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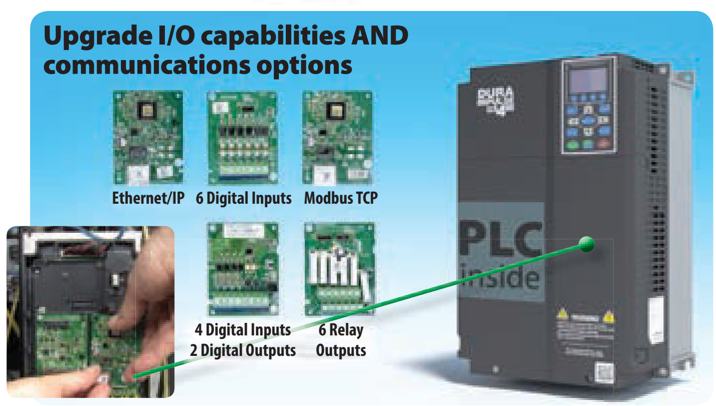

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BETTER (HOLIDAY) PLANNING

How a 3D printing strategy can also ease your busy schedule

Have you ever wondered what the stress of managing the holidays is doing to your brain?

One of the most cited pieces of research in this area was published in 2006 by the American Psychological Association in a research report simply titled "Holiday Stress" (http://plnt.sv/1712-ED01). In this survey, respondents cited one factor – time – as the most challenging to navigate. Specifically, 85% claimed that a lack of time added to their stress levels, and 67% reported that time management was their most significant holiday stressor overall.

In 2016, Harvard Medical School's neurobiology department weighed in on holiday-related stress (http://plnt.sv/1712-ED02), noting that the brain's prefrontal cortex goes into overdrive during the holidays because of the greater number of activities to track. "Over time, a high level of demand can decrease memory, halt production of new brain cells, and cause existing brain cells to die."

So, why bring this topic up in a maintenance and reliability publication? Two articles from this month's issue help answer this question: our cover story on 3D printing by managing editor Christine LaFave Grace, and Doc Palmer's latest column on planning and scheduling.

Doc has led the way this year in our coverage of this topic, starting in January with his argument that proactive maintenance via proper planning and scheduling helps plant teams unlock untapped reserves of extra labor. In this month's column, Doc makes a point that made me think of the holidays: To complete more work than normal, "have the scheduler fully load the weekly maintenance schedule with 100% of the available labor hours."

What? Isn't life stressful enough without going out of your way to fully load your schedule? As Doc explains, though, the goal isn't to stick to the schedule; it's to complete more work, and "a crew started with a 100% fully loaded schedule usually completes more work even if it frequently breaks the schedule to take care of operations' urgent concerns."

This point is balanced in our cover story by a strategic recommendation

TOO-HIGH DEMAND LEVELS CAN DECREASE MEMORY AND CAUSE BRAIN CELLS TO DIE.

from Mike Vasquez, founder of 3Degrees, for anyone exploring the role of 3D printing in their facility. Be sure that the application of the technology is tied to a specific business goal, he says, such as saving time to production, reducing inventory, or expanding an on-demand supply chain. "Just because you can 3D-print something doesn't mean you should," he says. "If you're telling me that you want to recreate these screws and just use 3D printing for no justification, then that's a challenge."

In other words, try not to stress out too much if your holiday schedule is 100% booked, as you'll ultimately see more people and do more things than if you had deliberately dialed back your schedule. And, do your best to make sure that each thing on that schedule is tied to your bigger personal holiday picture.

Thomas Wilk, Editor in Chief
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HOW TO CEDE CONTROL AND NOT GO CRAZY

What you need to successfully empower your team to make decisions and take action

Teams perform better when managers and supervisors empower them to make decisions and solve issues with the least amount of supervisory intervention.

Leaders who give their employees more control over their work and over decisions about how work should be done do so because they realize that the workforce is smarter than they are about the systems the team works on. Many enlightened organizations also find that, when empowered, the workforce can respond to situations more quickly. That's because the workforce knows that they have been trusted to handle the situation.

When issues get bigger, the empowerment may still be extended on an "act-then-report" basis. Acting first and reporting second retains the benefit of quick response. Reporting to the supervisor or manager what was done soon after the action was taken informs the boss of what happened but also provides the worker with "top cover" (support from their supervisor or manager). Of course, the larger the issue, the more thoughtful the empowerment should be.

What's required from the organization to allow for empowering teams? Several things must be present:

- There must be commitment from senior managers.
- There must be mutual trust between management and labor.
- The organization must maintain a commitment to training and education.
- The organization must select appropriate activities to delegate.

When you empower team members, you give up some control. Your tolerance for how much control you give up has a lot to do with the people you're considering empowering. The better the relationship between management and labor, the greater the likelihood that empowerment can work.

Senior managers must be committed to providing sufficient time and resources to prepare people to be empowered. In addition, they need to have the fortitude to allow decisions to be made that might not be the same ones they or the team leaders would make. Obviously, we want to avoid incidents that are unsafe or not in compliance with regulatory requirements and those that would significantly degrade operations or have high consequential costs.

Trust is critical. Managers and supervisors who are closest to the workforce will be the ones empowering specific individuals or teams. Each person or team member has a responsibility to perform all of his or her tasks in a manner that increases trust in his or her knowledge, skills, and readiness to take on empowerment. When team members get more authority, they have the opportunity to learn new things, develop new skills, expand their network, and improve their job security and earning potential.

Team members must be trained in any technical skills and/or managerial aspects of the role they will be asked to take on. They may need access to budget information or production scheduling to tackle tasks successfully.

MANY ENLIGHTENED ORGANIZATIONS FIND THAT, WHEN EMPOWERED, THE WORKFORCE CAN RESPOND TO SITUATIONS MORE QUICKLY.

Empowering workers also means giving them the knowledge they need to take on the responsibility for decision-making. This is why I'm a big believer in workforce personnel participating in cross-functional training and in team activities focused on subjects such as defect elimination, reliability-centered maintenance (RCM); failure modes, effects and criticality analysis (FMECA); and root cause analysis (RCA). When team members have opportunities to collaborate, they learn much more about the entire system.

Always remember that not all tasks or activities are good candidates for this process of empowering workers. Good empowerment tasks are ones that can benefit from being performed by people who are closer to the work and who know more about how a given system operates.

My advice for managers and supervisors is to create an atmosphere that supports collaboration and trust. Lower-level team members and their managers and supervisors need to be comfortable with the transfer of authority, and employees need all relevant tools and skills to perform reliably.

Once a team or team member has been empowered, the manager or supervisor has to retain accountability for the task. Think of it this way: The leader retains accountability, but the empowered person is responsible. The manager or supervisor must take the heat for things that don't go well.

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SMART TECH COMES TO PUMPS

Digital twins and data analytics enable engineering, process improvements

Making pumps smarter and more connected to the industrial internet of things (IIoT) streamlines condition monitoring, predictive maintenance (PdM), and engineering improvements. Digitalizing these practices reduces the risk of and costs associated with unplanned downtime.

New, intelligent, connected technologies can alert managers and technicians to adverse conditions, giving them more time to make crucial decisions. Modern modeling approaches improve pump engineering and reliability while also driving new service offerings.

IIoT ELEVATES PUMP MONITORING AND MAINTENANCE

When real-time pump performance data is available, conditions that affect performance –such as cavitation and off-curve operation – can be remedied quickly, before machine damage occurs, says Gene Vogel, pump and vibration specialist at the Electrical Apparatus Service Association (EASA).

The capability is fundamental to large pumping operations such as refineries and chemical processing facilities, and "smart" technologies can make the same data available to mid-range and low-end pump users that don't have distributed control systems (DCS) or other real-time data systems available.

"Pump service centers can play an important role in installing and maintaining the acquisition points necessary to make that data available," suggests Vogel.

Smart solutions such as the i-ALERT sensor, mobile app, and Ai platform from ITT PRO Services let users view real-time and historical data, diagnostic information, and machine records. Designed to be easy to install and to allow for safe and efficient equipment inspection, they let users take more-timely action.

The i-ALERT sensor tracks three-axis vibration, temperature, and machine runtime. Data collection is managed via the mobile app, which also provides access to technical and bill-of-material information from participating equipment manufacturers such as Goulds Pumps. "With the Ai platform, customers can have a historical view of their i-ALERT-enabled machines and conduct analysis through the simple web interface," explains Jeffrey Sullivan, global product manager at ITT Goulds Pumps.

WHEN REAL-TIME PUMP PERFORMANCE DATA IS AVAILABLE, CONDITIONS THAT AFFECT PERFORMANCE CAN BE REMEDIED BEFORE MACHINE DAMAGE OCCURS.

Petasense provides wireless vibration sensors and machine learning analytics that continuously monitor assets, analyze sensor data in real time, and assign a numerical health score to machines. Plant managers and engineers receive real-time alerts when the health score falls too low, so they can make timely decisions to avert failures.

"Recently, we have also collaborated with OSIsoft to provide reliability engineers with process control data alongside vibration data. It enables better diagnosis of failures and helps improve the prediction models," says Abhinav Khushraj, co-founder of Petasense. "Using multiparametric sensor data, plants can maximize asset reliability and seek to operate pumps more efficiently."

SCOUT Cloud Software and SensoNODE Gold Sensors from Parker Hannifin enable wireless, cloud-based, remote condition monitoring to improve the reliability of pumps and other critical equipment. The SensoNODE Gold sensors are IP65-rated for harsh environments and designed to continuously monitor assets for pressure, temperature, humidity, flow, or power.

A solution such as SCOUT Cloud Software and SensoNODE Gold Sensors that lets users monitor their pumps and other systems via a web browser can go a long way toward early issue detection, reduced downtime, and improved worker safety, explains David Shannon, business unit manager with Parker's quick coupling division (QCD).

