Life Is On | Schneider Electric

Summer Edition

Maintenance

PLANT ENGINEERING 2019 eBook Series

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AI-based maintenances improve pump uptime

Data-driven information supports advanced predictive maintenance.

Industrie 4.0 and digitalization offer optimization opportunities for operations and maintenance functions. Innovations such as digitalization, artificial intelligence (AI), machine learning (ML), neural networks, and cloud computing have raised the capability to collect, analyze and trend equipment condition/health in real time.

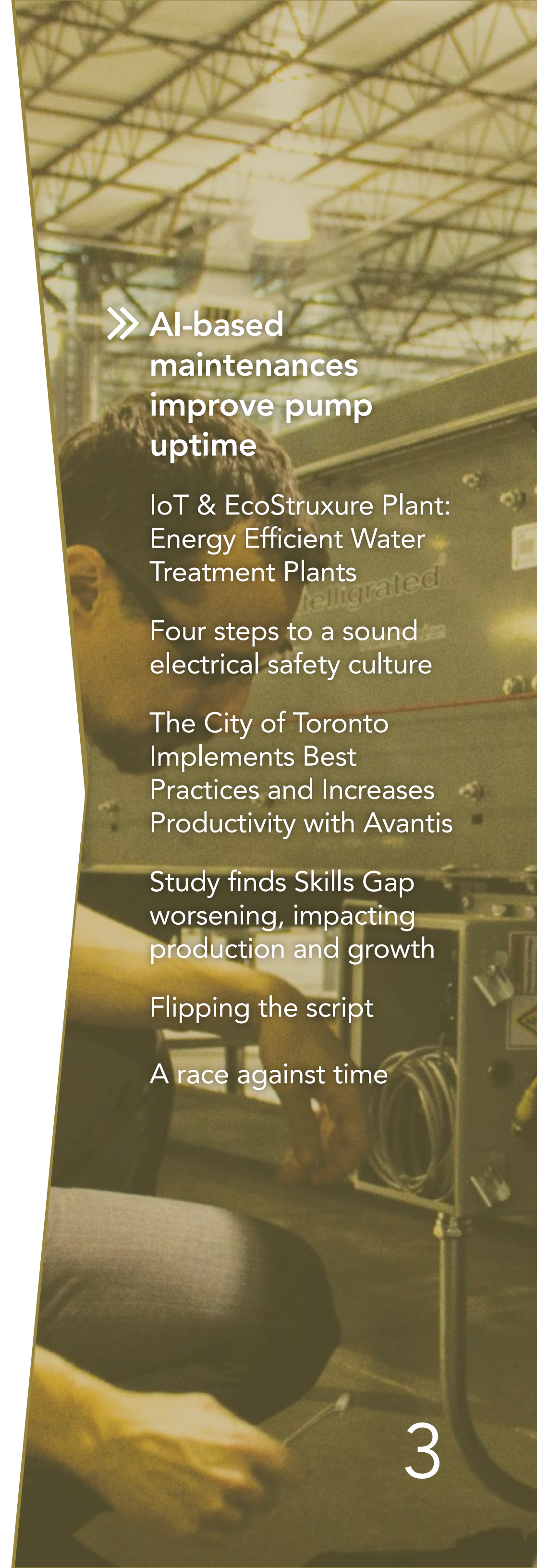
With these advanced monitoring equipment and analytics methods, reliability engineers can step up predictive maintenance (PdM) programs to achieve profitability goals, including:

- Optimizing critical assets' service life
- Minimizing unscheduled downtime
- Controlling maintenance costs
- Improving plant safety and operations.

Maintenance can be a profit center

Energy, power and chemical/petrochemical processing plants are very complex and complicated facilities. Numerous equipment and infrastructure items manage, contain and store feedstocks, process fluids and gases. Decreasing process unit and plant downtime due to unavailable equipment and systems are central to improving company profits.

Mechanical failure is the leading cause of processing industry accidents (Figure 1), while



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equipment failures result in 36% of unscheduled plant shutdowns (Figure 2). Creating better maintenance and planning programs increases operational excellence and facility uptime.

Figure 1: *Root causes for accidents and safety events occurring in the processing industry. Courtesy: Nanoprecise Sci Corp.*

'Smart' maintenance profitable

According to a recent McKinsey report, PdM can increase asset availability (either process unit or equipment) by 5% to 15%. Optimized PdM activities lengthen the service life of key assets by 20% to 40%. More importantly, PdM effectively can reduce maintenance costs by 18% to 25%. Improved monitoring and early proactive maintenance significantly reduce repair and replacement costs for key processing equipment and minimizes unscheduled downtime and lost productivity. In addition, unexpected equipment failures may result in losses greater than the replacement value of the asset.

PdM benefits

In general, rotating and reciprocating equipment have the highest failure rates (Figure 3). Vibration problems are predominant root causes for rotating equipment failures, espe-

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cially pumps. All rotating equipment vibrates, however, the changes in vibration levels over time are indicators of possible problems. In the hydrocarbon processing industry, about 7% of the pumps in use consume 60% of the money spent on pump maintenance and repair. Finding and addressing the root causes for vibration or temperature changes supersedes just treating the symptoms.

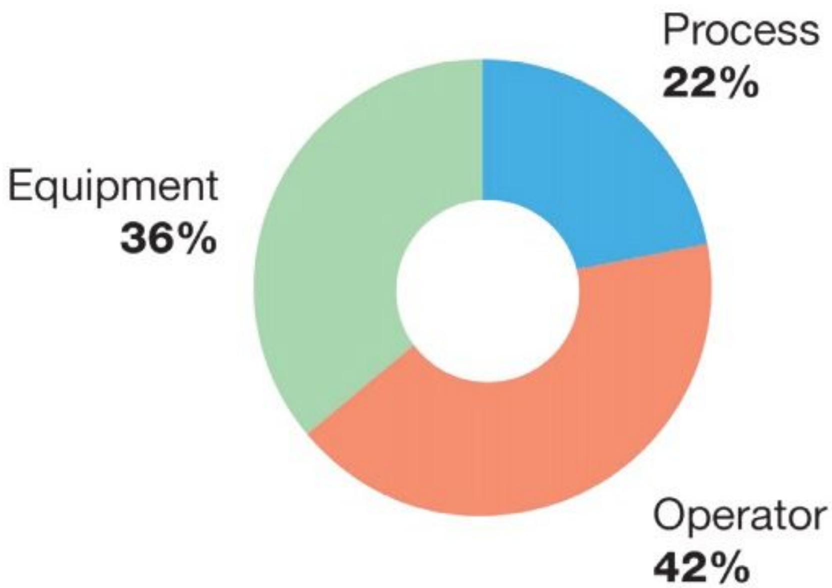
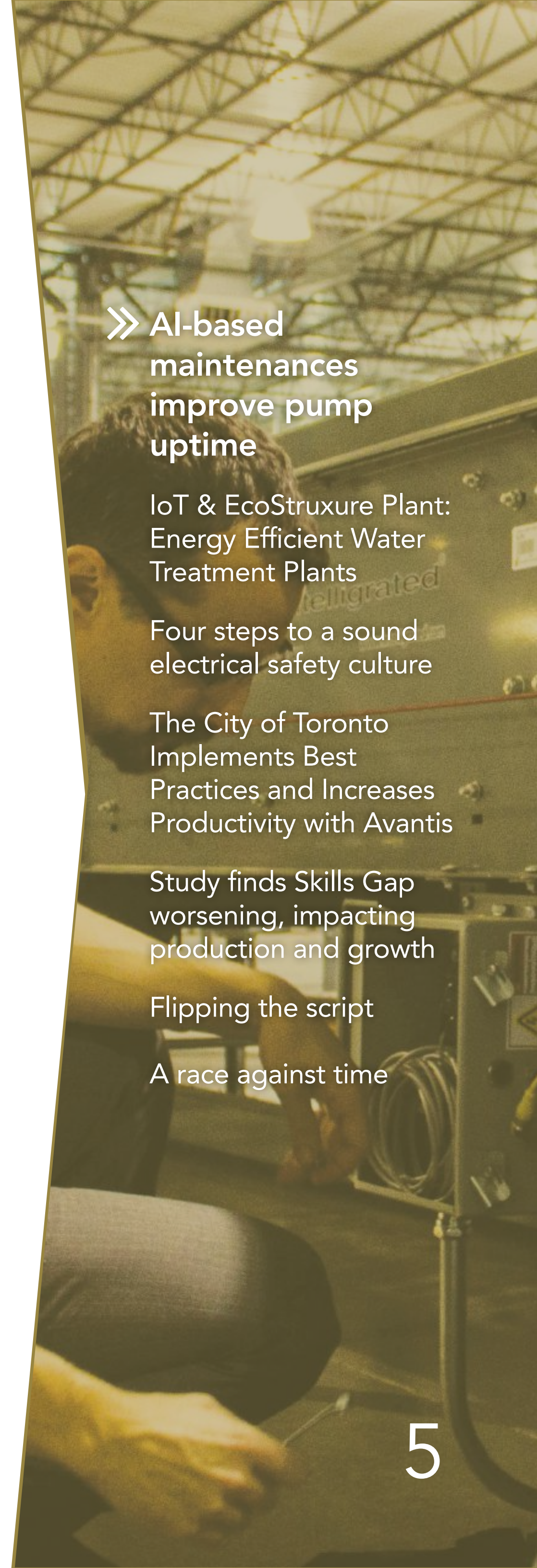


Figure 2: Root causes for unscheduled downtime occurring in the processing industry. Courtesy: Nanoprecise Sci Corp.

To avoid repeat failure, pump owners must push routine maintenance practices to a superior level. Increased use of smart manufacturing strategies and cloud computing can raise the integrity of PdM activities.

Not a new concept

Since the 1970s, maintenance and reliability engineers installed stress (piezoelectric) sensors to monitor and detect performance issues on pumps and motors. Unfortunately, these early methods encountered trending and continuity problems with data collection. These vibration sensors often operated at different frequencies and amplitudes and had their own baseline signatures.



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Deciphering collected sensor data into usable information required interpretation by data scientists. Stress sensors often were lost or removed by routine maintenance actions. Early sensors were connected physically to minicomputers or terminals by wires. Contaminants such as dirt and lubrication oil degraded sensor signals.

