model Number	TF760X0500
Motor Mfg	General Dynamics
Plant Tag	3210
Power	500 HP
Serial Number	60100836A1
Speed	3600 RPM
Voltage - Stator	460 V
Air Gap	0 in
Bars - Rotor (cnt)	0
Comments	SMELTING AIR COMPRESSORS
Connection Config (Stator)	WYE

Figure 1. Maintenance and reliability programs succeed or fail based on the level of CMMS data accuracy. *Source: 24/7 Systems*

A further benefit of walk-down inspections is identifying process equipment inefficiencies. For instance, power is wasted if a process change means an 800 hp fan is intentionally run at a fraction of its capacity because less air is now required. Walk-downs can lead to installing right-sized equipment and putting expensive, overpowered equipment to better use elsewhere. Similarly, walk-downs can bring to light processes running with undocumented or unresolved workarounds so they can be addressed.

HOW TO SET UP A WALK-DOWN INSPECTION

Walk-down advocates have developed useful strategies for planning and optimizing the inspections. For instance, Yenchik recommends the following to anyone with CMMS data quality challenges:

First and foremost, develop a process to review existing systems and walk-down field assets—or use somebody that has a process—even if it is just gathering general equipment information like the nameplate data to compare the BOM, OEM manuals, and verify what is in the CMMS. Tablets and software apps make field rounds and equipment walk-downs much easier.

- Conduct a standardized review twice a year, once a quarter, or whatever works for you, taking into account maintenance strategies and criticality.
- Start with your critical equipment first and then proceed to defined areas before approaching your balance of plant.
- Ensure that all components on your condition inspection program are present and correct in the CMMS.
- If you have people around the equipment doing PdM, PMs, or operator care rounds, make it part of their normal process to take an extra minute or two to at least verify the installed equipment and nameplate data, or take a picture of it for later review.

Blom suggests leveraging whatever situation you find yourself in to develop the CMMS system, for example:

- If you find you have interns available, the interns can start learning the equipment by updating the CMMS.
- Make it a standard for maintenance personnel to take pictures of the equipment/device nameplate as part of their work and upload them to the CMMS.
- If outside contractors for are used for PMs, require detailed PM reports with photos of nameplates and equipment arrangements and upload them to the CMMS.
- Most suppliers have great databases of projects and parts that they have provided your facility in the past; ask these suppliers to share these databases with you to update your CMMS system.

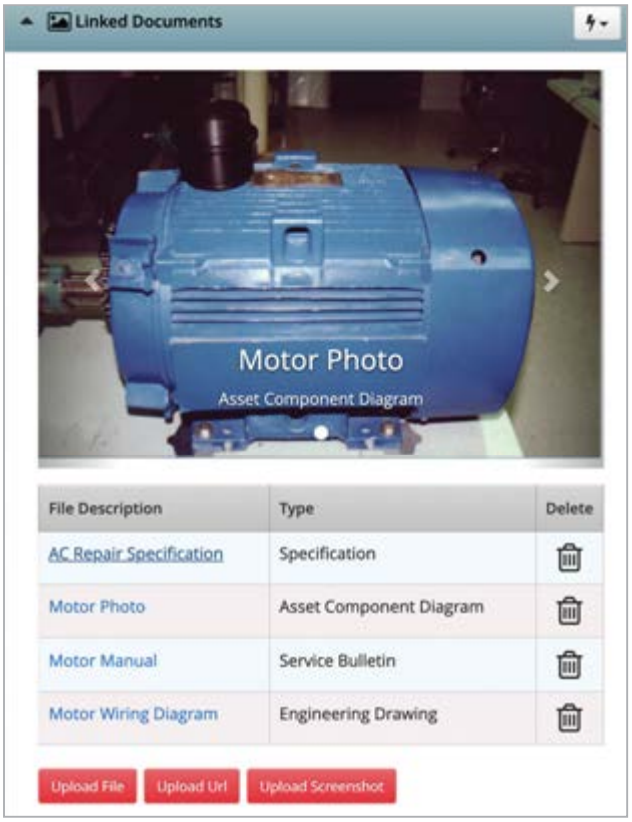


Figure 2. All walk-downs and audits generate money and time savings provided the learnings are documented in the CMMS system. *Source: 24/7 Systems.*

According to Slygh, the problem is not having enough people to do a full walk-through. He advises:

- Do some type of self-assessment every three to five years, whether using internal or outside resources. Lots of outside companies do walk-downs—all the vibration and lubrication companies, for example—because they want to make sure they have the right information.
- Go into an area and check 10-20% of the equipment, and if you find issues, walk that whole area and update the CMMS.
- If the equipment nameplate or tag is too dirty to read all the information, try cleaning it off and get all the information possible. Then, go back into your files or to the manufacturer to fill in the gaps.