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DIGITAL TWINS DELIVER ENGINEERING INTELLIGENCE

Digital twin technology allows the virtual modeling, simulation, and analysis of products and processes using real-time operational data to let users make more-informed predictions. Pump and systems manufacturer Grundfos partnered with ANSYS, a provider of engineering simulation software, to create complete digital twins of its products to improve product quality and performance and develop new service offerings.

"The combination of the IoT with the unique insights provided by simulation enables the creation of a virtual, digital version of any product that creates an incredibly compelling platform for value-added services on top of product development," says Rob Harwood, global industry director at ANSYS.

For the pump-driven oil and gas industry, digital twins of a plant, refinery, or rig are enabled by the recent partnership of Baker Hughes, a GE company (BHGE), and KBC, a Yokogawa company. Combining KBC's Petro-SIM process simulation modeling with BHGE's asset performance management software and analytics on the cloud-based GE Predix platform enables end-to-end process and operational analytics, machine learning, and "molecularly enabled digital twins" of assets, according to BHGE.

"This moves the industry further towards sophisticated data analytics – taking previously offline models and making them available and updatable, anytime, anywhere, with high-performing, high-velocity data models – reducing time to obtain valuable insights," observes Diego Comina, midstream and downstream digital product manager at BHGE.

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WEEKLY SCHEDULE: NOT WHAT YOU THINK

Weekly scheduling is about goal-setting with 100% schedule loading

The fourth principle of scheduling is having the scheduler fully load the weekly maintenance schedule with 100% of the available labor hours. Fully loaded schedules are a great departure from typical scheduling practices that allow room for break-ins. Best practice is 100% loading because the weekly schedule functions as a goal-setting tool. Lesser parts of this principle provide guidance on filling the schedule with higher-priority work even if it means underutilizing the skills of some persons and considering whether to include interruptible jobs.

Nothing strikes fear in the heart of maintenance crew supervisors more than fully loaded schedules. Typical weekly schedules leave room for the break-ins that will inevitably happen. In addition, employees sometimes call in sick. Supervisors feel there is no way that they can complete all the scheduled work in a fully loaded schedule. Yet the supervisors who feel this way and the managers who have placed them in this position have missed the entire objective of the weekly schedule: *The objective of weekly scheduling is to complete more work than normal, not necessarily to complete the schedule.*

Saying up front that it is OK not to complete the schedule doesn't seem to make much sense, does it? Not surprisingly, the renowned management consultant Dr. Peter Drucker said: "Management by objective works – if you know the objectives. Ninety percent of the time you don't."

A proper weekly schedule can accomplish the objective of helping a crew complete more work than normal by using goal-setting to defeat Parkinson's Law, which states, "The amount of work assigned will expand to fill the time available" (Cyril Parkinson, "Parkinson's Law," The Economist, Nov. 19, 1955). The meaning is that if a schedule does not include enough work, the work included will take more time than it should. Crews given schedules that fill only 70% or so of the available labor hours are destined to complete less work than they otherwise might.

The normal amount of work a crew typically completes is that work of taking care of operations' urgent concerns and ensuring everyone has something to do. But a crew started with a 100% fully loaded schedule usually completes more work even if it frequently breaks the schedule to take care of operations' urgent concerns.

Another consideration is that only fully loaded schedules give management a standard for productivity. How much work should a crew with 400 available labor hours be able to complete? The answer is 400 hours of work. Yet, if the crew finishes all the work on a schedule of only 320 hours of work, management cannot clearly identify any productivity problems. And neither can management clearly identify productivity problems if the crew does not finish all the work on a schedule of 480 hours of work. It is best to assess and control productivity by scheduling 100% of the available hours and comparing actual work completion.

NOTHING STRIKES FEAR IN THE HEART OF MAINTENANCE CREW SUPERVISORS MORE THAN FULLY LOADED SCHEDULES.

A lesser part of fully loading scheduling is choosing higher-priority work over lower-priority work even if it means underutilizing the skills of some craftspersons. For example, consider a higher-priority job in the backlog that requires only a helper, but the schedule has already utilized all available helpers. Furthermore, some welders still are available, and some lower-priority, less-urgent welding jobs exist in the backlog. Best scheduling practice would be to use welders as helpers (within union agreements, of course) to put the higher-priority helper work on the schedule.

Another lesser part of fully loaded scheduling is considering whether the fully loaded schedule should consciously include some jobs that can easily be interrupted or deferred. What does it matter if some work is deferred on a 100% schedule versus not scheduling it to begin with on a 70% schedule? As far as interrupting in-progress jobs, new urgent work can frequently wait a day or so to allow in-progress jobs to finish or at least come to a good stopping point.

The proof is in the pudding. Actual experience shows that crews given fully loaded schedules generally have higher wrench time and complete more work orders than those with schedules that are too lightly (or too heavily) loaded.

Doc Palmer 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. Visit www.palmerplanning.com or email docpalmer@palmerplanning.com.

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MOVE IT: OPC CLASSIC > OPC UA MIGRATION

Here's how to ensure a seamless transition to the OPC Unified Architecture

The OPC Unified Architecture (OPC UA) increases productivity, enhances quality, and lowers costs by providing not only more industrial data but also the right kind of information to critical systems that need it. Organizations deploying this modern standard will be able to better leverage plant-floor-to-enterprise communications as a vehicle to participate in industrial internet of things (IIoT) applications.

OPC UA is the key to moving information vertically through the enterprise of multivendor systems as well as providing interoperability among devices on different industrial networks.

This article describes the key features of the OPC UA versus the legacy OPC Classic standard and outlines the motivation for upgrading to OPC UA based on a managed, secure, and seamless migration path.

PROGRESS OF THE OPC STANDARD

The OPC standard, first issued by the OPC Foundation in 1996, allows for secure and reliable exchange of data across manufacturing and other enterprises. Countless OPC Classic-based systems are in use around the globe, ensuring the safe and reliable exchange of data among industrial software components.

With OPC UA, the next-generation OPC technology, the vision of "global" interoperability will become a reality. The standard was developed to break down communication barriers that have been limited by dependence on Microsoft's underlying DCOM technology. It is a platform-independent, scalable, service-oriented architecture (SOA) that integrates all of the functionality of the original OPC specifications into a single flexible framework.

Those who deploy OPC UA will be able to better leverage plant-floor-to-enterprise communications. This technology supports multivendor, multiplatform interoperability for moving data and information from the embedded world to the enterprise.

BENEFITS OF THE LATEST TECHNOLOGY

By adopting OPC UA, automation vendors get the best in open data connectivity for today and in the future. OPC UA offers and expands the standard functionality of OPC Classic, and in doing so, it resolves the difficulties associated with security, platform dependence, and DCOM problems.

There are several specific reasons to migrate from OPC Classic to OPC UA:

- By natively enabling OPC UA in devices and applications, users no longer have to rely on clumsy tools for protocol translation and information modeling. This solution reduces operating and capital expenses by eliminating middleware on the shop floor as well as the need for hardware to install servers and clients.
- Unlike OPC Classic, OPC UA is inherently cyber-secure and thus eliminates the need to layer multiple security gateways or software.
- OPC UA offers a rich set of functionality, including the ability to provide contextualized data that is valuable for advanced analytics to enable improved insights and better decision-making.

It is clear that switching to OPC UA is worthwhile, and for those developing tomorrow's intelligent devices, it's a necessity. OPC Classic simply cannot address the requirements of Industrie 4.0 or IIoT initiatives.

PROVEN MIGRATION STRATEGY

A growing number of OPC Classic users are starting to ask themselves how and when they should begin the implementation OPC UA. In many cases, the migration path to the new standard isn't clear. There's often a lack of understanding of how OPC UA works, and even after the decision to transition has been made, there may be confusion about the best approach. Many users are also reluctant to "rip and replace" existing investments. Automation assets are typically supplied by different OEMs that maintain proprietary protocols and are concerned with protecting their installed base. All too frequently, the customer has no choice but to purchase new products to access new OPC UA features.

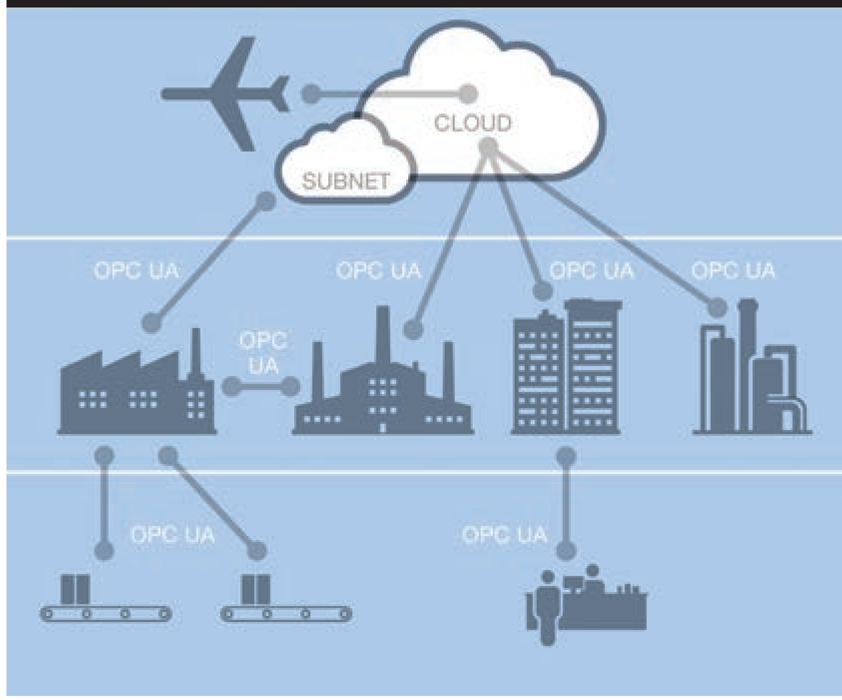
The aforementioned obstacles can make technology migration costly and difficult to manage. And although it's safe to assume that OPC UA will one day replace OPC Classic, an immediate switch to OPC UA isn't necessarily required for every business. With the right tools and careful planning, migration becomes accessible and doable.