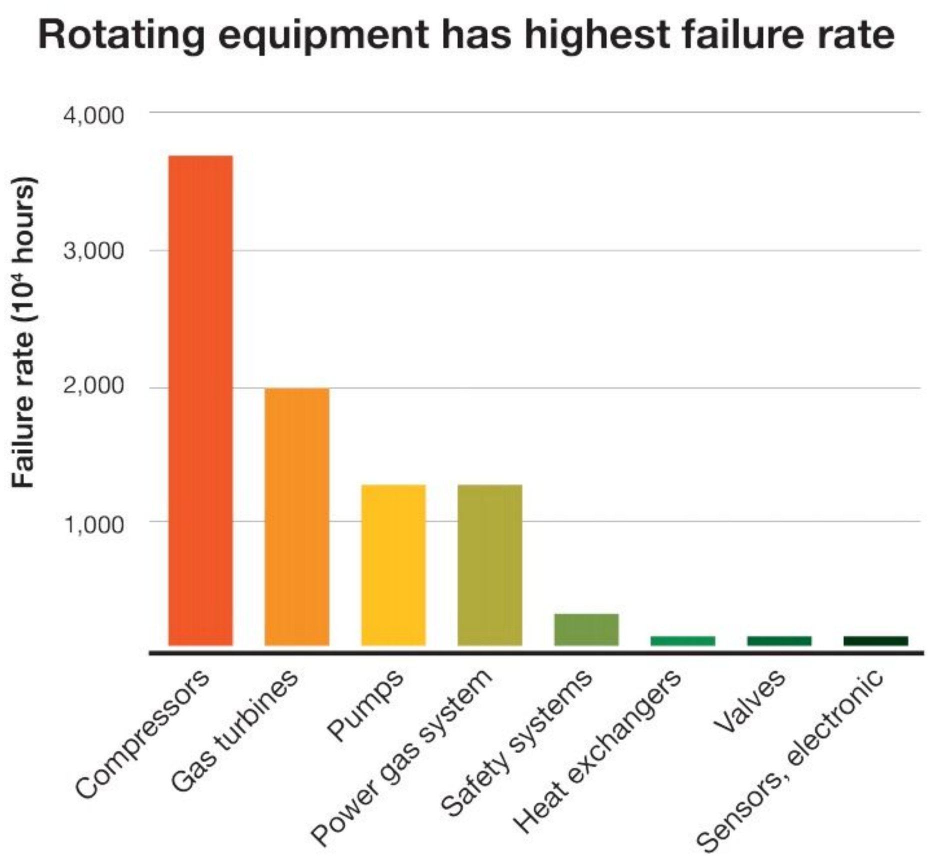
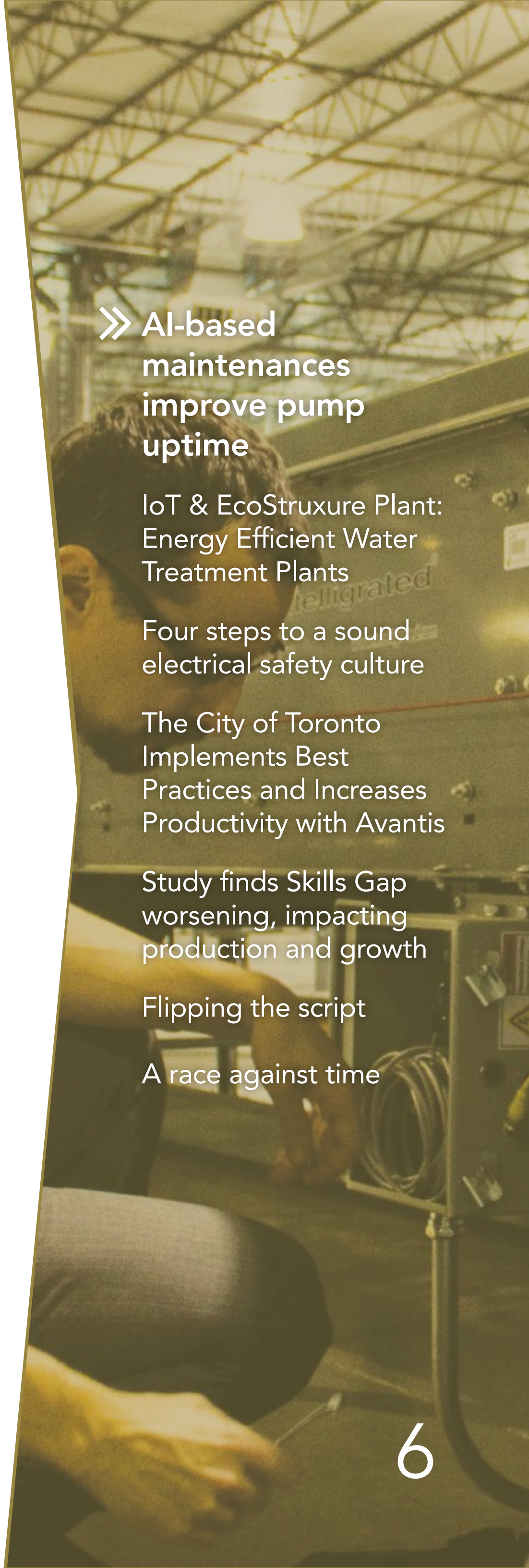


Figure 3: *Failure rates for major plant equipment. Courtesy: Nanoprecise Sci Corp.*

Reliability and maintenance engineers found that early vibration-monitoring methods did not yield desired results.

Improvements in minicomputers, terminals and hand-held sensors improved equipment monitoring programs. However, real-time information and data connectivity remained limited due to computer hardware and software capabilities. Converting vibration sensor signals into useable information remained a tedious task. In addition, data trends and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information were siloed in databases and not easily shared among users.

Remote monitoring methods were incorporated in preventive maintenance programs. The amount of data collected was never the issue. In some cases, too much data decreased the ability to find key information on equipment health. The long-standing problem remained understanding what the data were indicating about an asset's condition. Simply put, you can't effectively correct what you don't understand.

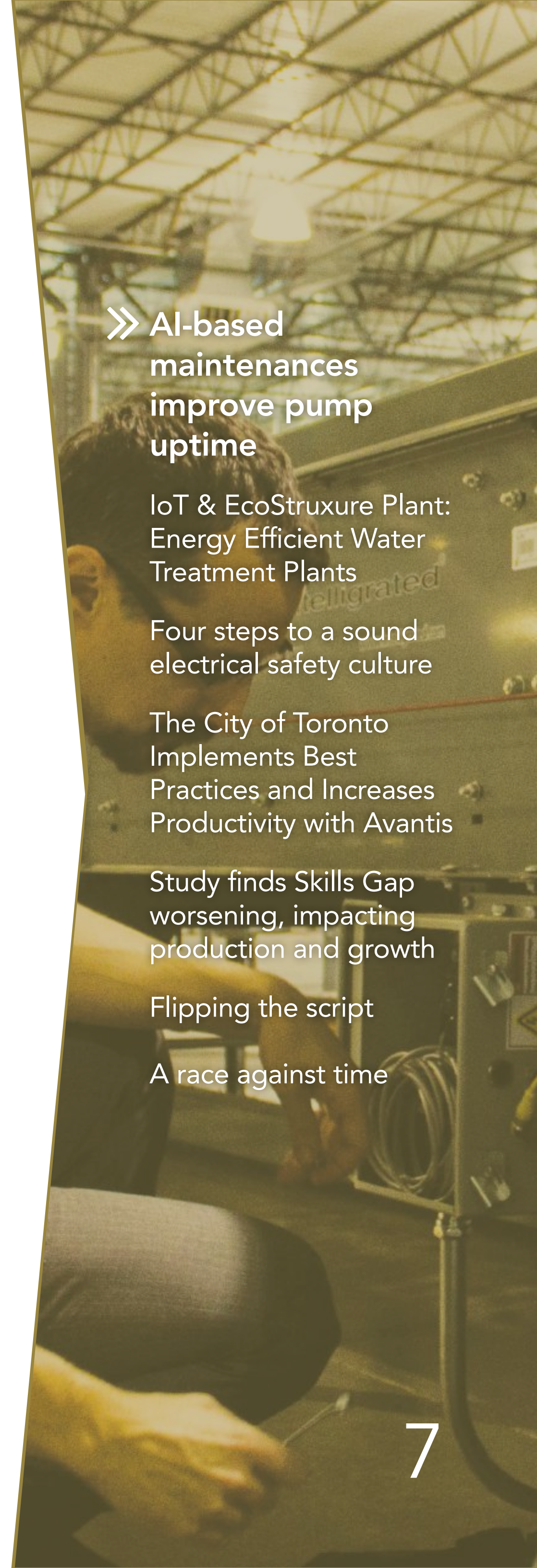
Vibration monitoring methods still struggle to provide and convert collected data into reliable real-time information. Too often, routine and preventive maintenance programs discover deteriorating conditions of rotating equipment after significant damage has occurred.

Real-time monitoring

Over the last 10 years, the use of wireless technologies, cloud computing, smart-field devices and AI enable the management of plant assets through advanced PdM programs. While preventive maintenance is done on the manufacturer's recommended schedule, PdM pushes maintenance activities to the next level. In PdM, real-time process and equipment data build trends and histories that be used to forecast changes within process equipment. Improving equipment availability and process uptimes through enhanced reliability/maintenance programs, such as advanced PdM, can increase operational excellence and plant safety.

Advanced PdM analytics

To be fully effective, PdM programs require robust and valid data and the analytics to develop information-driven decisions. Recent advancements in AI and ML enable analyzing



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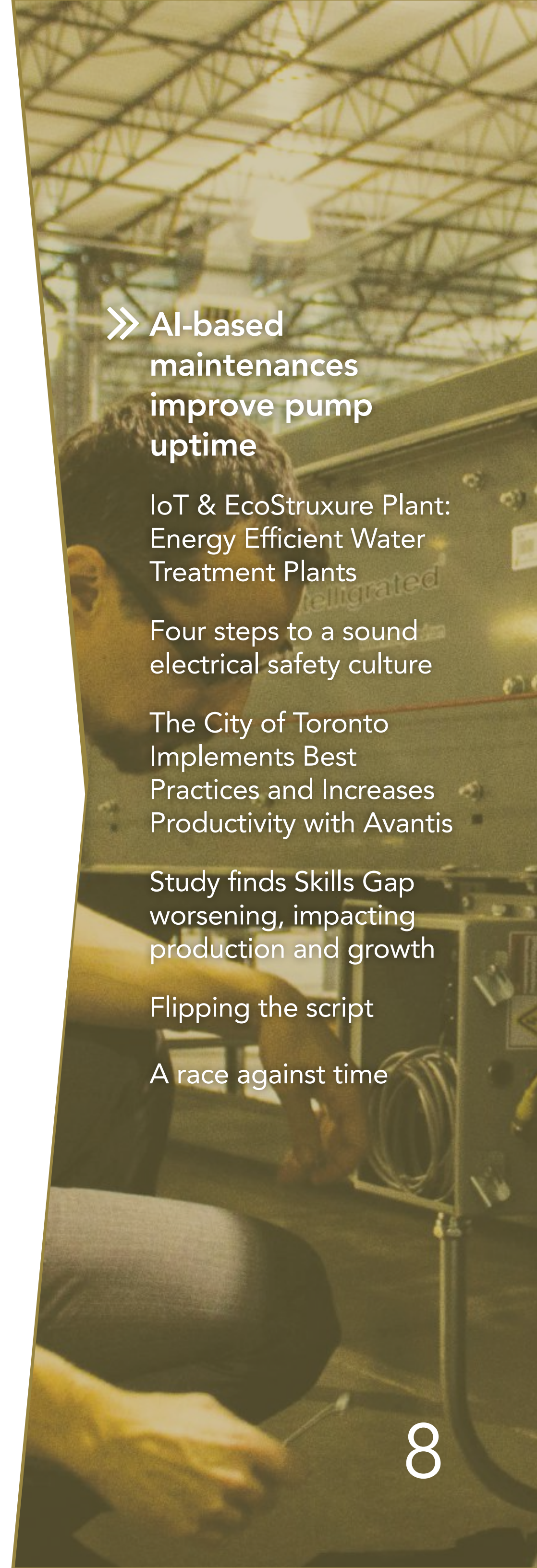
and converting huge volumes of collected data into patterns. To monitor rotating and reciprocating equipment, advanced vibration sensors use cloud computing to upload real-time data in various formats. Innovative AI and ML algorithms, built on a combination of software and neural networks, convert and analyze wireless sensor data.