"For one reliability improvement project, one of the first things we did was assess the data," says Slygh. "We chose a random list of 10% of the equipment in each area to walk down, with the expectation that if that 10% group was 95-97% correct, then we would accept the data. But if it wasn't, we would have to walk all their data down and make all the changes before we even started our process. We really need

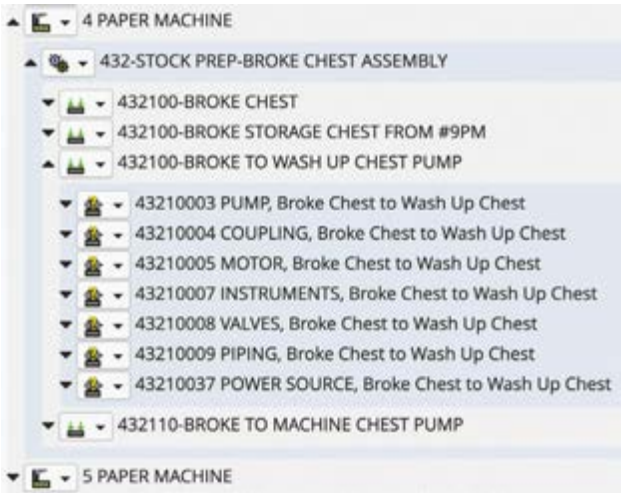


Figure 3. Errors in the CMMS make troubleshooting slower and less efficient. *Source: 24/7 Systems*

to have the asset list correct before we can start things like determining asset criticality or doing preventive maintenance optimization (PMO) projects."

Fortunately, with the advent of the connected worker approach and the IIoT, the processes and tools have come such a long way that walk-downs are even more cost effective, observes Yenchik. "CMMS and reliability information management systems such as Tango are now joined by tablets, data visualization, and digitized asset/equipment information forms that can be filled out on the go and uploaded electronically to the CMMS. It's like night and day," he notes.

QR codes and scanner software are another advantageous development. They allow walk-down inspectors to quickly pull up the correct equipment record in the CMMS versus manually entering data from an equipment tag or card catalog. QR technology also streamlines and accelerates walk-downs due to improved location accuracy when every physical movement of equipment is tracked. Equipment QR codes can be scanned at install and removal, before and after repairs, and at entry and removal from stores.

TASKS TO INCLUDE IN WALK-DOWN INSPECTIONS

Completing any or all of the following tasks and updating the CMMS and any accessory reliability information management system will help to improve data integrity and reliability program success:

- Verify the asset location exists as identified in the CMMS.
- Add the asset location if not already in the CMMS.
- Verify all asset locations are in the CMMS.
- Check the availability of the location's documentation (installation instructions, visual inspection checklist, manuals, procedures, service bulletins, warranties, original purchase orders).
- Perform a visual inspection.
- Take photos of the nameplate and component.
- Take baseline vibration levels and signatures.
- Install a plant asset ID tag on equipment that is repairable, if not already present.
- Verify and update as needed:
  - the installed equipment nameplate information, including serial numbers
  - the equipment ID as recorded in the CMMS
  - the required lubrication type, amount, and interval
  - the filter numbers (oil and air)
  - the gauges and readouts
  - coupling and belt information
  - bearing and seal information
  - the operation type (continuous, random, spared)
  - whether constant or variable speed
  - whether the component is rebuildable or disposable
  - the P&ID number for each component
  - whether the equipment is properly sized for its current process
  - whether there are workarounds that need to be corrected.
- Check if the component is in the critical spares program.
- Verify the existence and location of critical spares.
- Check the status of the spares in plant stores.
- Check the status of required accessories in plant stores.
- Sketch the asset train layout.

START NOW TO REALIZE RELIABILITY OPTIMIZATION

Maintenance and reliability programs succeed or fail based on the level of CMMS data accuracy. It is essential to establish and enforce procedures to ensure consistent data quality, including how to properly apply MOC to record all equipment and component changes, when and how to conduct walk-down inspections, and defining visual inspections. At minimum, assess and update your most critical asset information now using the tips provided above.

As Slygh pointedly reminds us: "There is an awful lot of opportunity out there for companies to clean up their databases because if they are not up to date, the data is not considered trustworthy, which will hamper your reliability improvement efforts."