Leading automation suppliers regard the OPC UA standard as a solution for meeting the need for enhanced connectivity in all plant things – from device to cloud – in a cyber-secure environment. This includes advancing cloud connectivity, predictive maintenance, asset health/performance monitoring, anomaly detection, and condition-based monitoring.

Industrial organizations need to be mindful of the following best practices intended to enable a smooth transition from OPC Classic to OPC UA:

Step 1: Be sure that all legacy proprietary protocols are future-ready. Complete migration refers to replacing OPC Classic via a comprehensive switch to OPC UA. To that end, however, users need to keep third-party data always accessible using an open standard that enables reliable communication between human-machine interfaces (HMIs), applications, and devices. By utilizing suitable OPC servers that support open connectivity to communicate with multiple units, protocols, and APIs regardless of the vendor, they can achieve secure connectivity with all established management systems and applications via OPC Classic.

Industrie 4.0 / IIoT: Smart World



Source: Honeywell Process Solutions

Step 2: Start with partial migration. OPC UA has been designed to remain adaptable for the future and to support legacy implementations. In the intermediate phase, it will be possible to use DCOM-based OPC products together with UA products.

Users can still run a variety of products from their current favorite manufacturers. This allows for a soft migration in which they retain OPC Classic data sources and integrate OPC UA in future devices according to their needs and capabilities. Devices using OPC Classic cannot communicate with OPC UA on their own. For these instances, it is wise to use a wrapper to provide a partial solution for handling communication between existing OPC Classic servers and OPC UA clients.

Users are finding that a new breed of software tool provides a secure method of migrating OPC Classic data sources to OPC UA. It lets OPC UA-enabled client applications communicate with OPC Classic servers and clients as well as OPC UA servers. The reverse is also true. Such tools are designed to enable seamless OPC data transfer through multiple mediums across locations, address problems with using OPC Classic components based on DCOM, and eliminate permission issues.

Step 3: Enable OPC UA connectivity across products and platforms. The continued demand for open and secure connectivity between devices (machine-to-machine) and edge-to-cloud solutions makes it necessary to have a single, fully scalable toolkit to allow users to easily interconnect industrial software systems regardless of platform, operating system, or size.

Today, automation OEMs can use an advanced software development kit that provides high-performance capabilities (e.g., multi-threaded, load balancing, small memory footprint, etc.) and makes it easy to embed an OPC UA server into a chip, device, and/or application. With this solution, developers can natively enable OPC UA servers and clients in controllers as well as in devices, sensors, and applications.

OPC UA is a crucial enabler of major advancements such as the IIoT, Industrie 4.0, and cloud computing. Many industrial firms are seeking to take advantage of this innovative technology but are wondering where to start. Users need an effective strategy for migrating from OPC Classic to OPC UA – one that employs logical steps to minimize the time, cost, and risk associated with this process. The goal is to make it easy to assess an organization's migration requirements and then implement a seamless, end-to-end solution.

Arun Ananthampalayam is senior product manager for OPC UA connectivity solutions within Honeywell Process Solutions. He's a member of the Honeywell Connected Plant IIoT team and has more than 10 years of experience working for IT and IIoT businesses.

DON'T JUST SHELVE IT: CARE FOR SPARES

Your spare parts deserve some maintenance TLC to ensure they're ready to run

by John Brokaw, Valin Corp.

We think of routine care and maintenance of a system to stave off failures as standard practice, but what about preventive maintenance of the replacement parts used when the system does fail? It's easy to forget about spares sitting on the shelves when systems are running smoothly and there's no need for them. This could be a costly mistake, however, when a drive goes down and the next in line has been sitting untouched in the same spot for more than a year. To keep spares useful and running for years, proper planning, maintenance, and storage are vital.

STANDARDIZATION WILL SET YOU FREE

The first step to saving money on the back end with respect to spare parts is good planning in the design system. Controls, motors, and drives all work together with a common goal and can use common components as well. Designing a system with standardized motors and drives provides an operator with the ability to put fewer backups on the shelves because specific parts can be used in more than one place.

Induction motor standards usually are based on the size of the shaft or the bolt circle, so pay specific attention to those measurements to be able to use one spare across multiple parts of a system. For example, if a motor is being applied to conveyors, it makes more sense to standardize the parts with the right size and selection and just keep one spare with a large amount of horsepower. If the spare motor in storage is a 3-hp motor, it can be used anywhere in the conveyor to replace a motor ranging from 1–3 hp, as opposed to having a backup for each component. The same concept can also be applied to drives as long as the tuning parameters for each application are always on hand.

TAKE CARE OF THE SPARE

Just like food sitting on a shelf, spare motors and drives can expire in storage – notably, if they are not regularly used and cleaned. "Regularly" might seem like a word that suggests frequent attention, but performing routine maintenance on spares once or twice a year is all that is necessary. For example, look at most variable-frequency drives. One of the common components in these is an electrolytic capacitor. If used regularly, it will keep working, but if it sits on a shelf untouched for an extended period of time, it will die just like a battery. It's important to reform a capacitor after it has been in storage in order to revamp the voltage; this is as simple as hooking up the drive to a variable power supply and increasing the voltage slowly over a period of 15 minutes. Most manufacturers have written procedures for routine maintenance, so as long as the spare is on the shelf, it's a good idea to follow the guidelines that accompany it.

Storage of spares is just as important as spares maintenance. Conditions and environments don't differ much for motors vs. drives. Cool, dry storage is a must for both system components. When it comes to drives, dust and dampness are especially detrimental.

IT'S EASY TO FORGET ABOUT SPARES SITTING ON THE SHELVES WHEN SYSTEMS ARE RUNNING SMOOTHLY. THIS COULD BE A COSTLY MISTAKE.

A good rule of thumb is this: If it's not appropriate storage for a computer, it's not appropriate storage for a drive. Motor spares can have a few more stipulations when it comes to shelf life. Exposing them to dust and elements should be avoided, and the lubrication should be checked every couple of years. Given the numerous different types of motors, it is best to consult with the manufacturer for specific storage requirements for each.

PLAN AHEAD OR FALL BEHIND

Failures within a system are inevitable, so being as prepared as possible for when they do occur is the best way to prevent a loss of profit. Drives and motors usually go down, but they rarely do at the same time. Condensing inventory of spares for each component is a cost-effective and easy way to streamline backup of a production line.

Preventive maintenance of spares ensures there will be no time lost when the part is needed because a backup that has been neglected for too long fails. Neglecting parts in storage increases the chances of prolonged issues in a system, so keeping track of backup inventory always will save money in the end.

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by Christine LaFave Grace, managing editor

New Frontier

Here's where 3D printing is headed next

Back in July, when NASA's Marshall Space Flight Center began testing a first-of-its kind 3D-printed rocket engine igniter made using a hybrid additive/subtractive manufacturing process, the agency likened the igniter's production to building a ship inside a bottle. But, of course, when finished, NASA winds up not with an impressive decorative piece for a bookshelf but a with part designed to help launch a rocket into space.

It's a measure of how far 3D printing has come that at one end of the spectrum you can buy a $160 desktop 3D printer from Toys "R" Us for the STEM-loving kid or hobbyist on your holiday list, and at the other end NASA is testing the robustness of 3D-printed components for space travel. For years, two attitudes toward 3D printing dominated the industrial landscape: one, that 3D printing was little more than an expensive toy for manufacturers, useful for prototyping in a high-volume operation, maybe, but unlikely to make much of an impact on industry as a whole; and two, that additive manufacturing would pull the rug out from under traditional manufacturing, eventually rendering the latter obsolete.

The reality, say those who've watched and been active in the industrial 3D printing space for years, is somewhere in the middle. "3D printing is not here to compete with traditional manufacturing; it's an addition," says Nora Touré, general manager at 3D printing services and software provider Sculpteo USA and founder of Women in 3D Printing (www.womenin3dprinting.com). Or as Majid Babai, advanced manufacturing chief at NASA's Marshall Space Flight Center (www.nasa.gov/centers/marshall) and lead on the igniter project, puts it, "Additive manufacturing makes sense where it makes sense, and it doesn't make sense where it doesn't make sense."

But the parameters of where it makes sense are expanding, thanks to new technologies, such as the hybrid additive/subtractive production machine from DMG Mori (us.dmgmori.com) that built NASA's new igniter, as well as advances in metal additive manufacturing and a resurgence of interest in testing alternative and potentially more-robust 3D printing materials. As a result, there's growing confidence within the industrial manufacturing community in the reliability of 3D-printed products and the repeatability of 3D printing processes. In a Sculpteo (www.sculpteo.com) survey of nearly 1,000 manufacturing professionals at the beginning of this year, 90% of respondents indicated that they consider 3D printing a competitive advantage in their strategy, with acceleration of product development, offering of customized/limited-series parts, and increased production flexibility their top three priorities, respectively, when it comes to 3D printing.

Says Touré: "People are really using 3D printing not only for rapid prototyping anymore but for final product, and that was enabled by the fact that you have more material research, more equipment coming up and more investment in the industry."

NASA, for its part, has invested about $10 million in 3D printing hardware and machines in the past five years at Marshall and has 13 engineers (both government employees and contractors) working on additive manufacturing at the facility. In a field like aerospace with such small margins for error and potentially catastrophic consequences if a part fails, what gains is NASA looking to realize via its 3D printing research and broadened use of 3D-printed components? Significant ones, actually. The bimetallic printing process that the agency developed and tested with the new rocket engine igniter "could reduce future rocket engine costs by up to a third and manufacturing time by 50 percent," said Preston Jones, director of the engineering directorate at Marshall, in a NASA news release in September.

Lower production costs and faster, more-flexible, more on-demand production are central to the business case for additive manufacturing. The key to achieving these benefits, though – to making 3D printing efficient and cost-effective in any given organization – is to identify the appropriate applications and use cases for it. Here's where experts in 3D printing technology say its light shines brightest – and what organizations need to be aware of as they make decisions about where and whether 3D printing makes sense for them.