This information generates trends that identify normal and unhealthy operations. More importantly, the AI algorithms "learn" from the transmitted vibration data and discern between "normal" or unacceptable signals.

Using AI-based predictive analytics, ML and neural networks, correlations concerning the performance of critical equipment are possible. These validated analytics are instrumental in identifying true root causes for performance deviations of rotating and reciprocating equipment. Early fault identification enables optimum corrective actions to be selected before substantial asset damage or failure occurs, thus minimizing repair costs, reducing unscheduled downtime and ensuring safe operations.

Deteriorating conditions of pumps and compressors are not observed easily through visual or normal health checks. AI and ML algorithms identify patterns from the histories and detect performance decline as proven by deviations in asset trends. Equipment performance problems are identified much sooner than through traditional preventive maintenance methods. System-generated alarms alert maintenance engineers to conduct further investigations.

Also, AI-based predictive analytics go beyond failure notification. They use data and operating histories to estimate the remaining useful life (RUL) of failing equipment or a component item. With RUL, maintenance and reliability engineers have complete in-



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formation to plan repair and replacement actions that have the least impact on process uptime.

Visualization of data

Data without refinement have limited value. The basis of PdM is visualizing the data. Advanced PdM uses AI-based analytics and neural networks to distill collected data into usable information. They usually include dashboards that enable users to quickly survey equipment condition data and review trends. With such graphics, engineers can interpret equipment/process unit health easily and make more informed, data-driven decisions. In addition, RUL estimates are combined into the graphics for centralized information.

Secure wireless technology and mobile apps connect advanced sensors to the cloud for analysis by AI and ML software. Fully applying Industrial Internet of Things (IIoT) and cloud computing, maintenance and reliability professionals continuously can review the health of critical process equipment. The ability to forecast the RUL and "time to failure" is invaluable. With such information, maintenance and operations groups can plan repair actions rather than react to an emergency shutdown or unscheduled outage.

Case history: L&T Nabha Power plant

The L&T Nabha Power facility is the company's first supercritical, coal-fired power plant and is one of the most efficient power-generation facilities in India. This facility operates two 700-MW supercritical thermal power units and is the major electricity provider to the state of Punjab in northern India. As the chief regional energy provider, reliability of the Nabha power plant is critical. Unplanned maintenance and shutdowns of this facility have dramatic and adverse effects on the productivity and profitability of regional businesses

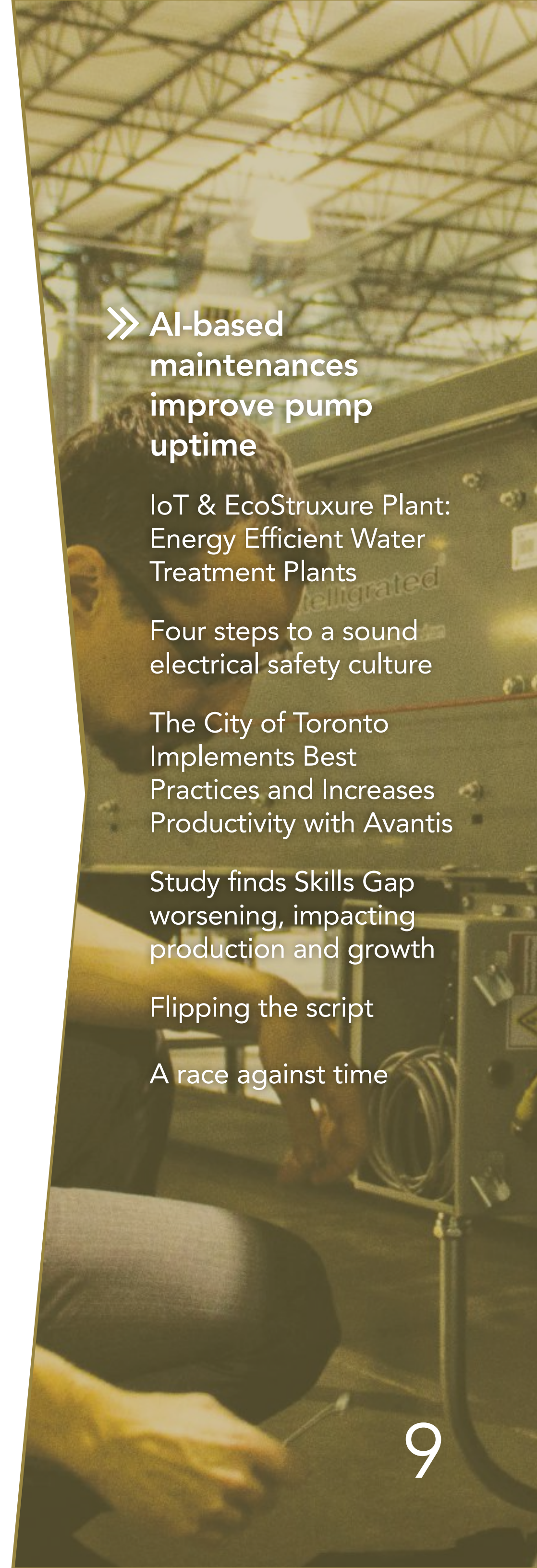

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Figure 4: *This condensate cooling-water pump experienced chronic cavitation and vibration events that resulted in bearing failures and unscheduled downtime of the Nabha power facility. Courtesy: Nanoprecise Sci Corp.*

and residential customers. Unfortunately, this power plant experienced three unplanned downtimes in one year due to critical-service pump failures.

In power generation, pumps are key processing equipment. The condensate cooling-water pump is one of the critical-service pumps to maintain steady-state operations of the facility (Figure 4). It is a horizontal vane pump operating at up to 1,650m3/hour with a discharge of 9 MPa (62 psi) at 986 rpm. Each day that this pump is offline costs the power plant up to $250,000 in lost revenue. Unplanned maintenance and failure of this pump

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can incur repair costs exceeding tens of thousands of dollars.

The facility's condensate cooling-water pump had chronic unscheduled downtime due to bearing failures from cavitation events. As the primary electric power provider for the region, reliability of the condensate cooling-water pump was a top priority at the facility.

To resolve failure conditions and increase unit uptime, plant engineers elected to install a real-time vibration monitoring and advanced AI-based predictive analytics solution on the condensate cooling-water pump. The new monitoring strategy focused on early fault detection of the pump and its components. Besides fault detection, this monitoring solution included AI-based algorithms to provide reliable RUL estimates before service interrup-

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Figure 5: Using past maintenance work orders, plant engineers selected optimum locations to install advanced acoustic-vibration sensors. Courtesy: Nanoprecise Sci Corp.

tions occurred. To solve the bearing failure problems for this condensate cooling-water pump, several advanced wireless sensors were installed to monitor:

- Non-drive-side bearing, electric motor
- Drive-side bearing, electric motor
- Drive-side bearing, pump
- Non-drive-side bearing, pump.

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***Figure 6:** The advanced wireless acoustic sensors were installed using a strong magnet and a two-part epoxy to endure the rigors of this pump's operations. Courtesy: Nanoprecise Sci Corp.*

The monitoring system used secure Wi-Fi-enabled sensors to collect and upload vibration data continuously via the cloud. Cloud-based AI algorithms analyzed and tended the collected data.

Approximately six weeks after the installation of the advanced sensors and analytics system, the new monitoring program alerted maintenance staff that a vane fault had developed. It was causing cavitation problems for the condensate cooling-water pump. The plant's maintenance staff verified the fault with a hand-held vibration monitor and did a

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partial disassembly to visually confirm damage to the pump vanes. A temporary repair of the damaged vanes was done before putting the pump back in service.

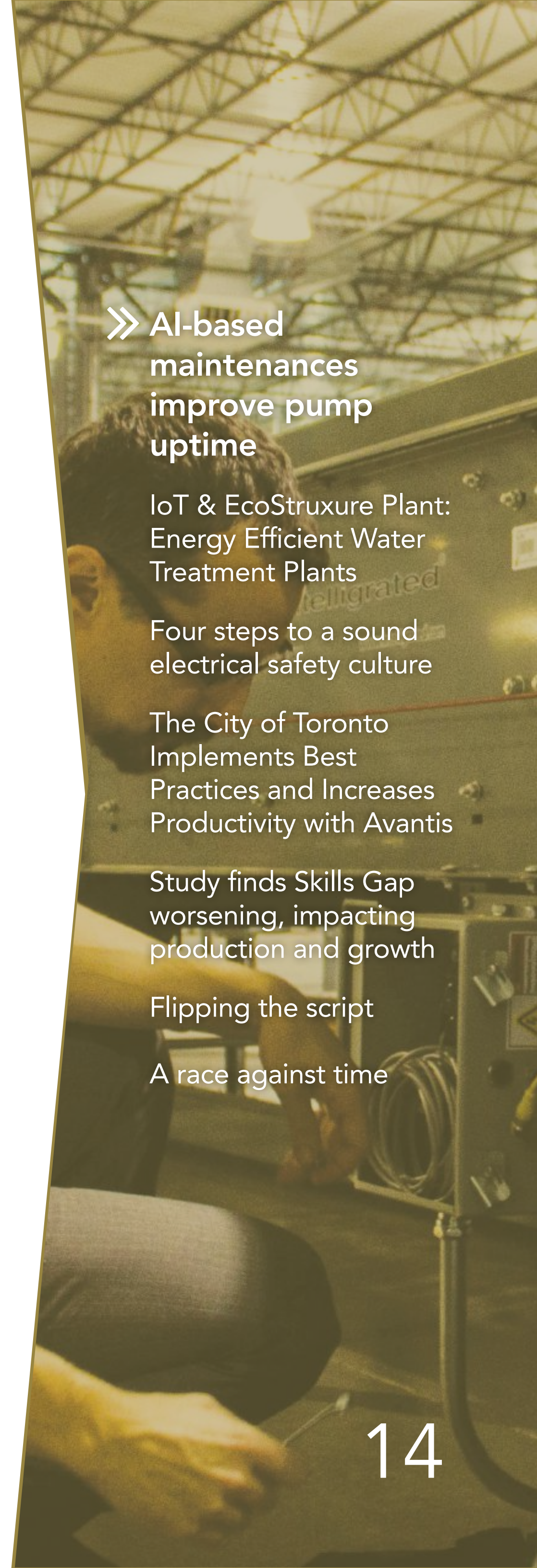
The advanced AI-based PdM system estimated a RUL of 25 days before total failure. This was sufficient time to schedule the pump replacement during an already planned maintenance outage. Applying AI-based predictive capabilities and advanced vibration monitoring, L&T Nabha Power avoided a serious pump failure and unplanned downtime. Early intervention reduced much needed repairs and minimized interruptions to facility operations.