Forrest Pardue is president and founder of 24/7 Systems Inc. After earning a BSEE at North Carolina State and then an MBA, Forrest has worked in the field of vibration analysis and PdM for more than 40 years. He was one of the founding members of Computational Systems, Inc. (CSI), and co-founded 24/7 Systems in 1998.

Sheila Kennedy, CMRP, is a professional freelance writer specializing in industrial and technical topics, and has been Technology Toolbox columnist for Plant Services since 2004. She can be reached at sheila@addcomm.com.

COMPRESSED AIR CHALLENGE: ASK THE EXPERTS

This month's topic: variable speed drives for compressed air systems

In this special feature, we pose some common compressed air questions to Compressed Air Challenge expert instructors for feedback.

Questions: *My compressor vendor wants me to purchase a variable speed drive (VSD) compressor to make my system more efficient. Is this a good thing and why? Are there things I should watch out for that might cause me problems?*

GREG ASHE (Kaeser Compressors, Denver, CO, L1&2 Trainer)
Variable speed compressors can reliably lower energy costs when applied correctly, but they may not be a perfect fit for all applications. If installed in a harsh environment or grossly oversized, repair and downtime costs can significantly outweigh potential energy savings. If you have moderate temperatures along with relatively clean and dry conditions in the compressor room, the next step would be to understand your compressed air demand and how it would benefit from a VSD compressor.

One large VSD compressor may seem attractive since it takes up less floor space and doesn't require any master controls, but there are limitations on how much speed/flow it can vary. Many oil flooded compressors can turn down about 70% from peak flow, meaning there's 30% where it can't operate and has to shut down or unload. This 30% gap is referred to as a control gap, and if the compressor spends considerable time operating there, it may lead to long-term reliability issues. This is a frequent concern when a facility has very different flow requirements for shift #1 vs shift #2. For example, if you needed 1,000 cfm for shift #1 but only 200 cfm for shift #2, it might be better to have several small compressors working together instead of one large VSD. Multiple compressor systems can include a VSD, but many do not and may depend on other factors such as load sharing and serviceability of the system.

At the end of the day, equipment selection frequently comes down to budget and spending more capital on a VSD would require some type of justification, usually in the form of energy cost reduction. While compressed air consultants can provide recommendations to maximize equipment reliability and system performance, it's difficult to accurately project energy savings from a VSD without first doing an air study or audit. Only after measuring the existing power consumption and flow can you then say that the new compressor X will reduce energy costs by 25% etc., assuming flow requirements don't change.

WANT TO LEARN MORE?
Send key staff to one of the CAC Fundamentals of Compressed Air Systems seminars to help them learn what is possible. Participation in our Advanced Management of Compressed Air Systems, and Compressed Air System Assessment & Project Development seminars can also pass on additional important knowledge on how to address complex compressed air problems and how to calculate possible savings. Also available is User Awareness training.

To learn more about upcoming training opportunities visit the CAC calendar at https://www.compressedairchallenge.org/calendar.

Do you have a compressed air related question you would like to ask our experts? Email training@compressedairchallenge.org to request an answer.

CHRIS BEALS (Denver CO, L1 Trainer)
VSD compressors will save energy if they are:

- Sized properly—In order to prevent a "control gap" the VSD compressor's turndown range should be equal to or greater than the variation in demand or the capacity of the largest baseload compressor to be unloaded.
- Operated always as the trim compressor—At full load VSD compressors are less efficient than constant speed compressors so the constant speed compressors should be set to unload between the VSD compressor's target pressure and its stop/unload pressure set point. Another option is to install compressor automation.

VSD compressors can prove unreliable if they are installed:

- Without sufficient storage—Insufficient storage can result in excessive hunting which can shorten the life of the capacitors in the variable frequency drive (VFD). Hunting can be reduced by tuning the VSD compressor's P&ID loop. In low demand situations rapid cycling of a start/stop VSD compressor can pump the lubricant out of the compressor.