"FULLY NEW DESIGNS"

Additive manufacturing can transform product design, Touré and others say, in part because it allows the ship-in-a-bottle-type approach to production: Today's 3D printing technologies make it possible to machine intricate structures inside a part while the part is being produced. "The limits of the technologies you've been working with so far are changing," Touré says. "It opens the scope of what you can do in terms of design."

Karsten Heuser, VP for additive manufacturing for Siemens AG's machine tool business (www.siemens.com/additive-manufacturing), echoes the comment. "With additive, the freedom is so large, you can do lattice structures; you can do fully new designs," he says. Touré cites this capability to machine extremely complex parts that weren't manufacturable before as the No. 1 reason to adopt 3D printing as a tool for mass production. "It doesn't mean with 3D printing you don't have any limits or constraints anymore; of course you do," she says. "But those constraints are a little more flexible."

Compelling applications for this additive approach to design and production can be found in the aerospace and automotive sectors. "Where I think it makes a lot of sense is with removing materials and using design to make a part lighter (or) increase fuel economy or fuel efficiency," says Mike Vasquez, founder of digital manufacturing and 3D printing consultancy 3Degrees (www.3degreescompany.com).

Stephen Anderson, business manager for additive manufacturing systems at manufacturer and metrology specialist Renishaw (www.renishaw.com) offers this example: "If you come up with a design for a lightweight aerospace component, or you want to infill a part with a lattice structure that you simply couldn't machine...that's when these technologies really start to play the part." 3D printing "comes into its own," he says, "when you can produce parts that you simply cannot manufacture in other ways."

What's more, 3D printing can make tweaking or updating a product's design a lot less cumbersome. This was a key selling point for Tom Hoenig, president of GTI Spindle Technology (www.gtispindle.com) in Manchester, NH, when his company

WHERE COULD 3D PRINTING WORK FOR MY COMPANY?

Mike Vasquez, founder of digital manufacturing and 3D printing consultancy 3Degrees, guides companies looking to add 3D printing to their toolbox, and he's quick to offer a reality check on the technology's possibilities and limitations. "Just because you can 3D-print something doesn't mean you should," he says. "If you're telling me that you want to recreate these screws and just use 3D printing for no justification, then that's a challenge."

Vasquez offers these questions for companies to answer in evaluating whether and where to incorporate 3D printing:

1. Are you saving time to production so you can get more product to the market sooner?
2. Will 3D printing allow you to reduce your inventory, creating more of an on-demand supply chain and saving on spare-part storage and maintenance costs?
3. How long is it going to take, really? "I think people underestimate the work that goes into post-processing," Vasquez says. "If we're talking about metals, you likely need to heat-treat or stress-relief that part afterward." Plus, he says, a secondary heat treatment could be required, taking several days in some cases. SLM North America's Richard Grylls notes: "If you imagine printing in layers of 30 microns and you've got a build height of up to 350 mm, depending on the laser run time and the amount of parts you're building, it can take days to build a set of components on a build cycle."

Siemens' Karsten Heuser, VP for additive manufacturing in the company's machine tool business, adds other considerations:

4. What is changing in your product? Is the frequency with which you're looking to make changes to core product components likely to increase in response to customer demand/changes in the market?
5. What kinds of materials are you able to handle in your production environment?
6. How could 3D printing change your business model, and are you ready to make that shift? "You could consider to store, for your service business, 3D images of your part, and then you may send or sell to your customer the service part as a 3D image instead of a part that you sell as a hardware piece" so that a customer using 3D printing can print the part locally, Heuser offers. Is on-demand, on-site printing of parts something your customers will be looking for in the next 5–10 years?

Then there's the personnel angle. As 3D printing moves from prototyping into production, "it's many more people that need to be educated on the machines and the safety and the different pieces of the 3D printing process," Vasquez says. That point leads to further questions:

7. Does your staff have the technical expertise to make 3D printing in-house successful? Moreover, will there be respect for the maintenance demands of 3D printing equipment? For example, "when you're dealing with a laser system with precision optics, you have to keep it clean," notes Grylls. "There's a big difference between making one and making 10,000," Grylls says. "You've got to do things for the long haul and keep up on your maintenance."

made the leap in 2014 to having its predictive sensors 3D-printed. "If we have to add a button or we need to make a special order for somebody of 25 that fits a specific application but it basically has the same innards, we can do that on the fly literally immediately," he says. "Almost every other year we're making improvements and changes," Hoenig adds. "This has just been awesome to work with."

It can also help businesses meet the demands of customers seeking customized, made-to-order products – a trend that has come to the fore in the consumer world and now is permeating into the industrial market. Richard Grylls, one of the first users of the first commercial metal 3D printer available in North America at The Ohio State University back in 1998 and now technical director for SLM Solutions North America (www.slm-solutions.us), has seen this make-

Source: NASA/MSFC/Emmett Given

Majid Babai (center), advanced manufacturing chief at NASA's Marshall Space Flight Center in Huntsville, AL, sees "tremendous cost savings" potential in 3D printing's ability to let end users produce needed parts on demand, on location. Here, Babai and Dr. Judy Schneider, mechanical and aerospace engineering professor at the University of Alabama in Huntsville, and graduate students Chris Hill and Ryan Anderson examine a cross-section of the 3D-printed rocket engine igniter prototype.

it-for-me interest evolve along with 3D printing technologies.

"In the case of high-end sports cars and luxury vehicles and so on, if you walk into a Rolls-Royce showroom, you don't normally buy a stock, off-the-shelf Rolls-Royce," he notes. For SLM, which sells additive manufacturing machines to (among other businesses) automotive companies and startups, 3D printing is a tool for offering mass customization. "If you go buy a Bugatti Chiron, it will actually have 3D-printed parts on it, on the transmission, that were made with SLM machines," Grylls says. Additive manufacturing tools, he says, "are where you can meet the consumer market in an interesting way."

From a personnel perspective, the design freedom that additive and hybrid manufacturing systems enable demands creative new approaches to product engineering, Siemens' Heuser and Sculpteo's Touré emphasize. "We have a slogan that additive manufacturing changes everything," Heuser says. "It changes the way your engineers design the product; it changes the way you construct your business model or you set up your manufacturing. ... You need to have people really rethinking how you design your product." Indeed, success with 3D printing will depend in part on the imagination and flexibility of your design team, Touré suggests. "You have to rethink and disrupt your entire designing and thinking and innovation process," she says. "You need to hire a team that's actually able to think out of the box."

Source: Siemens

A new partnership between Siemens and Stratasys aims to integrate the former's digital factory tools with the latter's 3D printing products, with the ultimate goal of furthering 3D printing's move into the production workflow.

"TIME IS MONEY"

When an organization needs to get to market, quickly, with not millions of a product but maybe hundreds or hundreds of thousands of an item, 3D printing can offer an efficient solution. "Time is money, so you want to be the first one on the market," Touré says. "If (your) product is small enough that with 3D printing you'd be able to print it within a few weeks," you could realize a competitive advantage vs. trying to produce the same product via traditional injection molding, she says.

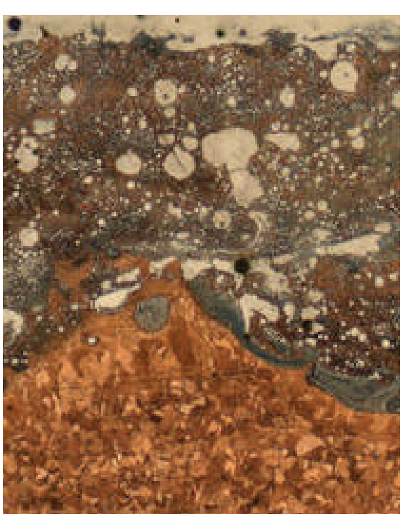
Babai sees 3D printing together with 3D laser scanning, which allows for reverse-engineering of limited-availability or out-of-production parts, spurring "a dramatic shift in reducing the developmental cycle of parts." In Sculpteo's survey of 3D printing users, 34% said they're using 3D printing for prototyping; 23% said they use it for proof-of-concept; and 22% said they use it in for production – the three most-common applications of additive manufacturing for respondents.

"You can print the part, test it, and based on that, modify your design and make another part and test it again in very quick fashion versus spending a lot of money and a lot of time to be able to make parts the conventional way," Babai says.

Already, this shift is taking place in markets such as oil and gas, medical devices, and aerospace, says Renishaw's Anderson. In the past 18 months or so, he says, "We've seen a significant upsurge in terms of taking these technologies out of the laboratory and out of the university and even out of prototyping," he says.

"PRODUCE THE PART AT THE LOCATION"

As new polymers and metal superalloys come into use and the durability of 3D-printed items improves, 3D printing stands to have a profound impact on the supply chain.



Source: NASA/University of Alabama, Huntsville/Judy Schneider

In a new, bimetallic 3D-printing process used to produce a rocket engine igniter prototype for NASA, two metals (copper alloy and Inconel) interlock to form a strong bond. The structure is seen through a microscope here.

"We see a huge trend with additive manufacturing that you have a kind of delocalized production network," Heuser says. Being able to take a 3D image file and produce a part on demand, especially for serving remote facilities such as offshore oil platforms, could help reduce inventory and warehouse costs and cut the risk of or mitigate unplanned downtime.

The implications extend to national security. "The fact of the matter is lot of the cost for war-fighting is logistics," Babai says. "Being able to produce the part at the location instead of shipping items from all around, where you have to have like 10, 20, 50 of every part in different locations throughout the world, (and) instead you just have raw material and are able to make the part as you need it, that's tremendous cost savings," he says.

That promise of quick, on-demand part availability holds appeal, too, as manufacturing industry professionals (especially younger workers entering the industry) increasingly are accustomed to Amazon-like turnaround. "It's really very much a 21st-century technology that resonates with young people," Grylls says. "If you send me a file right now, I'm sitting at home today; I could work on my computer for about five minutes; I could upload it to the server, and it could be printing out this afternoon."