Not just black boxes

IIoT, cloud computing and wireless technologies support AI-based data analytics as part of an advanced PdM program. Fully applying AI and ML methods, engineers can detect anomalies or faults in critical-service equipment well in advance of failure mode. Advanced wireless vibration/acoustic sensors support PdM programs in collection and uploading of real-time data.

With AI, ML and neural-network algorithms, advanced analytics develop historical trends of monitored equipment or components. With a complete operating history, AI-based analytics identify changes in the trending data and estimate the RUL of the monitored asset. With the RUL, maintenance and reliability engineers can take corrective action well before failure and focus on preserving the asset and maintaining safe operations. Advanced PdM programs support better results-driven maintenance plans that improve operations uptime and safety.

Sunil Vedula *is the founder of Nanoprecise Sci Corp., and* ***Don McClatchie*** *is the company vice president. Nanoprecise Sci Corp is located in Edmonton, Alberta, Canada*



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Water & wastewater treatment need smart solutions. Schneider Electric offers IoT technology to improve the resilience of water management systems while maintaining energy efficiency & cost-effectiveness.

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Four steps to a sound electrical safety culture

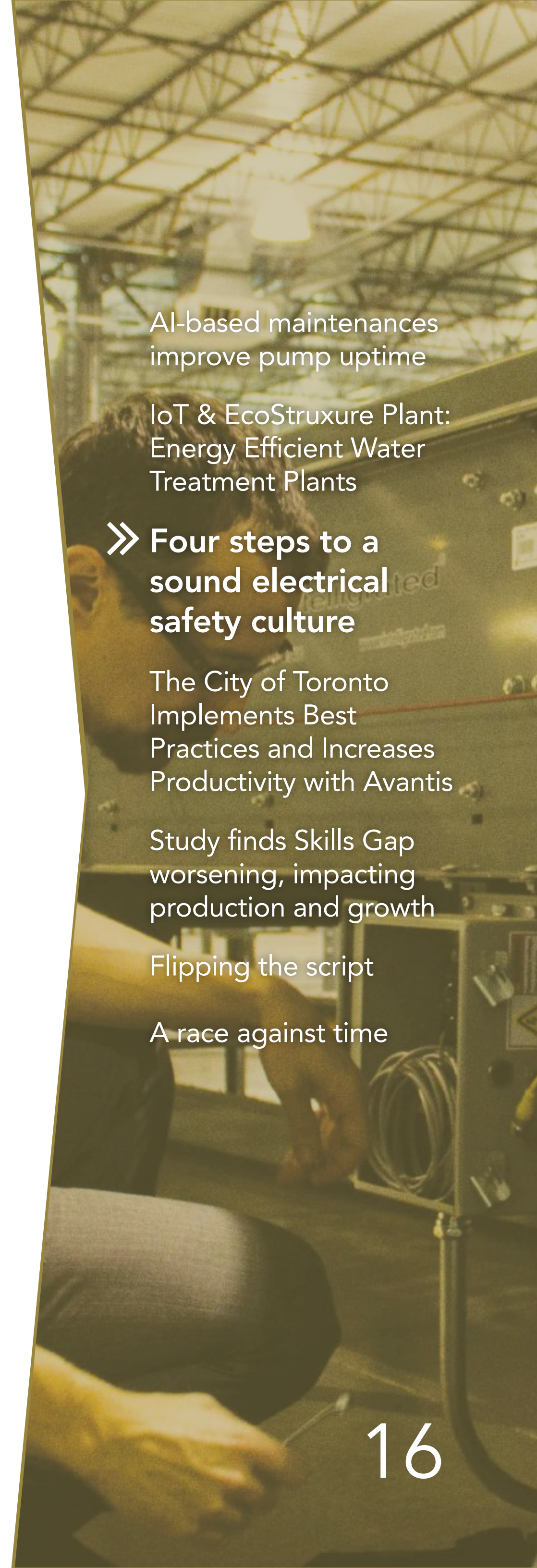
Training makes a difference, and so does communication.

It's a new engineer's first day on the job and a piece of the electrical system is not performing the way it should be. The manager asks the engineer to troubleshoot the issue, unaware the engineer has had no safety training. Afraid to appear they don't know what they are doing, the engineer approaches the equipment without any protective gear to see what's happening. We all know this could result in a serious injury, maybe even death — and this is more common in electrical facilities than one may think.

Despite the common understanding of prioritizing safety, electrical safety is still a workplace issue. Hazardous energy and lockout/tagout (LOTO) is fifth among safety violations cited by OSHA in 2018. However, restrictions on time and resources may lead employees to be less diligent as they should be in mitigating safety risks throughout their work day. And when safety is put second, electrical facilities can take big hits with respect to their employees and to profitability.

To keep electrical facilities running smoothly and efficiently, it is critical that facility managers and staff create a strong culture of safety for employees at every level. Proper training, top to bottom messaging, compliance checks and more can guarantee that employees are aware of how to work safely.

Facility staff needs to establish a solid culture that will keep everyone safe. Here are four ways to accomplish this:



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1. Establishing safety at EVERY level. Although engineers and electricians are the people who work most closely with electrical systems, everyone from top to bottom should be well versed in the proper safety protocols. Managers should encourage their staff to take their time when completing tasks to ensure they are adhering to the proper safety procedures.

Enforcing this and practicing it themselves will prove they are as committed to best safety practices as they want their employees to be. The single most important thing an employer can do is to empower employees to do the right thing, even if it means stopping work in an unsafe situation. Having the power to make these decisions can have positive impacts on their own and their coworkers' safety.

2. Embedding proper communication in daily workflows. As mentioned at the beginning of this article, inexperienced employees may not fully understand safety protocols and may feel embarrassed to ask, making communication critical to ensuring effective safety measures. Managers are responsible for effectively communicating to their staff what components make up an established safety culture, and explaining the risks and penalties associated with poor safety adherence.

Program documents such as the Electrical Safe Work Practices (ESWP) Policy should be readily available for all employees to read about electrical safety practices such as lock out/tag out procedures, selection and application of PPE, methods of establishing a safe work area, arc flash and shock protection calculations and more. These program documents should be living documents that are reviewed and updated as required.

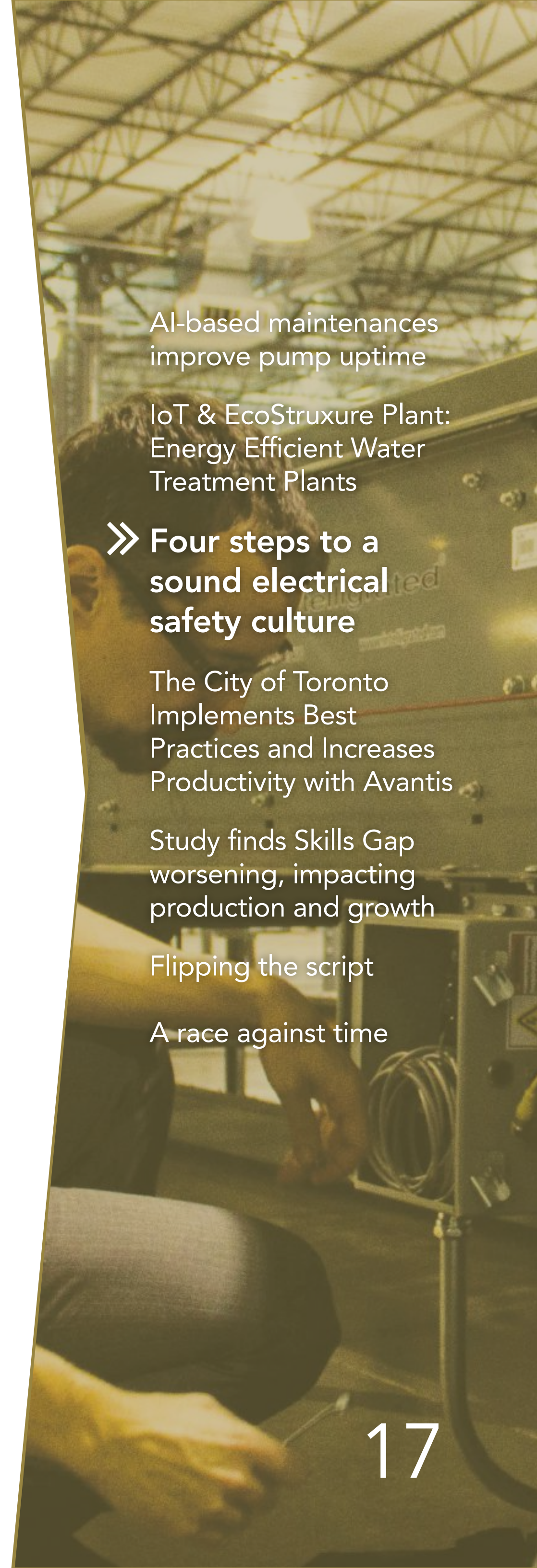

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Image courtesy: CFE Media

Safety audits are another way for managers to validate qualified personnel's knowledge of safety protocols. The National Fire Protection Association (NFPA) defines a qualified worker as "One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk." These audits also determine whether or not an employee is familiar

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and complying with NFPA 70E.