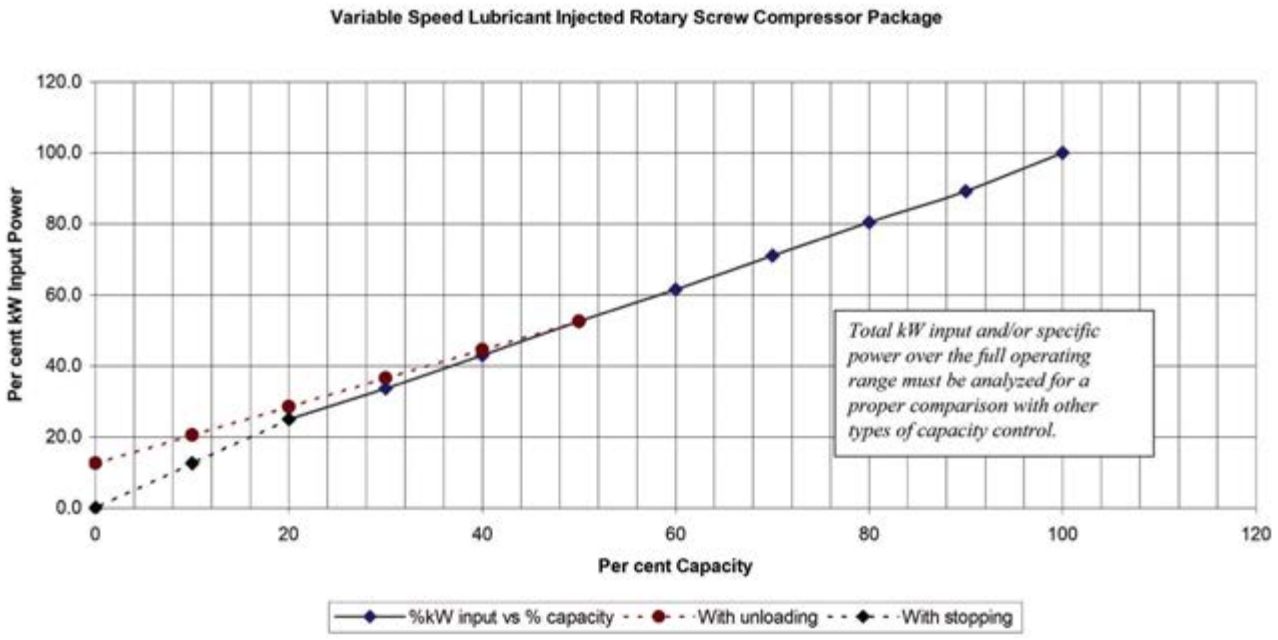


Figure 1. VSD Flow/Power chart. *Source: Compressed Air Challenge*

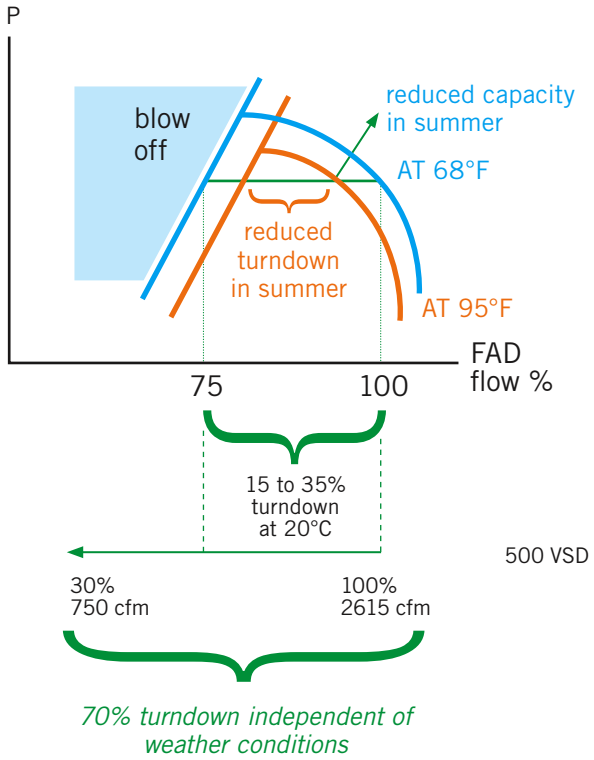


Figure 2. Turndown characteristics compared.

- In a dirty environment, an area with excessive heat, or outside where the VFD is exposed to sun loading—The VFD control panel is fan-cooled so a dirt buildup on the boards and capacitors and/or an environment with excessive heat reduce cooling, thereby reducing the life of the VFD's components.

Replacement motor and VFD availability can also reduce system reliability. Due to supply chain disruptions it is not unheard of to see long delivery times exceeding six months for specialized items.

FRANK MOSKOWITZ (Phoenix, AZ)

VSD compressors have some really nice benefits. The performance chart (see Figure 1) shows typical power versus capacity when using a variable speed compressor. This shows almost perfect power turn down with flow.

1. Speed variation is brought about by a change in the supply frequency to the electric motor by the frequency convertor.