GETTING IT RIGHT

The quality of 3D-printed components for industrial use is improving; there's a heavier focus on investigating and testing new materials for additive manufacturing; and 3D printing equipment itself is becoming more accessible from a user perspective. Still, significant work remains. For researchers, vendors, and end users in the growing 3D printing space, the priority is making the technology work in those select applications that offer a promising return on investment.

"The biggest thing with this industry right now is implementation, getting it right," says Grylls. "Because if a big company is implementing additive manufacturing, if they make any missteps, it sets it back by years."

GTI Spindle Technology's Hoenig, for one, is sold after three years' experience with 3D printing. "At first I was kind of skeptical, because I was like, 'I've seen 3D-printed components at all these trade shows we go to, and you can still tell they're 3D-printed.' And my developer said, 'No, no, no, the companies that are actually doing this as a service are quite more polished on the final product. ... And when we ran the samples, I was hooked." He adds: "Most of our customers can't tell that it's not a molded product."

"Once they get it, they get it," Touré says. "It's complementary to other manufacturing technologies."

WHEN COMPRESSED AIR IS THE PROBLEM, NOT THE SOLUTION

Want to cut energy costs? Stop using compressed air for things it doesn't need to be used for

by Ron Marshall, compressed air efficiency consultant

One of the most effective ways to save energy when it comes to compressed air is to reduce system flow. This requires dealing with the end uses and abuses of compressed air in an effort to eliminate or reduce the flow of compressed air that results from wasteful practices.

One often-cited opportunity for improvement is leak reduction – a valuable endeavor, but more can be done. Additional significant savings can be achieved by finding and fixing "inappropriate uses," which we can define as some sort of process that could be more cost-effectively supplied by another energy source. This is not a simple process: There are hundreds if not thousands of individual uses of compressed air in most plants. With that in mind, though, let's explore some of the more common potentially inappropriate uses of compressed air and look at examples of how plants have addressed these energy-wasters.

HOW EFFICIENT IS COMPRESSED AIR?

One of the problems with compressed air is the high cost of the power input that feeds the air compressors compared with the actual mechanical power that comes out at a compressed-air-powered device.

An example often used is the output of 1 horsepower using a vane-style air motor. A vane motor rated at 1 hp produces about 0.746 kW of rotational power from its shaft and translates this to a rotary motion that can drive a tool or a mixer. If typical specifications are consulted, we might find that this motor will consume 40 cfm at 100 psi to produce this level of power.

Now, if we look at a typical air-cooled lubricated rotary screw compressor running at 100 psi, we can find that it would consume a specific power of 18 kW for every 100 cfm of compressed air it produces. We can easily find this number from the Compressed Air & Gas Institute (CAGI) specifications published by most member manufacturers. Therefore, doing the math, we find that it takes about $18 \times 40/100 = 7.2$ kW of power input to the air compressor to produce about 0.746 output at the air motor shaft. Almost 10 times more power is required than is produced at the motor shaft. Most of the power is lost because of the heat of compression.

But it gets worse. The numbers presented assume a lossless compressed air system in which all of the air produced goes directly to the air motor without any leakage, pressure loss, or inefficiency resulting from partial loading of the compressor. In real life, these losses come into play to increase the actual cost of an air motor. Typically, about 30% of the compressed air produced at an air compressor is lost due to leakage before it gets to the motor. There's also typically about 10 psi of system pressure loss that stems from air dryers, filters, and losses that occur from connectors and hoses, so the compressors must produce 110 psi to feed the motor 100 psi. This adds about 5% to the energy input.

Moreover, a lightly loaded compressor will often consume

Item	Description	Solution
Abandoned equipment	Compressed air continues to be supplied to equipment that remains in place but does not operate	• Install shutoff valves • Remove redundant equipment
Aspirating	Aspirating uses compressed air to induce the flow of another gas with compressed air, such as flue gas	• Low-pressure blower
Atomizing	Atomizing uses compressed air to disperse liquid to a process as an aerosol	• Low-pressure blower • High-pressure pump
Agitation	Mixing of liquids using compressed air	• Low-pressure blower
Dense-phase transport	Dense-phase transport is used to transport solids in a batch format	• Low- to high-pressure blowers
Open blowing	• Blowing using compressed air applied with an open, unregulated tube, hose, or pipe for cooling • Drying • Cleanup	• Brushes • Brooms • Blowers • Electric fans • Nozzles
Equipment or personnel cooling	Personnel cooling using compressed air can be dangerous (fine particles or unsecured hoses striking personnel)	• Fans
Unregulated equipment	End-use equipment operating without a regulator at full system pressure	• Install pressure regulators
Vacuum generation	Compressed air is sometimes used in conjunction with a venturi to generate a negative pressure vacuum	• Vacuum pump

Table 1. Potentially inappropriate compressed air uses

more than double its CAGI-specific power rating because of partial-load characteristics not mentioned in the CAGI specification (the power specification for a fixed-speed compressor is valid only at full load). This can make the compressor-specific power more like 36 kW per 100 cfm. Add all of these costs to the equation, and the result is that the air compressor might consume the equivalent of 21.6 kW to produce 1 hp of shaft power – about 30 times the input power, making the wire-to-work efficiency about 3%.

In quite a few cases, it may be possible to replace a compressed-air-powered motor with a direct-drive electric motor, especially if it is a permanently mounted device. Of course, electric motors are not 100% efficient, but let's assume an efficiency of 80% and calculate the cost savings potential from there. An electric motor would consume about 0.9 kW while producing 1 hp of shaft output, thus consuming 7,884 kWh per year at 0.9 kW × 8,760 hours. This would cost about $788 per year if the motor were running full time, assuming a cost of 10 cents per kWh.

An air motor under the same duty would consume about $6,300 worth of power in a lossless system and as much as $18,600 if the system has typical losses applied. This simple mathematical exercise shows why compressed air is often called one of the most expensive utilities in an industrial plant. A useful exercise, then, is to find and classify the various uses of compressed air in a plant as appropriate or potentially inappropriate. An inappropriate use would be something that can be turned off or replaced with some source of energy that is more cost-effective. Applying energy conservation measures to compressed air end uses is often a quite effective solution in addressing the high cost of compressed air.

POTENTIALLY INAPPROPRIATE USES

Not all uses of compressed air are inappropriate; this is the reason for stating that some end uses are "potentially" inappropriate. The appropriateness often depends on many factors.

For example, vane-type air motors are used for ergonomic reasons in hand tools, as electric-powered tools are often too heavy for extended use. And air motors are used in hazardous locations where the spark from an electric motor might cause an explosion and fire. In these cases, the higher cost of their operation is justified. But in cases where electric motors can be used and these factors do not come into play, then the use of compressed air may be inappropriate.

There are numerous ways in which compressed air can be used and abused in a plant. Table 1 shows some of the more-common ones often discovered during plant surveys. Once these are found, some investigation needs to take place to find out whether there is a less-energy-intensive way to perform the same task. When a possible alternative is found, then a business case needs to be made to determine whether the change would be economical.

CASE STUDIES

If enough investigation is done, you will become skilled at finding ways to amend end uses to reduce compressed air costs. The following case studies are examples of actual projects done over the past few years; they illustrate what can be done with some careful thought and action to reduce inappropriate compressed air use.

CONVERSION OF COMPRESSED AIR AGITATION

A compressed air audit was performed at a parts machining plant that made transfer case parts for large farm machinery. Once the parts are machined, they're painted, but to ensure the paint adheres properly to the metal, the part must be carefully cleaned and treated. The part is dipped into a bath to remove any contamination. To ensure proper mixing of the chemicals in the bath, the plant chose to agitate the liquid with 10 cfm of 100 psi compressed air as shown in Figure 1. The energy consumption of this flow of compressed air was 2.8 kW, equivalent to about $2,450 in annual energy consumption.

It was discovered that the actual pressure requirement at the submerged nozzles was about 2 psi; the flow of compressed air was being throttled off with a ball valve. Plant personnel investigated installing a regenerative-style blower to use in place of the compressed air agitation as per Figure 2. Trial with a test apparatus found that the submerged piping actually produced more agitation air than was previously provided, causing a better mixing action. The blower's required power was measured at 0.42 kW – about 15% of the equivalent compressed air power consumption.

This particular plant had about four other containers of chemicals with agitation in place. Conversion of the compressed-air-powered agitation with blower style achieve a simple payback on the project of slightly more than two years, which was reduced to one year by a utility incentive.

Figure 1. Agitation was measured at 10 cfm of 100 psi compressed air.

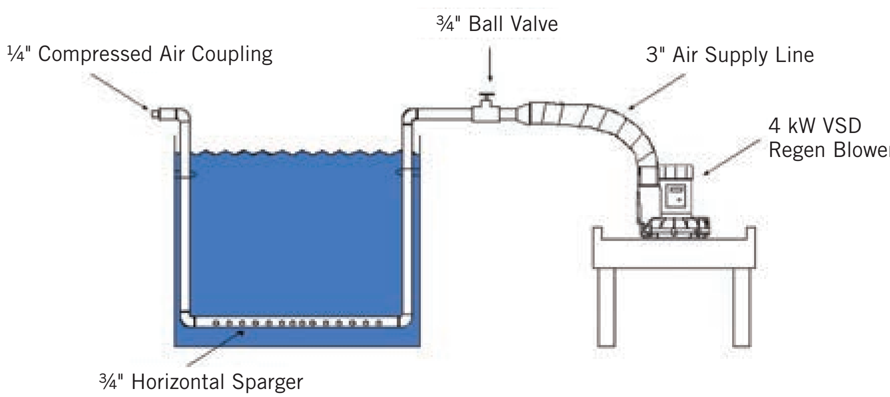


Figure 2. Sparging arrangement.