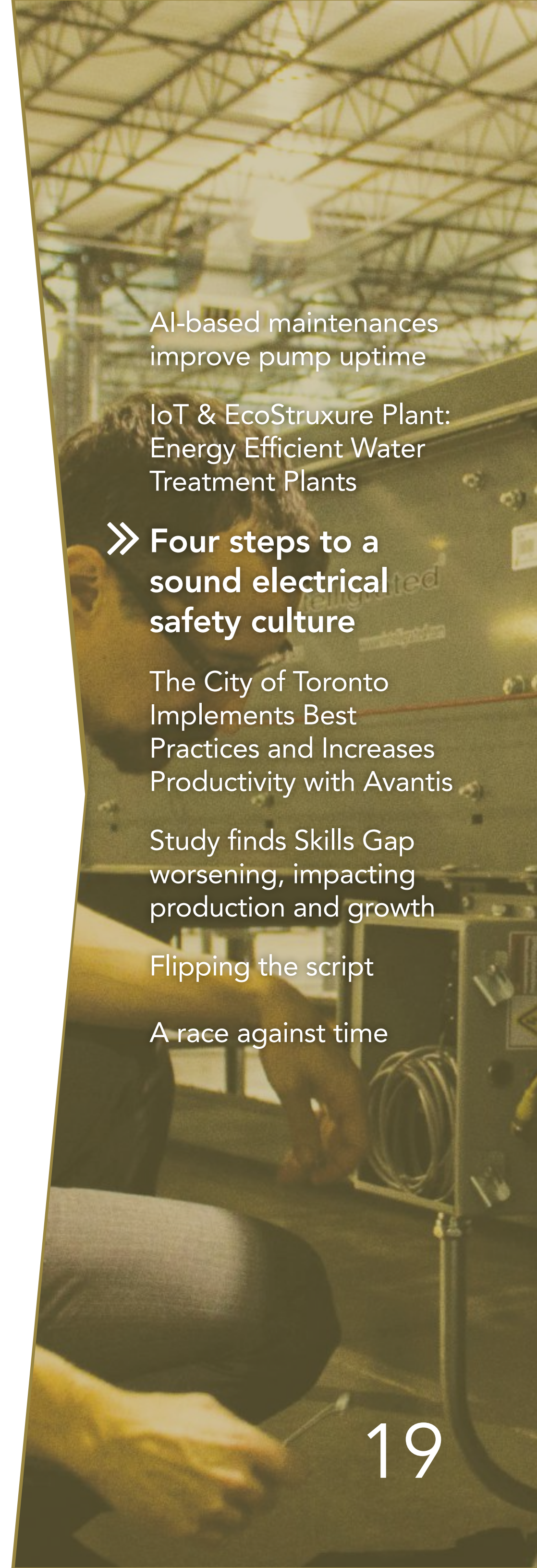
Incorporating safety messages into team meetings also can drive home the importance of safety in an electrical facility.

If a near-miss incident occurs, managers may consider reviewing and discussing them with the larger group to identify the missteps and communicate how to effectively mitigate the risk in the future. A near-miss also provides an opportunity review whether the existing safety policies/procedures adequately address the situation or if they need to be revised.

3. Providing the proper defense equipment. Wherever an electrical hazard is present, facilities should have personal protective equipment (PPE) available to minimize harm during procedures. Having materials such as an arc-resistant shirt, pants or coveralls, or a multi-layer flash suit, flash hoods, voltage rated gloves and more can reduce safety risks. But employees should understand when and how to use PPE.

While it may be uncomfortable, there are some situations where it is absolutely imperative. Alternatively, it's meant to be a last line of defense and it is the least effective risk mitigation control. PPE is designed to reduce burn injuries to be survivable, but employees may still suffer first- or second-degree burns.

4. Complying with the most recent codes. All electrical staff should be up-to-date on the most recent codes provided by the National Electrical Code (NEC) and the NFPA 70E. These codes provide guidance on best practices to keep staff safe and prevent dangerous events from occurring within a facility. Specifically, the NFPA outlines the hierarchy of risk controls including elimination, substitution, engineering controls, awareness,



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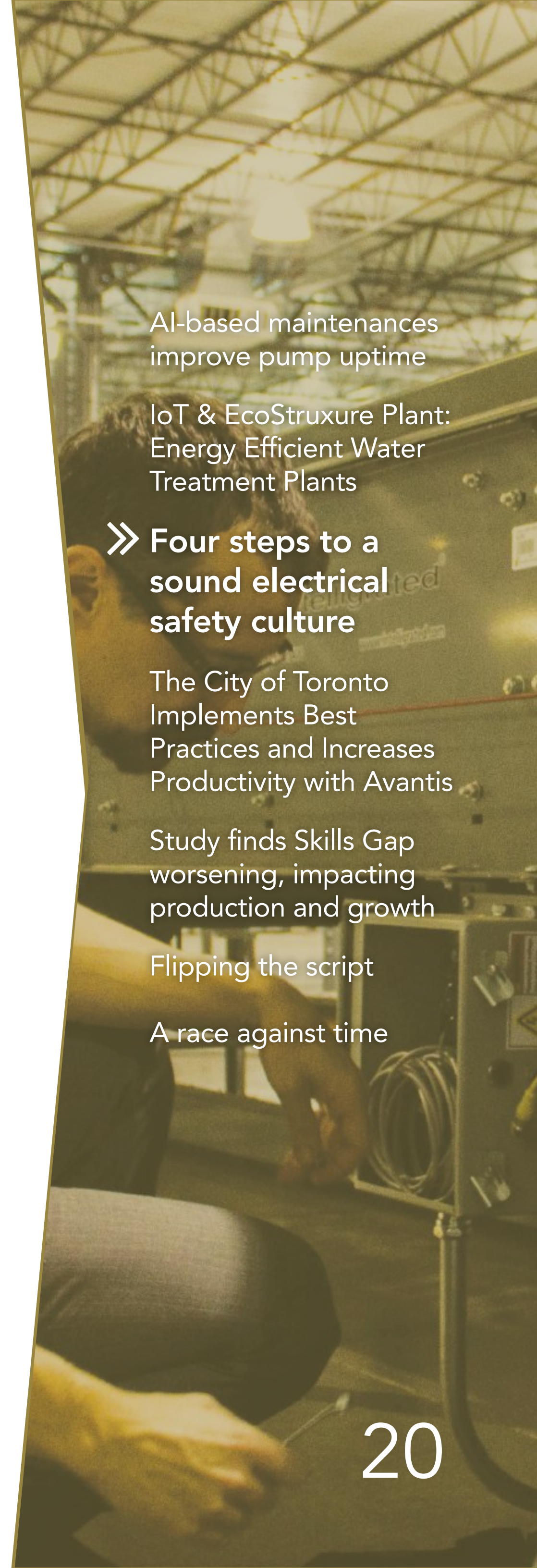
administrative controls and PPE. Additional articles within the code offer information about performing arc flash risk assessments and other protective measures.

Facility managers and staff must understand these codes are being upgraded continuously, with recent updates to the NEC incorporating additional energy reduction and documentation/labeling requirements.

The ultimate goal of safety only can be achieved when staff are committed to safety practices and are taking advantage of learning and communicating about safety on a continuous basis. Leveraging guidelines provided by OSHA, NEC and NFPA can lead facilities to become safer, but it will depend on the determination and actions taken by staff to create a truly safe facility.

Eddie Jones, P.E., *is engineering manager for Schneider Electric Engineering Services.*



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Report from Deloitte and The Manufacturing Institute points to digital skills needed for the future.

Toronto, Canada – The new City of Toronto was created on January 1, 1998, through the amalgamation of the seven separate entities of the former Municipality of Metropolitan Toronto. The City provides a full range of services to the more than 2.5 million residents of Toronto through its six major departments and a number of agencies, boards, and commissions. Toronto is the largest city in Canada and the 5th largest city in North America.

Toronto Works Best Practice Program

The Water and Wastewater Division of Toronto Works and Emergency Services (WES), with the responsibility to produce and distribute potable water across the City as well as collect and treat the City's waste-

Goals

Increase and improve productivity, share maintenance information, reduce operating cost and improve customer service

Solution

Avantis.PRO®

Story

Previous systems consisted aged preventive maintenance and inventory programs developed internally. Each facility had its own version of these programs and the functionality of those applications was very limited

Results

- *Meets all of the EAM core functional requirements (work management, inventory, procurement)*
- *Management can determine accurately and quickly the costs of performing maintenance at water and wastewater operating facilities*
- *The Division is identifying real savings by maintaining optimized inventory levels and improving replenishment procedures*
- *Ensures that the Water and Wastewater staff has readily available, accurate, and relevant information to help them be more effective in executing the work management process*

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water, is involved in a broad improvement initiative called the Works Best Practices Program (WBPP). WBPP is focused on developing a highly efficient organizational structure through the application of redesigned work practices and the acquisition of new process control and information systems as an enabling foundation. Revitalized maintenance practices and supporting technology are key ingredients of the WBPP. An Enterprise Asset Management (EAM) system with full maintenance, inventory, and purchasing functionality was identified early on as a key component of the WBPP applications architecture.

"We developed the Works Best Practices Program to substantially reduce operating costs, while at the same time improving overall customer service. In order to reach our goals, we knew that we must incorporate broad work practice and organizational redesign in concert with advanced information and engineering technologies. After a highly competitive evaluation that included nineteen initial

> "Overall, our staff is excited about Avantis. They are impressed with the ease of use and speed with which information previously unavailable to them can now be acquired."
>
> *Jim Coe*
> *Program Manager,*
> *Water and Wastewater Division*

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EAM vendors, we selected the Avantis solution to support the management of all maintenance and schedulable work activities. Our partnership with Invensys reflects our philosophy of continuous improvement through business synergy and technological innovation," said Jim Coe, Program Manager, Water and Wastewater Division.

Client Challenge

The Water and Wastewater Division's previous systems environment consisted primarily of aged preventive maintenance and inventory programs developed internally using dBase and similar products. Each facility or plant had its own version of these programs and the functionality of those applications was very limited.

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Coe said, "We recognized that we had a productivity gap and that one of our primary weaknesses was spending most of our time in a reactive maintenance mode. Analysis indicates that the optimum level of proactive versus reactive maintenance is about 70%. We knew we needed to move in that direction and that business tools and information systems would be keys to our success."

Realizing significant benefits with Avantis

Since implementing the Avantis solution at the first site, the City of Toronto is beginning to realize significant benefits, including:

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Integration Capabilities — the Avantis solution meets all of the WBPP's EAM core functional requirements (work management, inventory, procurement), and easily adapts to the middleware enabled "integrated information environment" being implemented under the WBPP.

Maintenance Costing and Work History — the Avantis solution is central to the Division's efforts to implement "Program-Driven Maintenance," effectively moving from a largely reactive to a fully planned maintenance environment. Management can determine accurately and quickly the costs of performing maintenance at water and wastewater operating facilities. They can review work history and generally do better planning and make better maintenance and business decisions.

Lower Inventory and Procurement Costs — using the Avantis solution, the Division is beginning to identify real savings by maintaining optimized inventory levels and improving replenishment procedures. Increased control of maintenance assets and related activities will enable the Division to better meet service agreements with its customers.

Easy Access to Information — the Avantis solution ensures that the Water and Wastewater staff has readily available, accurate, and relevant information to help them be more effective in executing the work management process.