- The system is controlled by a pressure sensor mounted at the end of the air compressor package.
- This develops a 4-20 mA signal, which is first fed to the controls and compared to a setpoint.
- Depending on the signal, the communication is sent to the convertor to either increase or decrease the frequency to the electric motor.
- The VSD machine maintains the pressure within a band of about 2 psi and without pressure over-shoots.

2. VSD machines show a higher parts lifetime due to the absence of torque peaks and machine loading and unloading, but also due to lower average rpm than fixed speed machines.
   - An example for bearings—Considering a fixed design constant C/P (bearing design constant) of 5,000 for a bearing, for a fixed rpm of 2,000, the bearing shows a lifetime of 50,000 hours. On the other hand, a machine running variable speed at an average 1,000 rpm, the life of the bearing doubles.
3. A comparison to a centrifugal compressors (turbos)
   - Turbos operate in a stable condition in their turn down range being the zone between the operating point and surge. This is typically 15-35% depending on the ambient conditions. If stable pressure is to be maintained below the surge limit, blow-off is necessary.
   - VSD machines operate with a stable pressure down to about 20-30% (depending on make and model) of their rated capacity irrespective of ambient and with no blow-off (see Figure 2).
   - This is a major energy saver.

RON MARSHALL (Winnipeg, MB, L1&2 TRAINER)

Few things in the compressed air industry have positively changed system performance as much as variable speed drive compressor technology. The key to saving energy in a system is the elimination of the unloaded run time that happens when a partly loaded system uses fixed speed compressors. Screw compressors use significant power when they run unloaded, VSD compressors do not. So, the use of a properly sized VSD compressor in a system of one compressor, or with multiple fixed speed compressors can save lots of energy, typically averaging 20% to 30% over fixed speed drives.

VSD compressors also provide a more constant and stable air pressure output, allowing system pressure to be reduced, saving about 1% power for every two psi in average pressure reduction. As the pressure reduces, many of the unregulated compressed air consumers in the plant will use less air, about 1% less per one psi reduced. This reduces compressor power even more.

And due to the almost perfect turn down relationship between power and flow, if you are diligent in doing frequent leakage repair and eliminating other wasteful compressed air demands, having VSD control will save the most money. The efficiency of this technology unlocks extra savings for demand reduction.

But heed the warnings already mentioned by previous experts, VSD compressors do not perform well in hot, humid, dusty environments, so keep them clean and cool. And be sure to have a compressed air assessment done on your system to make sure the equipment you are purchasing will be properly sized for your application. It is not good to oversize a VSD and have it run constantly in its minimum speed range.

Check all these boxes and you could have a well managed VSD controlled system that saves you money, year after year.

The Compressed Air Challenge (www.compressedairchallenge.org) is a voluntary collaboration of industrial end-users; manufacturers, distributors, and their associations; trade organizations; consultants; state research and development agencies; energy efficiency organizations; and utilities. The CAC has one purpose in mind: helping compressed air users enjoy the benefits of improved system performance. The mission of CAC is to promote energy and operational efficiency in compressed air systems for industry through information and training, leading end users to adopt efficient practices and technologies while leveraging collaborative cooperation among key stakeholders. To carry out the mission, CAC maintains a group of 20 highly qualified and experienced instructors who are available to deliver various product-neutral training offerings through in person or online training delivery.

EASE INSTRUMENT COMMISSIONING AND ENHANCE MAINTENANCE WITH IO-LINK

Empowered with simple configuration, cost-effective implementation, and comprehensive diagnostics, plant personnel—especially in the food & beverage industry—are leveraging IO-Link-enabled digital instruments and sensors to create insights | by Ola Wesstrom

Ask any plant manager, operator, or engineer with more than a few weeks of experience, and they can recall multiple instances attempting to troubleshoot issues with insufficient information available. To address this and related issues, many technological innovations are filling in the informational voids, aiding root cause analysis.

In the instrumentation realm, advancements in device diagnostics are making scores of data points available for consumption by central host systems, supplementing historical process data and increasing maintenance, repair, and operational insights. Modern digital communication protocols provide the backbone for receiving all this data, which is natively suited for monitoring and analysis in edge or cloud computational engines, without the need to convert analog measurement signals.

There are various industrial Ethernet protocols and fieldbuses that form these digital pathways, but in many applications, such comprehensive technologies add unnecessary installation and design complexity to systems that require only simple diagnostic capabilities.