MORE-EFFICIENT CABINET COOLING

A furniture-making facility had a number of complex CNC machines that were controlled by PLC. The PLCs were installed within sealed metal enclosures near the machine in an often-warm environment, with the enclosure's internal temperature reaching high levels thanks to a power transformer installed within the same cabinet. The high temperature often caused thermal failure of the control, and plant personnel recognized that they needed some sort of cooling to prevent this problem. Compressed-air-powered coolers were chosen because of their simplified design and ease of installation. To save costs, these coolers had no temperature controls installed, and therefore they ran 24/7, even when the plant was down during evenings and weekends.

A compressed air audit found that this style of cooling was quite expensive. Each cooler consumed a continuous 20 cfm of compressed air while producing 1,500 btu/hr of cooling – equivalent to about 4 kW of air compressor power. There were about 12 similar coolers, operating in the plant, contributing about $42,000 per year in operating costs.

The plant sourced some refrigerated panel coolers to use in place of the compressed-air-powered units. The units were installed with temperature controllers to ensure that the cooling circuits turned off when their use wasn't required. Each of these coolers produced 3,000 btu per hour of cooling, with the average power consumption measured at about 4% of that of the compressed-air-powered coolers. Estimated payback for this conversion was 1.3 years based on $40,000 per year savings.

Through the years a number of similar cooling applications have come up. It is very common to see cabinets with a small cooling fan installed but no secondary ventilation hole to allow the air to circulate. In some of these cases simply providing better fan-powered ventilation with no refrigeration cooling provides the necessary solution.

It should be noted that site personnel installed thermostatic controls on the compressed-air-powered coolers and realized a savings of 25%. This measure could prove a valuable solution in situations where compressed-air-powered coolers must be used.

REVERSE PULSE BAGHOUSE IMPROVEMENTS

A protein processing facility was using a number of reverse pulse baghouses to filter and capture processed protein out of the air stream. The facility had been having trouble with the filtering process; the filter elements would become clogged, choking off the air flow and plugging the filter. Plant personnel tried everything but finally settled on increasing the pulse duration from a blast of 100 milliseconds to about 350 milliseconds and increasing the pulse frequency to one pulse every six seconds. The filters worked satisfactorily but not optimally. A total of 100 blast valves operated at random cleaning filters during peak plant production.

This change had a significant impact on the total flow of compressed air in the plant. Whereas previously the plant was able to run on one air compressor, now a second compressor was required. This additional required capacity significantly increased compressed air operating costs and reduced the facility's air quality because the air dryer was sized for only one compressor. The poor air quality allowed moisture to pass downstream and caused the filters to work poorly during some periods of hot weather. Air pressure also fell significantly because of high velocity in the undersized dryer.

An auditor immediately recognized that the blast valves were operating inefficiently, just by their sound. Properly operating valves should have a short and forceful pulse to shake the bags clean. These units had a less-forceful and long whoosh of air – less effective in freeing the captured dust. Investigation revealed that some piping issues were causing low pressure at the blast valves and that the feed lines to each manifold on the blast valve assembly were restricted. The manifolds on the blast valves were sized too small to provide the air volume needed for a blast that would fully clean the filter elements.

The auditor suggested installing secondary storage receivers of about 30 gallons as close as possible to each baghouse manifold. This move significantly increased the potential energy available to each blast valve and noticeably changed the cleaning force. For example, a 6-foot section of 3-inch pipe used as a manifold holds only about 2 gallons of compressed air. A 30-gallon receiver increases the available volume by 16 times.

Piping was improved and receivers were installed. The pulse duration and frequency have fallen enough that the plant now runs on only one compressor. The compressed air flow has decreased by 26%, but because a compressor has turned off, the actual total reduction in compressor power is 33%. The payback for this project is well under a year, with a savings of $32,000 annually in energy costs.

LOWERING HUMIDIFYING COSTS

A printer of lottery tickets is in a location that gets very cold in winter. Because of the volatile nature of the inks used in printing, a large flow of ventilation air is needed to ensure the environment is not contaminated with hazardous vapors. This ventilation draws in very cool and dry outdoor air, making the environment much too dry for proper operation of the printing presses.

The paper used to produce the tickets expands and contracts with changes in the ambient humidity level. In extreme cases, as in winter, the paper contracts so much the product becomes out of specification, causing quality issues. For this reason, the plant must humidify the ambient air to keep the relative humidity above a certain minimum level. When first placed in production, the plant used compressed-air-powered atomizers, with each nozzle using about 2 cfm of compressed air. There were about 150 nozzles in use at the site consuming an average of 60 kW of compressed air power, worth about $31,400 in electrical costs.

The plant sourced a high-pressure water humidification to use as a retrofit instead (Figure 3). This system uses 2,000 psi water pressure supplied by electric pumps to produce atomized air without the need for compressed air. This new system provides the same humidity level but at the much lower cost of only $8,500 per year – a reduction of 73 percent. At the same time, the plant's compressed-air system needed to be replaced. The reduction of the compressed air flow saved the plant on purchase costs because the new compressor and air dryer could be sized smaller.

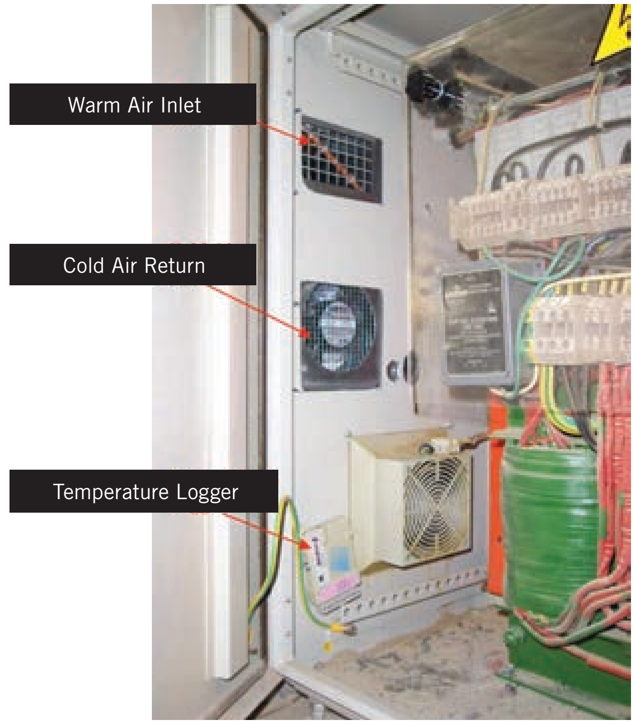


Figure 3. Better ventilation and refrigerated cooling reduce operating costs.

LOWER BLOWING COSTS

A cabinet-making plant used a special machine that drilled holes in the side panels for wood dowels. Some of these holes would plug up with sawdust and prevent the dowels from being inserted properly. To correct this, a blowing device – basically a pipe with holes drilled in it – was connected to the compressed air system to provide a forceful blow. This plant operated on a two-shift, 4,000-hours-per-year schedule, and the drilling machine sent product through with a duty cycle of about 10%, yet the blowing was installed to blow continuously at 20 cfm, equivalent to 3.6 kW. Annual costs were $2,200.

This blower was retrofitted to include a proximity detector that turned off the blowing if a panel was not present. This reduced the operating cost by 96% to about $100 per year, thanks to the low duty cycle.

OPTIMIZED BREATHING AIR CONTROL

A bus manufacturer used breathing air purifiers in its paint booths to prevent carbon monoxide from affecting workers who were using compressed air in painting hoods. Because the facility manufactured highway transport buses, the possibility that one or more of the air compressors could inadvertently suck in exhaust from a motor was real. The company had five breathing air purifiers that consisted of a fixed-cycle desiccant dryer on the intake side to remove moisture and a catalyst element to remove any carbon monoxide. Each

Figure 4. Dewpoint control reduced the operating cost of this breathing air purifier.

desiccant dryer consumed about 15% of its rated flow on a 24/7 basis even though the breathing air only needed to be available for a daytime eight-hour shift for five days a week. Total purifier purge load was estimated at 200 cfm of constant flow, costing $25,000 per year in electricity charges.

Flow meters were installed on the purifiers, and it was determined that breathing air is being used only about 15% of the time, and during operation the flow was about 20% of the purifier's rating. Plant personnel sourced a retrofit for the purifier dryers (Figure 4). New dew-point controls were installed that turned off the dryer purge when the dewpoint was adequate for the operation of the onboard catalyst. Resulting purge flow decreased by 90%, saving about $22,900 in operating costs per year.

Although time-consuming, searching your industrial plant for potential inappropriate uses is often is rewarding in terms of reducing operating costs and increasing profits. Lowering compressed air flow will usually result in a significant reduction in power if the compressors are operating in a well-controlled system. This is a key point: Proper control of the plant's air compressors is an important requirement. If not properly done, most of your efforts will be wasted.

Often hiring a reputable compressed air auditor to do an end-use study can be a good first step in addressing your end uses. Make sure your auditor is prepared to poke his or her nose out of the compressor room and into the workings of the plant.

Before retiring in 2016, Ron Marshall was the industrial compressed air systems expert at Manitoba Hydro, where he worked for 38 years. His efforts supported the organization's Power Smart Performance Optimization Program, and he now operates his own compressed air energy efficiency consulting firm and is a member of the project development committee at the Compressed Air Challenge. Contact him at ronm@mts.net.

BEST OF PLANT SERVICES 2017

Here it is: our annual roundup of the most insightful and eye-opening quotes from the pages of Plant Services and plantservices.com in the past year. We can't wait to bring you the best in digital manufacturing, maintenance, and reliability in 2018.

– the Plant Services editors

"There is a great deal you can do to ensure that your organization doesn't go the way of the dodo bird. While industry players negotiate the standards required to enable the promise of the IIoT and Industry 4.0 and IT teams work on organizations' information 'plumbing,' maintenance and operations teams have an opportunity to do some very important foundation work."