According to Coe, "Overall, our staff is excited about Avantis. They are impressed with the ease of use and speed with which information previously unavailable to them can now be acquired. Because they had been unfamiliar with such advanced technology being part of their day-to-day work practices, they feel motivated to improve their skill levels to gain a measure of confidence and ultimately to see just how much they can benefit from Avantis."

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Study finds Skills Gap worsening, impacting production and growth

Report from Deloitte and The Manufacturing Institute points to digital skills needed for the future.

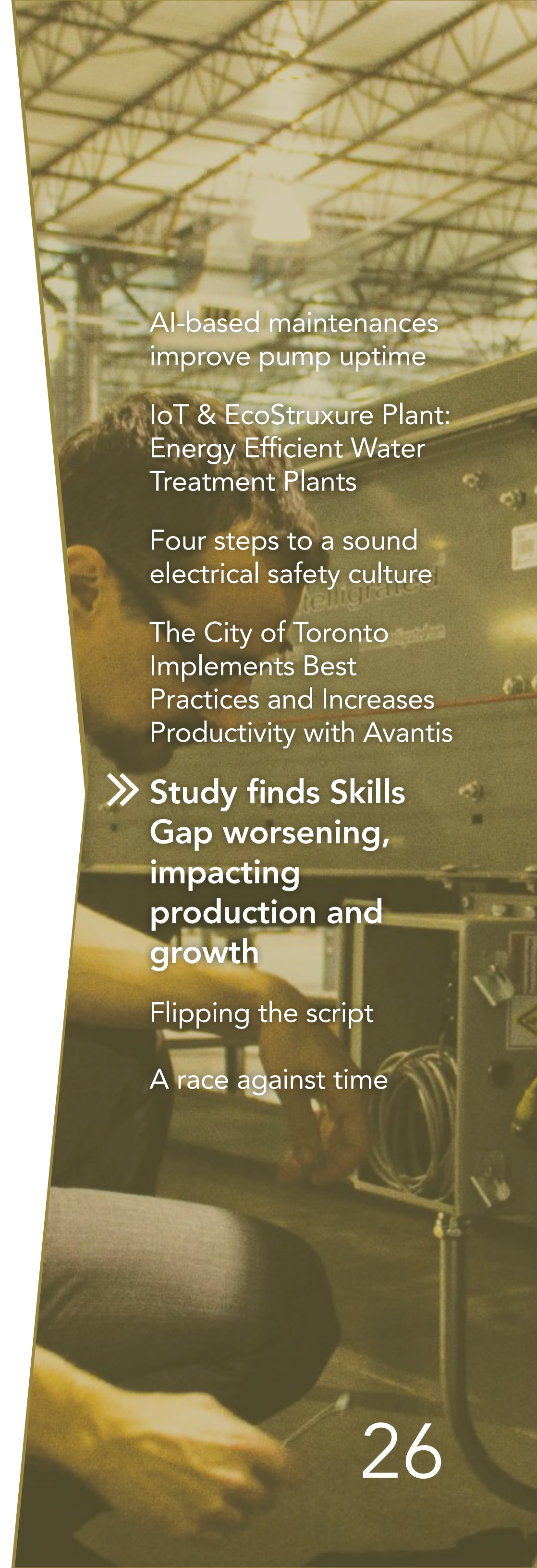
Despite what they concede is a healthy overall economy, Deloitte and The Manufacturing Institute's fourth annual skills gap study shows a worsening gap between manufacturing jobs and the workers available to fill those jobs.

"The industry would need to employ approximately 1.96 million additional workers between 2017 and 2028 to produce the goods the growing economy could demand," the report notes. "However, the lack of skills identified by manufacturing industry executives and impending retirements suggest the industry could experience employment bottlenecks, leading to a potential 2.4 million jobs going unfilled, with the risk of limiting production below these projections."

Paul Wellener, vice chairman and US industrial products and construction leader for Deloitte LLP, discusses the study findings and how manufacturers can—and must—reserve this trend:

CFE Media: *We've been talking about the Skills Gap in manufacturing for more than a decade. During the recession, the issue was urgent; now we've reached a critical stage. What's kept this issue from being addressed sooner?*

Wellener: Manufacturers have been actively addressing the talent and skills shortage for the past several years, as the issue has grown in seriousness. The reason it is reaching critical stage stems from several factors: the growth the manufacturing industry has experienced over



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the past few years, the increase in baby boomer retirements over the coming decade, and the historically low unemployment rates, which leads to a decrease in the available talent to fill the open jobs. This scarcity is causing manufacturers to rethink how they manage talent, and how this will need to continue evolving to reflect the broader changes in the future of work.

A new Deloitte study finds that the five skill sets that manufacturing executives said could increase significantly in their sector in the coming years are technology/computer skills, digital skills, programming skills for robots/automation, working with tools and technology and critical-thinking skills. Image courtesy: CFE Media

CFE Media: *With the advent of the Industrial Internet of Things (IIoT), have those skills changed?*

Wellener: We are certainly seeing the IIoT and other advanced technologies have a noticeable impact on skills across jobs and roles in manufacturing. Our research identified that the top skills, broadly speaking, that executives identify as necessary in today's technologically advanced workplace are very digitally-infused.

The five skill sets that manufacturing executives said could increase significantly in their sector in the coming years are technology/computer skills, digital skills, programming skills for robots/automation, working with tools and technology and critical-thinking skills.

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CFE Media: *On the other hand, are the lack of skilled workers delaying the implementation of technology improvements such as IIoT?*

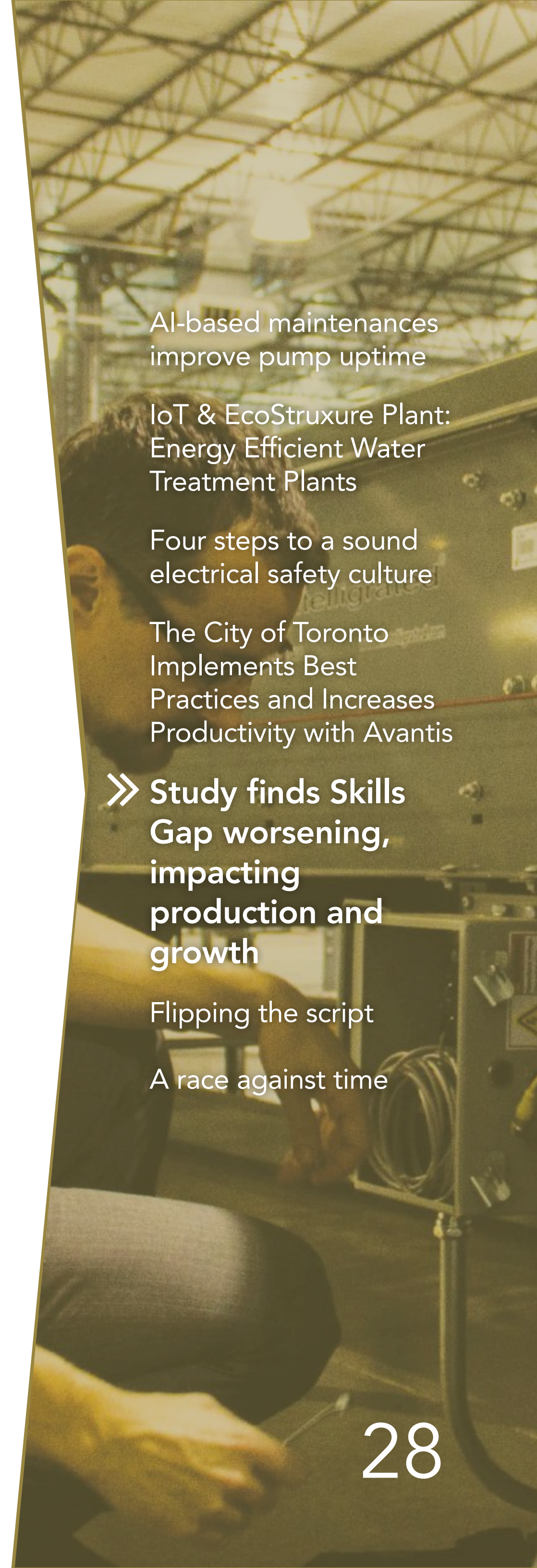
Wellener: We have not seen evidence that the lack of skilled workforce directly delayed the implementation of technology improvements. In some cases, we have seen manufacturers apply automation to help supplement the workforce, and 64% of those manufacturers that did so found automation helpful to overcome the challenge of filling job openings with qualified talent. Low-skilled production in particular was an area of focus.

CFE Media: *What tactics are working? How are manufacturers successfully addressing their individual Skills Gap?*

Wellener: We have seen those companies that have used automation to supplement specific segments of the workforce find themselves able to address their individual skills gap. Additionally, we have seen manufacturers improve their HR management practices to attract, hire, and retain talent along with rethinking how work is structured, which ties into the broader future of work efforts the industry is undergoing. Outsourcing work to gig workers, enabling remote work, distributing work to other locations, and using advanced technologies to power virtual work are all approaches producing different levels of effectiveness.

CFE Media: *One area mentioned in the study is the use of retired workers to help fill some of the worker shortfall. What are some of the implications of this strategy?*

Wellener: Engaging experienced, committed employees as they plan to exit the workforce is a positive way to retain knowledge and create a formal system for knowledge trans-



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fer within the workforce. We have already seen a number of large, global manufacturers do this successfully.