IO-Link is a lighter digital protocol, easier to configure and at a lower cost to install and maintain than fieldbus and Ethernet-based communication packages, while still providing most, if not all, of the required diagnostic and process data points digitally to a central host system. This manufacturer-agnostic open protocol was developed as a simple and universal solution, requiring only standard M12 cables and connectors. IO-Link is applicable to both analog instruments, such as one used to measure temperature, and discrete sensors, such as a limit switch, with the term "instruments" used throughout this article to represent both types of devices.

With an estimated 27 million nodes in operation worldwide as of 2021 and a rapidly-growing base, especially in food & beverage facilities, IO-Link is supported by a wide and growing range of instruments, providing data-rich visibility, along with other benefits of digital technology.

TRADITIONAL COMMUNICATION SHORTCOMINGS

Many plants today are performing process measurements using conventional instrumentation, and most of these measurements are transmitted to a host control system—such as a programmable logic controller (PLC) or distributed control system (DCS)—via 4-20 mA analog current signals.

While industrially robust, there are many factors that can interfere with the performance and quality of these instruments' measurements and analog outputs. Because traditional 4-20 mA instruments scale a single process value as electrical current, there is no ability to transmit secondary variables or diagnostic data.

Without instrument diagnostic data, it is challenging for operators to know whether the 4-20 mA signal processed by a central host system is accurate. Additionally, communication is one-way only, so there is no means to send commands from a host system to an instrument.

Figure 1. An Endress+Hauser Picomag electromagnetic flowmeter digitally transmits primary and secondary process variables—plus instrument diagnostic data—to a central host system via IO-Link. *Source: Endress+Hauser*

PATHS FOR UPGRADE

By incorporating smart instrumentation into plant designs, facility operation and optimization become much more manageable tasks. These instruments incorporate digital communication protocols, sometimes in place of—and other times superimposed on, in the case of HART—traditional analog communication protocols, greatly increasing capabilities and value. In fact, it is estimated that 90% of all analog instruments installed already have digital HART capabilities, but 97% of these remain unused.

For retrofitted applications where hardwiring transmitters back to a host system is convenient, instruments can use the two-way digital HART communication protocol. It is superimposed on an analog current loop, and it enables sending and receiving of data with a local calibration device or host system.

The exchanged data includes diagnostic, calibration, maintenance, process, and other information, increasing configuration ease and operational process insights as compared to traditional analog-only instrumentation.

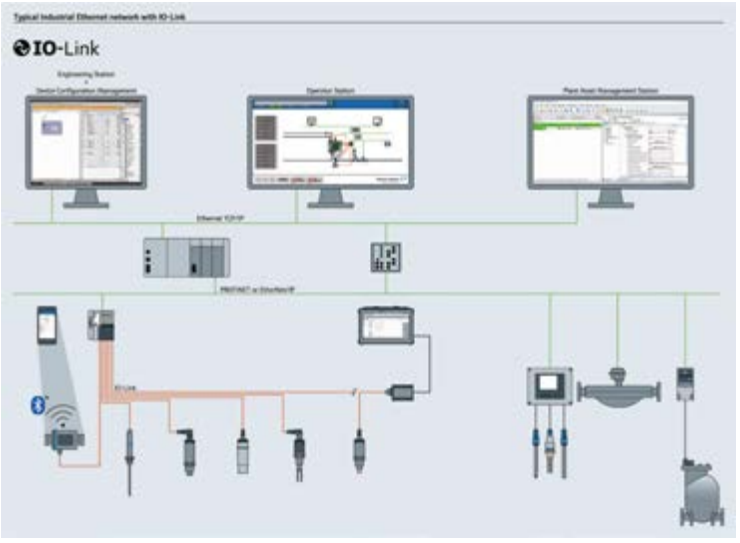


Figure 2. IO-Link can integrate seamlessly with an existing plant Ethernet network by way of the master device that transmits data among connected instruments and host systems, or it can act independently.
Source: Endress+Hauser

Transmitting this data is also possible via Ethernet-based protocols, which provide many of the same benefits as HART, but they typically operate at higher speeds, enabling inclusion of more information, along with faster response times. Wireless data transmission options—including Bluetooth, WLAN, and WirelessHART—also are available for many modern instruments.

IO-LINK FILLS A SWEET SPOT

While each of these digital protocols has ideal uses, IO-Link possesses a unique set of advantages for many applications, combining simple configuration, a standardized protocol, fast data transmission speeds, and low cost. Recognized as an international standard, IEC 61131-9, IO-Link is a bidirectional digital communications protocol. It provides measurement and other devices with basic functionality, most notably instrument diagnostic information (see Figure 1).