Bruce Hawkins, director of technical excellence, Emerson, and Scott Bruni, independent consultant
"Seize the IIoT in Just 3 Steps," January

"The hard-to-believe concept that most good maintenance workforces operate at only 35% wrench time means there exists an untapped source of extra labor for proactive maintenance."

Doc Palmer, Richard Palmer and Associates
"Plan-It Fitness," January

"A common strategy across all industries is to **start small with (IIoT) pilot projects**. Findings provide the proof needed to address executive leaders' concerns and get their buy-in to fund bigger projects."

Jason Kasper, research analyst at LNS Research
"Game On! How the IIoT is Transforming Asset Lifecycle Management," January

"Many companies overlook the critical issue of how their IIoT data should be operationalized. To get returns from IIoT investments, it's important not to stop at collecting and analyzing IoT data. If you do only that, you still have not made a dollar. To benefit from the IIoT, the knowledge and insight you gain needs to be turned into action that optimizes your business."

Dan Matthews, CTO at IFS / "Busting 3 IIoT Myths", January

"Today most asset information that operations and maintenance people are working with are old or out-of-date drawings. **Visual software in the same way as sensors is flagging to the maintenance people visual information – there's something changing about this view.**"

Anne-Marie Walters, global marketing director at Bentley Systems
"Freeze-Frame: Picturing Asset Health," January

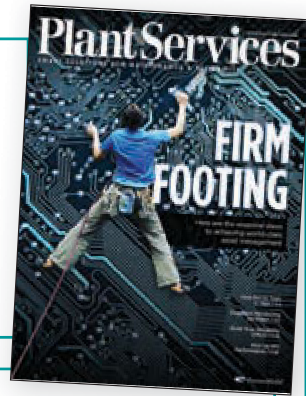
"There's no getting around it: The top finding of this year's (workforce) survey is that industry is highly dissatisfied with the effectiveness of company recruiting programs."

Thomas Wilk, Plant Services editor in chief
"Help Wanted!," February

"Only 20% of material presented in typical workshop is retained if it is not reinforced by timely application of the learning."

Tom Moriarty, Plant Services contributing editor and president of Alidade MER

"How Not to Train in Vain," March



"Have you ever noticed that your boss keeps adding assignments to your to-do list but never seems to take anything off your plate? Remember this as you map out each program element. Every time you decide to assign a new task to someone, consider what they have to give up to work on the task."

Phil Beelendorf, maintenance technology senior manager at Roquette America

"Peak Performance: How to Achieve World-Class Asset Management," March

"As a Millennial, we're used to having answers right away and **I'm shocked that places don't have (real-time data access).** Some are still writing down inventory on paper. **It's actually amazing to me.**"

Allie Schwertner, account manager at Rockwell Automation

"Why Automate? Why Not?" March

"In our industry, there are more opportunities than time, so there's a tendency to focus on quantity rather than quality. ***But it's hard enough to see around one corner; to see around two is nearly impossible.***"

Joe Limbaugh, VP operations at Motion Industries

Blog: Supply Chain Joe, "Pave the Path, or Pour a Sidewalk," April

"Data from the wider world is increasingly showing us that the hard line between economic growth and energy use is being broken. **Does the energy plan for your company reflect that new reality?**"

Peter Garforth, Plant Services Energy Expert and principal of Garforth International

"Decouple Growth from Energy Use," May

"It's not a one-week kind of thing where you just turn on the software and your whole world changes. How are you going to transform your people, help train them and (adjust) processes to really take advantage of the predictive analytics?"

Chad Stoecker, leader of managed services at GE Digital

"Taking Off the PdM Training Wheels," May

"Evolving to prescriptive maintenance, where probable cause and automated maintenance are implemented, is a necessary next step in the Industry 4.0 journey in order to keep up with the demands of fast-paced change in our market."

Mary Bunzel, general manager, manufacturing and industrial solutions, Intel

"What is Prescriptive Maintenance, and How Soon Will You Need It?" May

"If we're going to increase our infrastructure, if we're going to throw $1 trillion at infrastructure, if we're going to do some work around cybersecurity, **tell me where you're going to get the people to do it.** If we don't have people to put it in right and know how to do this and have the technical skills to manufacture these things, then we're kidding ourselves."

Larry Hoing, senior manager of asset care at Wells Enterprises Inc.

"SMRP Goes To Washington," May

"Rx maintenance is unique in that instead of just predicting impending failure, it strives to produce outcome-focused recommendations for operations and maintenance from the Rx analytics."

Sheila Kennedy, Plant Services contributing editor and managing director of Additive Communications

"RxM: What is Prescriptive Maintenance, and How Soon Will You Need It?" May

LINKS TO ARTICLES

See the full list of the year's best quotes and articles at www.plantservices.com.

8 Steps to Improve Asset Reliability
http://plnt.sv/BEST17-01

Alarm Management: More Time to Make the Right Decision
http://plnt.sv/BEST17-02

Automated for the People
http://plnt.sv/BEST17-03

Be a Smooth Operator
http://plnt.sv/BEST17-04

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Why Automate? Why Not?
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Worldwide Problem Plagues Compressed Air Systems
http://plnt.sv/BEST17-31

"New and improved technologies developed specifically for batch picking or multiorder picking help increase warehouse productivity, eliminate errors, and save money when it comes to total cost of ownership. The question, however, is **which technologies will provide the biggest return on investment? And when is the right time to buy this equipment?**"

Sue Rice, product manager at Raymond Corporation,
Blog: Today's Optimized Facility
"New Technology: Is It Right for My Operation?" June

"While only a few staff are usually responsible for PID controller tuning, the performance of those controllers affects nearly everyone, and it has a direct effect on a plant's bottom-line profitability."

Bob Rice, VP of engineering at Control Station, Inc.
Blog: The Feedback Loop,
"What's to Gain from Everyday Process Changes?" June

"If human-robot coexistence in factories is to be defined less by separation than by collaboration, then ***it's critical that plants evaluate not just the technologies but also the strategies they employ to keep workers safe***. Parameters for contact that doesn't result in an automatic stop of the machine need to take into account both where on the body contact may occur and the user's physical characteristics."

Christine LaFave Grace, Plant Services managing editor
"Hand in Hand: What Collaborative Robots Mean for Worker Safety," June

"To establish a solid foundation for reliability, the organization must first address the basics. When digging deeper to determine the root causes of unreliability, you'll often find the MRO storeroom not functioning well, the PM program poorly designed (at best) and without use of effective condition-based approaches, a lack of maintenance planning, and a minimal weekly maintenance schedule."

Jeff Shiver, founder / principal of People and Processes
Blog: Ask Jeff, "8 Steps to Improve Asset Reliability," June

"Having this ability to see what we can now see has saved our behinds a few times…**Once you have the data, you'll know how your assets are really performing, and you won't always have to be scrambling** to find parts or to buy parts or to react to downtime that could have been prevented."

Garrick Reichert, senior engineer at Stone Brewing
"IIoT in Action: 6 Companies Putting the Industrial Internet to Work for PdM," July

"You've still got the knights-in-shining-armor-riding-in-to-save-the-day scenario present; there is some natural excitement for some people in that situation. **I've worked with some folks that missed that hero mentality,** and to them the new style doesn't feel like we are accomplishing as much, **until they see the numbers.**"

Jason Anderson, maintenance manager at Drylock Technologies
"Unlocking World Class Maintenance," July

"We need to take a step back and say, 'Why is one or two things going wrong every 10 minutes acceptable?' I think you're seeing a lot of the larger companies looking at alarm management and operational management as being intertwined. If they can manage the process better, they don't have the alarms."

Tyron Vardy, global product director at Honeywell Process Solutions
"Alarm Management: More Time to Make the Right Decision," August

"*Although 'all-purpose grease' may be suitable for horse-drawn carriages, it should not be used at plants and facilities intending to keep machines reliable.* You may think your facility wouldn't need these reminders, but industry continues to experience equipment and component failures that could have been avoided by simple root-cause analysis and appropriate specification follow-up."

Heinz P. Bloch, owner of Process Machinery Consulting
"Be a Smooth Operator," August

"*Frontline personnel ownership is really to me the key to success.* We can train folks in maintenance and reliability practices; we can give them white papers; we can show them presentations; we can send them to conferences; and we can do a million other things. But unless they see how they tie into the company's business goals, unless they can visualize how they impact those goals, and in addition to that, unless the company shows a dedicated leadership to what those goals are, then how can we expect success?"

George Williams, director of asset management at B. Braun Medical
"Interview: CMRP Veteran Professional of the Year," September

"As with all aspects of IT-OT convergence, security should be central to a remote-monitoring implementation. Certainly, the remote-access platform itself must have multiple security measures."

Phil Bush, product manager at Rockwell Automation
"Perfect Vision: Remote Monitoring," October

"New technologies are coming online that allow manufacturers to achieve standardization at low cost and low risk but with high reward. Lean performance means you can see problems and fix them in real time. ***Standardization means you can perform those fixes across a multisite network.***"

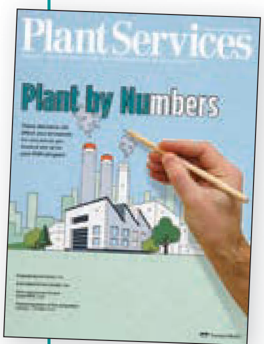
Bob Argyle, chief customer officer at Leading2Lean
"Lean Performance: For No Surprises, Standardize It," October

"A common problem is plaguing compressed air system across the world, and it's costing millions of dollars in lost company profits. The issue is poor compressor control, which leads to wasteful compressor operation."

Ron Marshall, compressed air energy efficiency consultant
"Worldwide Problem Plagues Compressed Air Systems," October

"**We have a disconnect between the skills and competencies that our education and training institutions are developing in students and the skills required by the jobs open in industry.** The result is a shortage of qualified talent, many unfilled jobs, and lots of internal pain associated with meeting production targets with fewer people."