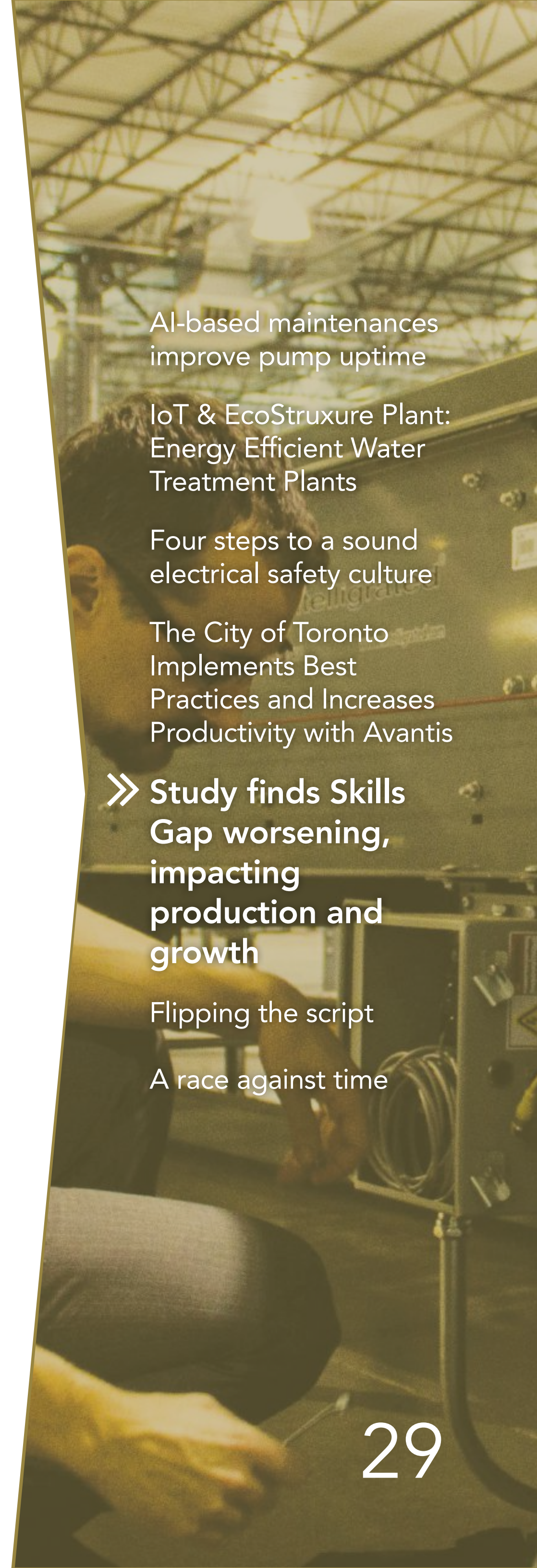
CFE Media: *Automation increasingly is looked at to solve a large part of the manufacturing Skills Gap, but the workers skills needed to manage that automation also change. What are the steps needed to address this issue?*

Wellener: Our research shows a current gap between sourcing the skills needed today and identifying all of the potential new skills and jobs for tomorrow. So, to begin, manufacturers need to create future scenarios about what work looks like in 2025, for example. Our future of work in manufacturing series attempts to help manufacturers visualize a future that contains the exact scenario you identify.

We have created a series of "personas" written from the personal job perspective to highlight how jobs and roles are changing with the influx of technology and automation. We have already published a profile of a digital twin engineer (you can read it here), and one of our upcoming personas is for a "robot coordinator," a new role that involves helping humans and machines work alongside each other in harmony.

The responsibilities and time spent on activities that we identify in these profiles act as a tool for backtracking from the future to the present, where leaders can create tactical plans for getting from now to tomorrow on the talent front. are meant to help manufacturers consider how to modify talent management strategies that will accommodate for the changes in skills, roles, and jobs over the next five to 10 years.

***Bob Vavra** is the former Content Manager for* Plant Engineering.



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Maintenance strategy requires technology—and a new mindset.

Today's manufacturing plants tend to consist of a wide assortment of assets patched together like a colorful quilt. The machinery and equipment can range from highly advanced robotics to outdated legacy solutions, stretched past their normal life expectancy.

Plant engineers must make these disparate assets integrate and perform as one, which can be a challenge, especially when lean budgets, escalating market demands and conflicting strategies add to the complexity. Forward-thinking plant engineers, though, can step up to the challenge, elevating processes beyond simple reactionary mode. It begins with a new mindset—and modern technology.

How did we get here?

Most plant engineers already have witnessed at least one transformational episode during their career, whether it was the adoption of Lean Principles in the 1980s, deployment of mobile solutions in the 1990s or migration to the cloud in early 2000s. More disruptions are coming. The pace of change continues to escalate, even as manufacturing growth starts to slow. Fear of tariffs with China, potential trade wars and lack of clarity from the European Union all add to global market uncertainty. U.S. plants must be prepared for the long game.

In order to remain competitive in this high-stakes era, manufacturers must be agile, resilient and finely-tuned enterprises operating with minimal downtime. Waste, inefficiency and delays need to be curtailed, too, so the enterprise can focus on priorities: aligning with customers and developing new products. Increasing competition makes these capabilities more important than ever.

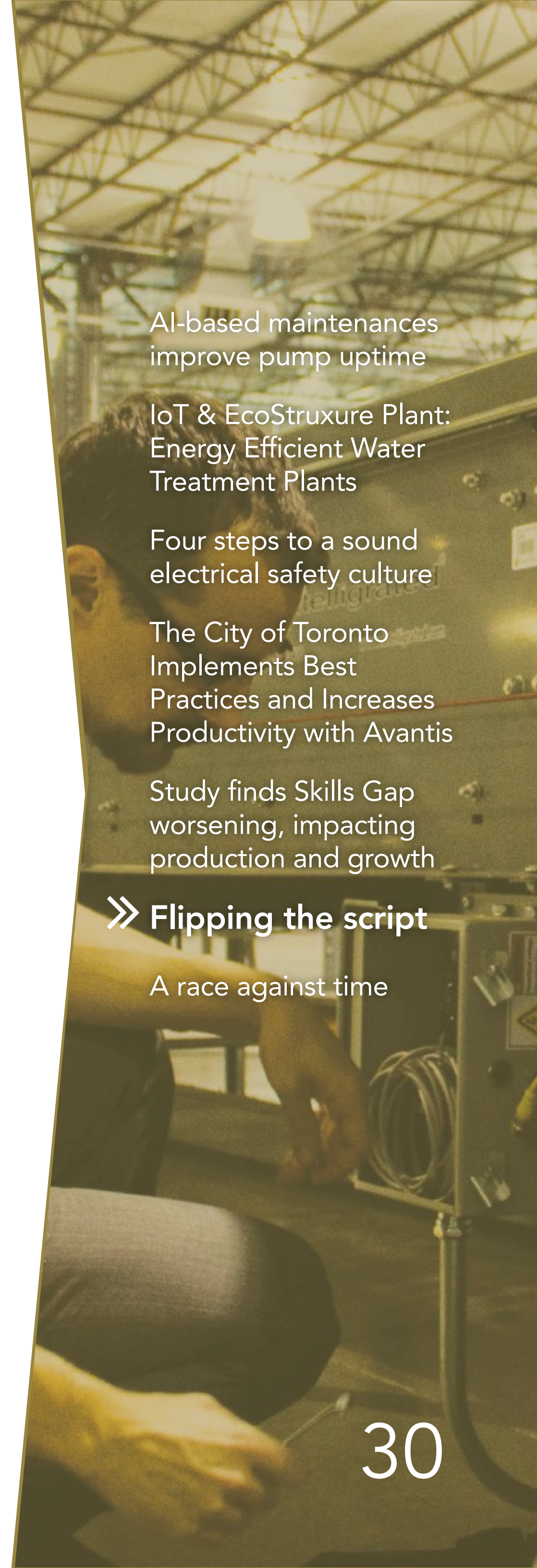

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Image courtesy: Katie Spain, CFE Media

Assets must keep running, even the machinery that may be past its prime and needing frequent repairs. With minimal resources and numerous demands for their time, maintenance teams must develop and follow a strategy. Today's shortage of highly skilled technicians also places a strain on operations. Work smarter, not harder, is the refrain many managers sing. Reactive maintenance is no longer acceptable. Fixing breaks, one emergency after another, is an inefficient use of resources. It frustrates personnel, managers and customers.

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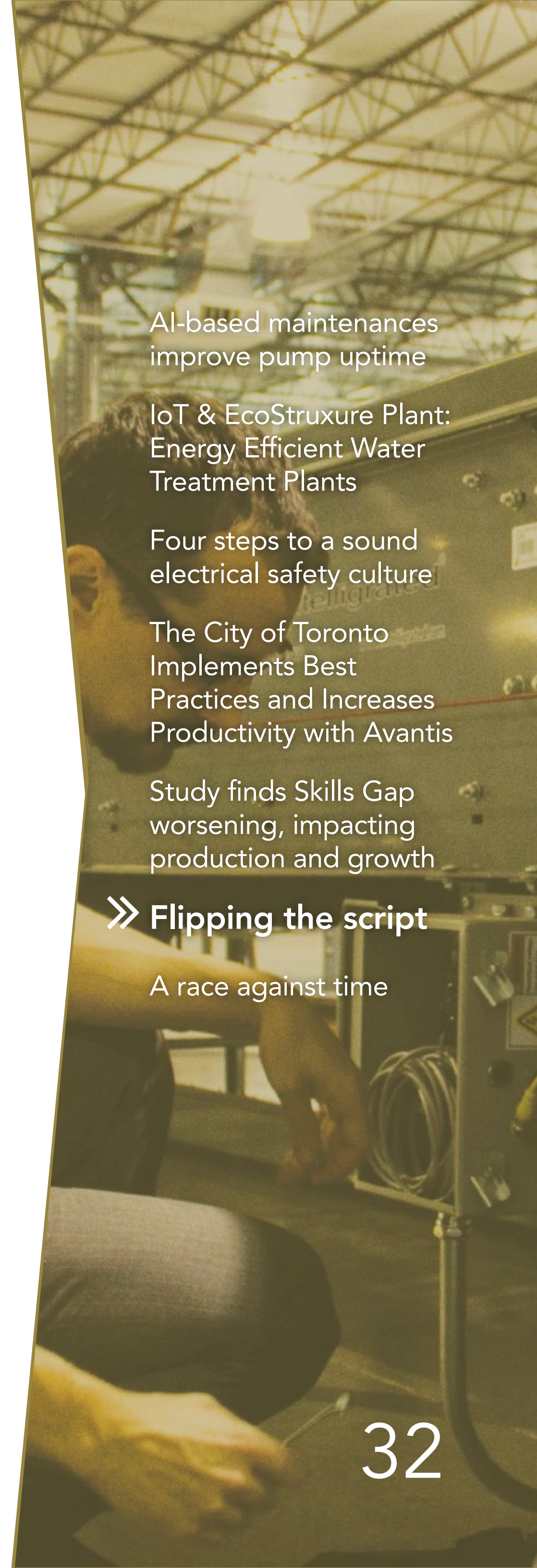
First, change the mindset

Achieving prescriptive maintenance, at the top of the asset maintenance maturity model, requires an evolution of processes and technology. But the change in thinking must come first. The new mindset must be the foundation for the journey, and like most changes in the company culture, this one must come from the top of the organization. Only the top executives can establish priorities for use of resources and establish that assets have intrinsic value which must be protected.

Whether it is a robotic arm that performs welding, an autonomous forklift that follows a track in the warehouse floor, programmable packaging equipment, or overhead doors on the shipping bays, each asset represents a cog in the overall enterprise. Some, like power generation, are mission-critical and cannot be allowed to fail.

Others may be less essential, but still play a role in operations or customer engagement. Size is not the driver influencing value, neither is the cost to replace the asset. One innocuous-looking, $2 belt on the conveyer system can halt all packaging, keeping a customized order from shipping on-time and jeopardizing a pending million-dollar deal.