Similar to a remote input/output (I/O) hub, an IO-Link "master" device is used to connect multiple instruments to a host system via an industrial Ethernet protocol, such as EtherNet/IP, PROFINET, or Modbus-TCP/IP. The master serves as a gateway, transmitting diagnostic data, secondary process values, and host system commands among all connected devices (see Figure 2).

Integrating IO-Link-capable instruments is especially popular among machine builders and skid suppliers in the food & beverage industry. This is because basic instruments with support for IO-Link fulfill most operational requirements, while the diagnostics of IO-Link can drastically improve troubleshooting efforts when issues arise. The installation requirements of fieldbuses add complexity and costs, and by contrast, IO-Link instruments are about as close to "plug-and-play" as any come.

Additionally, the majority of IO-Link instruments can be optionally operated in 4–20 mA analog mode with simple configuration and wiring changes, enabling flexible installation and integration. When ready, facilities can switch the devices to digital mode to harness the power of offline parametrization, increased instrument diagnostic data, and multiple process variables transmitted from a single instrument.

This includes provision of secondary process values, such as temperature, alongside a main measurement, or continuous measurement values alongside a switch status. Some standard diagnostic data points indicate:

- Is the device active?
- Is each process value valid?
- Hours of operation
- Marginal operations
- Overload conditions
- Device identification information
- Instrument error codes.

IO-Link functions as a compelling alternative to simply monitoring non-digital devices, like 4-20mA transmitters or digital input switches, which only permit a single process variable per cable pair. These traditional instruments also require scaling and local configuration, operations that must be repeated manually every time a device is exchanged.

By contrast, IO-Link-enabled instruments come ready out of the box, retaining the full resolution of measured values for transmittance to a host system. Using M12 washdown grade connectors and unshielded cables up to 20 meters in

length, it is easy to deploy large quantities of IO-Link instrumentation in a short span of time.

Standard configuration software is readily available, and it is often hosted on the IO-Link master's web server, accessible in any browser through a network-connected cell phone, laptop, or tablet. The software's intuitive interfaces graphically guide users through parametrization, and this can be performed remotely through a network-accessible master device, reducing commissioning time during startup, and troubleshooting time during operation (see Figure 3).

Figure 3. Guided by intuitive interfaces, commissioning IO-Link instrumentation is as simple as plugging in each device to an IO-Link master, and then connecting a host system to the master to access instrument data. *Source: Endress+Hauser*

Figure 4. A food & beverage processor upgraded its inventory management system with Endress+Hauser instrumentation—including iTHERM TM311 temperature instruments (pictured) and others—leveraging Netilion, a cloud-based condition monitoring system, to ensure operational reliability. *Source: Endress+Hauser*

In the event of device failure, replacement is simple because parametrization can be stored and saved online or offline, and quickly loaded when a new master or instrument is placed in service. Because IO-Link is a standardized technology, every instrument implemented according to specifications works with any manufacturer's master, providing users with flexibility for instrument selection.

Compared to instrumentation with direct Ethernet connectivity, IO-Link devices are not directly accessible from an upper-level system, such as an asset management system. Instead, users must tunnel through the IO-Link master to reach them. However, faster data polling speeds make this quicker than connecting to instruments via HART. But the greatest strength of IO-Link systems is the simplicity of instrument configuration and ease of device replacement, reducing the level of training required to maintain and service plant instrumentation.

INDUSTRY 4.0 CAPABILITIES FOR THE DIGITAL FUTURE

Upgrading analog instrumentation with digital capabilities provides a number of CapEx benefits for machine builders and end users, including simpler design, easier commissioning, and faster startup. Digital technologies in general, and IO-Link in particular, provide fast device data exchange, precise transmission accuracy, multiple process value measurements per device, and many diagnostic data points. These capabilities can be used to improve operations and maintenance throughout instrument lifecycles.

Sustaining a competitive edge in the food & beverage industry requires top-notch production efficiency, among many other practices, and a wide variety of products are comprised of perishable raw materials, which are subject to loss if improperly stored. For this and other reasons, precise monitoring of stock, hygiene, safety, and inventory conditions are crucial to minimize material waste and adhere to strict standards. IO-Link can help food & beverage processors that are challenged by the constant threat of loss and the difficulties of rigorous manual management.

Although most widely adopted in the food and beverage sector, IO-Link-capable instrumentation has something to offer processors across many industries because it helps expand visibility and generate holistic insights. These insights empower plant personnel to optimize operational efficiency, maintain product quality, and maximize profitability.