Tom Furnival, director of training services, Marshall Institute, Blog: Super-Skill Me
"Reconnecting Educational Institutions with the Job Market," October



"*Revolutions don't always feel like revolutions.* Akin to being on a drifting boat, pulled by a gentle stream, we often aren't aware of the change in our location until we have a reference point in sight."

José M. Rivera, CEO at Control System Integrators Association
"Automated for the People," September

"In addition to providing actionable information, **you need to constantly sell what you do**. Tell management about the costs you have avoided and the risks you have averted. Save bearings and gears that have been removed from machines and keep them on display."

Jason Tranter, founder & CEO at Mobius Institute
"How to Make Your Condition Monitoring Program More Valuable," October

"As long as humans are involved in maintaining physical assets, it remains crucial for CMMS / EAM software to be intuitive to all users. The reward of having software with superior user-centered design elements is a much happier workforce and an enormous gain in productivity."

David Berger, Plant Services Asset Manager and president of The Lamus Group Inc.
"Peak Usability," November

"Two technologies that I think work wonderfully together are ultrasound and IR. Both can be the lead technology. I just recently had a couple of major examples where one technology found and issue and the other didn't, and vice versa, but all during an electrical inspection."

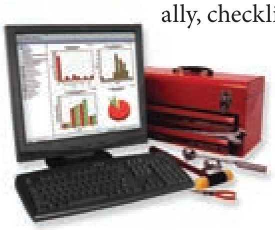
Roy Huff, VP at The Snell Group
"Hot Take: What's Next for Infrared," November

ASSET MANAGEMENT SOFTWARE

Leverage mobility and the IIoT to maximize asset performance and control costs

MAPCON 6.4 CMMS

MAPCON 6.4 includes many updates and new features, including the ability to add checklists to equipment and work orders, thus enabling workers to be more organized and keep better records on repairs. Mapcon users can pick between the simple and advanced checklists; both can be added to a piece of equipment, which means the list can be automatically added to any work order written on the equipment. Additionally, checklists are available on the mobile app, called Mapcon Mobile, allowing users to complete the tasks on their smartphone or tablet instead of trekking back to a PC.



Mapcon Technologies

www.mapcon.com

TOFINO SOFTWARE PUNCHOUT MODULE

Tofino Software's "PunchOut" cXML and OCI-enabled eCommerce module is integrated into the MRO procurement and inventory management workflow of the Tofino Resource Management Suite CMMS. PunchOut allows buyers to securely access a supplier's online web store while they are using the TRMS application. Buyers use the supplier's website to search and select items for purchase and then fill a shopping cart. The procurement application converts the shopping cart into a requisition or a PO, which is worked, approved, and in the case of a requisition, converted to a PO.

Tofino

www.tofinosoftware.com

FLUKE ACCELIX PLATFORM

Fluke Accelix is an open, cloud platform that connects maintenance software, equipment, and critical plant systems. Accelix integrates Fluke's portfolio of more than 40 wireless tools and condition monitoring sensors with eMaint, Fluke's SaaS CMMS, and SCHAD Automation's SCADA system and shares information with enterprise solutions of choice. When data is gathered and aggregated electronically, industry professionals have the ability to correlate data from different technologies (for example, infrared, vibration, and power) and share them across the enterprise.

Fluke

www.fluke.com

ASHCOM'S MAINTIMIZER BLACKBOX²

Ashcom Technologies Inc. has released MaintiMizer BlackBox², a plug-and-play version of its MaintiMizer web-based CMMS. Choose to connect the self-contained unit to your network and/or to the internet via hard-wired Ethernet cable or wirelessly. MaintiMizer BlackBox² comes with the MaintiMizer, Microsoft SQL Express, web server pre-installed and preconfigured. It has all the functionality of the MaintiMizer web-based CMMS, including work-order, preventive maintenance/equipment, inventory, vendor/purchase order, time card, and utility modules.

Ashcom Technologies, Inc.

www.ashcomtech.com

SEEQ R18

Seeq R18 offers visual analytics for IIoT and process manufacturing data, including a new Organizer feature for assembling the results of investigations and analytics on time series data into dynamic documents for reports and dashboards. Seeq also announces support for the Microsoft Azure cloud platform, with Seeq availability on the AppSource marketplace. The SeeqOrganizer module builds on the investigation and analytics in Seeq Workbench, letting Seeq visualizations from any worksheet be inserted into a document dynamically generated for any time range and/or operating condition.

Seeq

www.seeq.com

ITT'S i-ALERT Ai PLATFORM

The ITT PRO Services i-ALERT Ai platform is a web interface allowing customers to take advantage of the industrial internet of things to monitor all of their i-ALERT2-enabled rotating equipment in one place. With i-ALERT Ai, customers can monitor and manage their i-ALERT-enabled machines and sensors in a simple web interface, allowing users to view trend data, machine notes, technical data, and vibration spectrum data collected via the i-ALERT2 app. Customers can set up designated routes and the app will automatically guide a user to which assets and what type of data to collect on the route.

ITT Corporation

www.i-alert.ai

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"I WANT TO GET MY HANDS DIRTY"

Juan Chacon's words of wisdom for fellow Gen Yers: Hands-on work is high-reward

Juan Chacon, 21, is a mechatronics student at Moberly Area Community College (MACC) in Columbia, MO, and is on track to graduate with an associate's of applied science degree in late 2018. After attending the Society for Maintenance & Reliability Professionals' 25th annual conference in Kansas City this fall, he spoke with Plant Services' Christine LaFave Grace about what excites him about a career in the reliability field, the attitudes of young people today toward maintenance work, and advice he'd give young people questioning what career path they should pursue.

PS *Your coursework includes classes in topics such as industrial electricity, maintenance fundamentals, fluid handling, and control systems. What appealed to you about mechatronics as a field of study?*

JC In high school I took a lot of the career readiness courses, and I took a lot of the electronics/robotics classes because I felt like I recognized that something was going to happen in those fields; I felt that that might be something secure. It was also just something I wanted to get into.

(At MACC) we study robotics, electronics, fluid control; we study maintenance, drive systems, all of the stuff that's needed in a factory setting. I really like it because it's more of a hands-on degree. I tried doing the engineering thing, and I felt like I would be a better technician because I liked the hands-on more than the calculations.

PS *What are your career ambitions, both immediately after you graduate and farther down the line?*

JC I understand I'm a young person just entering the industry. I'd like to start out as just a maintenance technician. I want to go on rounds; I want to test machines; I want to put signals on them; I want to put ultrasound on them; I want to put everything on them – the vibration sensors, all of that. I want to get my hands dirty.

Beyond that, I think after a few years of that, I'd like to move up, hopefully. I'd like a safety position because I've taken my OSHA 10(-hour) course, and I plan on doing more safety because I understand the importance of safety and reliability put together. If the machines are running safely, your workers aren't leaving; your stuff is not malfunctioning (as) often. I felt like that was a pretty natural segue for me, because I've been told that I am too much of the "dad" of the group; I care about everyone too much.

I'd like to do that for a few years and then maybe move to private consulting. I feel like that's something I could really do well.

PS *There's a complaint from some more-experienced managers that young people today aren't interested in getting their hands dirty. What would you say to them?*

JC To the managers, I'd say: "Give me your address; I'll send you my resume. I'm ready to go."

But I agree completely about my peers. We were born when social media and online things were just booming, so we're all under the notion that that's the best way to do it – that's the way to get things done: Just get really good at computing, and sit behind a computer and work at your desk. No one wants to do anything hands-on anymore.

Nobody wants to go out and fix the thing that they're programming.

PS *What was different for you? Were you a kid who was always tinkering with things, taking them apart and reassembling them?*

JC Oh, my gosh, there are so many taken-apart cars and put-back-together-with-different-parts cars in my house; it's crazy. I have those little electric cars that I took apart and put, like, after-market monster wheels on them. My room was always a mess.

PS *What would you say to students a few years younger than you contemplating their career options?*

JC I would say if you're unsure of what you want to do, if you want to give something fun a try that's pretty rewarding because you'll see something that's going to break or something that has broken, and you'll be like, "I know exactly what to do for this," and you'll have the instant gratification of everything working again or getting that to work again, and you like getting instant gratification or any gratification in general, this might be something you're interested in.

Customer Success Story

KAESER COMPRESSORS
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Kaeser puts automotive supplier in the driver's seat of compressed air efficiency

PROBLEM: A Tier 1 automotive seating and electrical supplier was interested in taking advantage of local utility rebate incentives. For their compressed air needs, they had been relying on four compressors manufactured in the 1980's, inherited from a sister plant. Each unit operated in modulation control and was manually switched on and off, leaving the units continually fighting each other, resulting in wasted energy, fluctuating pressure, and increased maintenance costs.

SOLUTION: Kaeser performed a complete Air Demand Analysis (ADA) to identify the plant's current compressed air needs and to develop a plan for implementing the most energy efficient solution possible. Additionally, Kaeser recommended a Sigma Air Manager (SAM) master controller to properly control the system and ensure the most energy efficient combination of units would be selected to meet current plant demand.

RESULT: Thanks to better controls and adding an energy efficient variable frequency drive compressor, the customer was able to reduce their annual maximum power consumption by 865,440 kWh—the equivalent of removing 100 homes from the power grid for one year—all without compromising stable system pressure. With the older compressors relegated to back-up, annual maintenance costs have been reduced from $37,000 to $18,000. Less maintenance also means less downtime, for increased productivity.

Specific Power of Previous System:	28.93 kW/100 cfm
Specific Power of New System:	17.66 kW/100 cfm
Annual Energy Cost of Previous System:	$252,988
Annual Energy Cost Savings:	$114,720
Additional Savings in Maintenance Costs:	$19,000
TOTAL ANNUAL SAVINGS:	**$133,720**
Utility Rebate:	**$71,579**
TOTAL SAVINGS:	**$205,299**

Let us help you measure and manage your compressed air costs!

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