Ola Wesstrom is the senior industry manager of Food & Beverage for Endress+Hauser USA (www.endress.com). He is responsible for the development and implementation of best practice measurement solutions, supporting customers throughout the industry segment. Ola has a BS degree in instrumentation and automation from National Pulp & Paper College in Sweden. Since joining Endress+Hauser in 1992, he has held various positions, focusing on Food & Beverage since 2001.

AD LITS

COMPRESSED AIR SAFETY AND SAVINGS

Compressed air safety is a concern within manufacturing environments. Learn about the dangers that can come from high pressure and noise exposure. Improper use of compressed air commonly exceeds OSHA's noise exposure standards and causes noise induced hearing loss. Learn how to be sure you are OSHA compliant. Download EXAIR's latest white paper, "Understanding Compressed Air Safety and Savings".

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Best of BPI 2022

Our annual look back at key thoughts and insights from the past year

"One thing I like about water is you have friends in all the other water utilities around you, because we don't compete with each other. Each community has got their own water supply and distribution system, so there's a lot of working together, and calling my counterpart at a different utility and saying, 'Hey, how do you guys deal with this?'"

Paul Crocker, CMRP, CRL, CAMA, ReliabilityX

Reliability In The Drinking Water Industry, February

"Number one, you didn't hire the operator to be your data management keeper, right? You hired the operator because you need to get widgets out the door. (Also), nobody wants to write down the fact that they got the recipe wrong, right? The records have an element of corruptibility to them."

Larry West, Sales Engineer, Perceptive Controls

Why You Should Automate OEE Data Collection, March

"I've learned it's not about price, it's about putting on the right piece for the right piece of equipment for the job it does, and if you do it right and maintain it, it'll last for a very long time."

Mike Macsisak, CMRP

Looking Back On A Life In Maintenance, October

"The interesting part and where I see the risk lies is that all of these pledges and commitments and goals and ambitions were made at a country level, but it's up to us in the industry on every part of the supply chain to make sure we are aligned so that we can meet these goals."

Oswaldo "Oz" Rodriguez, Head of Product Go-To-Market Strategy, Lloyd's Register Digital Products,

It's Time For Industry To Come Together To Promote Sustainability, April

"Going from where we are today to net-zero in something well under a single generation is going to require deep rethinking of the energy infrastructure of corporations. That's going to require game plans, which are not the usual operational ones."

Peter Garforth, Plant Services Energy Expert

Now Is The Time To Rethink Your Energy Plan, May

"(Companies) using digital transformation as a tool to improve the business – and not necessarily a tool to drive technology with inside of the business – are getting a much higher return on their investment. The ones that really have a difficult time are the ones that approach it from a technology standpoint."

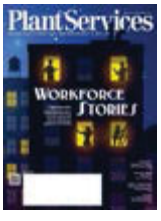
Eric Whitley, Director of Smart Manufacturing, L2L

Digital Transformation Success Is More Than Just Buying The Right Tools, August

"You guys have to partner with different styles of people throughout the day, like people who do different things. And I think that partnership, that collaboration leads to that next big idea, always."

Lee Kitchen, Founder, Magical Dude Consulting

Why Industrial Plant Teams Need To Embrace Their Creativity To Achieve Greater Success, June



"We believe that APM is this foundational bedrock of energy transition (and) I think sustainability, net-zero, energy transition, however you want to frame it, is the most pressing issue of our generation, and more importantly, of future generations."

Tracy Swartzendruber, VP Marketing for Power Generation and Oil & Gas, GE Digital

Accelerate Your Asset Performance Management Program, July

"It's pragmatic to take those steps and slow down, but also not be afraid to ask questions. Can this PLC withstand downtime? Can this specific manufacturing asset suffer downtime? What does that represent in terms of dollars?"

David Anteliz, Senior Technical Director, Skybox Security

The Importance Of Network Segmentation In Cybersecurity Strategies, September

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Flushable wipes, trash bags, mop heads, rags and other stringy materials can be hard on pumps – that's why your facility needs a dependable solution for handling solids-laden wastewater. Gorman-Rupp is now offering Eradicator Plus™ solids reduction technology for 3", 4" and 6" Super T Series® self-priming pumps to help tackle municipal wastes, industrial by-products and a variety of other aggressive applications. The extra-thick, self-cleaning wearplate is designed to cut and shred organic solids entering the pump, while the rugged, continuous vane impeller prevents the build-up of debris and keeps your pump operating at peak efficiency. A lightweight inspection cover allows for easy access to the inside of the pump without disturbing wearplate-to-impeller clearance.

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