Wellness focus: It is easy for manufacturing plants to fall into the habit of pushing machinery to its limits, reacting to failures and treating symptoms. A more holistic approach with an emphasis on prescribed maintenance and preventive care is an entirely different approach, requiring a long-term view, rather than focusing on than the next emergency to be addressed. One way to transition to this new thinking is by deploying prescriptive maintenance in one department first as a proof of concept. This allows the



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team to gather success data and help make the case that preventive care is more cost effective.

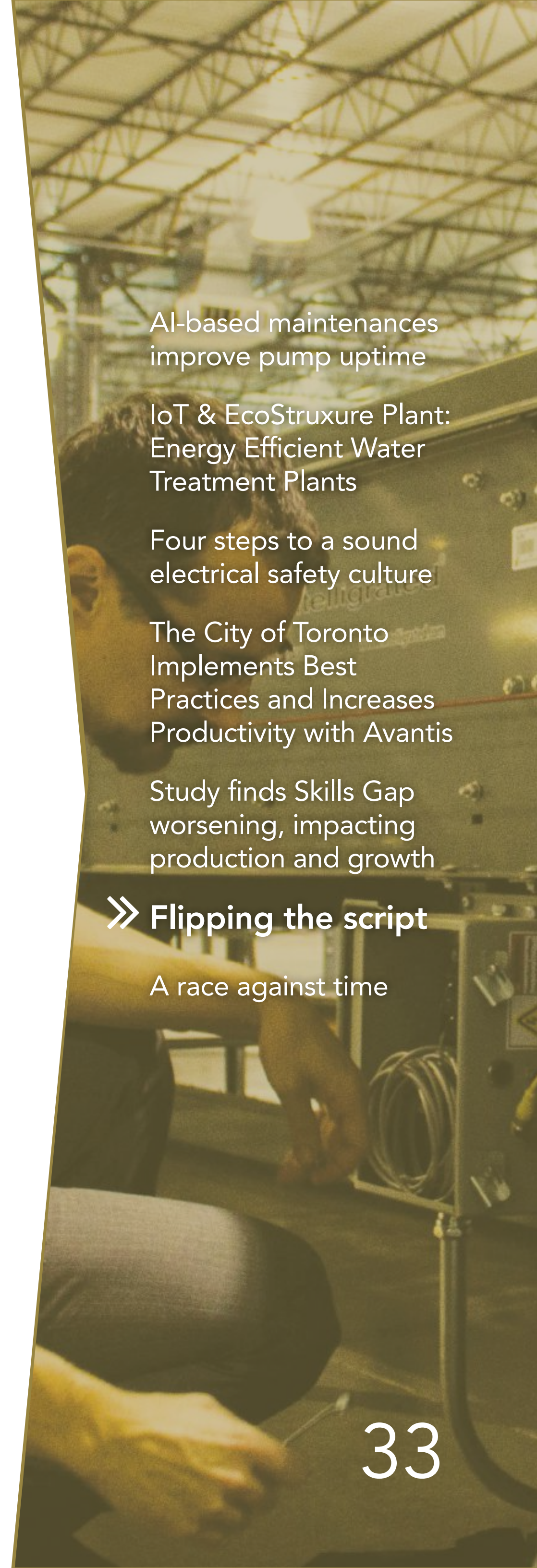
Risk assessment: A comprehensive risk assessment helps to change attitudes. An assessment, which can be done by a third party or internally, takes into consideration multiple attributes and helps prioritize assets, based on data and facts, not emotional anecdotes from users. Scores are based typically on the impact the asset or component has on fulfilling customer orders on time, user safety, satisfaction of customers, environmental impact, compliance with federal and state mandates, maintaining profit margins and keeping the plant open and operational.

Condition assessment: Assessing current conditions is like performing a wellness checkup on the assets in the plant. Initial assessments can require substantial resources, but after the first round of evaluations are completed, updating the status on a regular basis becomes much easier and well worth the time. Condition assessments are fact-based, using standardized definitions and objective and consistent standards.

How technology can help

Modern enterprise asset management (EAM) solutions help plant engineers and maintenance teams step up their processes and make effective asset management part of the overall enterprise strategy. Here are seven ways modern solutions help plant management:

1. Reliability. Reliable plant operations can become a differentiator. Customers will notice that orders are always on-time, as ordered and with unwavering product quality. These are unusual characteristics in some industries.



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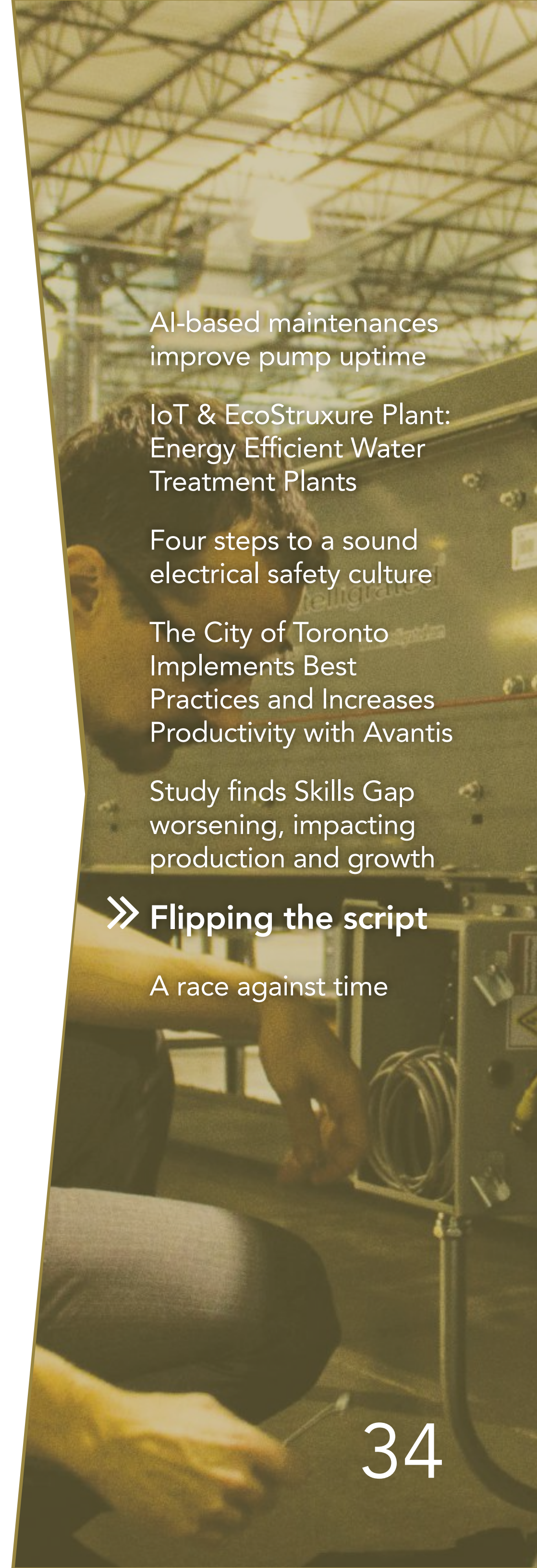
2. Streamlining routine. Technology helps streamline and automate basic tasks, such as scheduling routine inspections and maintenance, tracking parts and materials used so inventory is accurate, and monitoring use of consumables (ink) and replaceable (filters), and parts subject to wear (belts and brake pads). When the basics are covered easily, personnel have time to focus on more advanced questions such as diving into analytics.

3. Planning cashflow. Using risk assessments and condition assessments, managers will be able to project future needs and calculate related costs, including replacement parts or any outside special services or contractors that may be needed. With data easily accessible, managers can evaluate replace versus repair decisions and factor in the cost of downtime.

4. Predicting the future. Today, innovative business intelligence solutions with artificial intelligence contain powerful predictive capabilities, using algorithms and data science to identify patterns in data points and project next likely outcomes. Users can explore "what if" scenarios and obtain forecasts of likely costs and likely demands.

5. Prioritizing investments. This glimpse of future investment needs can be juxtaposed against projected cash cycles also taking into account forecasts for shifting demand. Managers can then prioritize major capital investments when funding and political backing is in place. Plans for stopgap, bare-minimum fixes may be needed when funds are limited.



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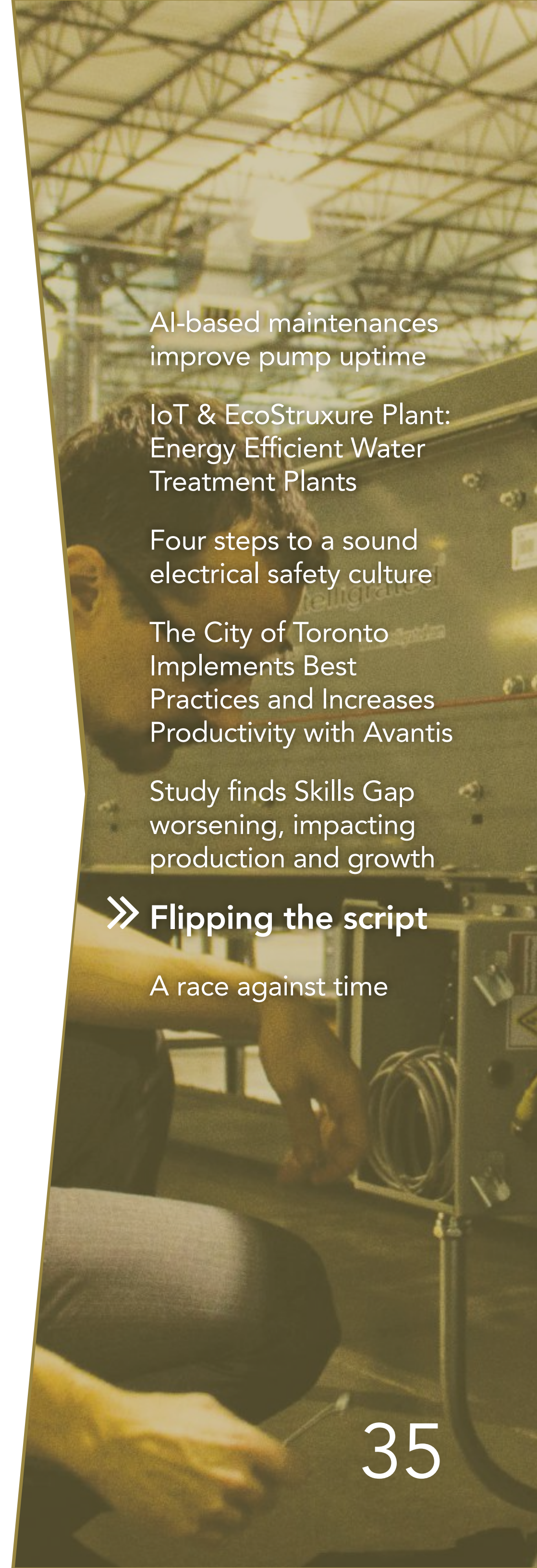
6. Providing early warnings. Managers will be able to use predictive analytics to identify some potential critical issues early so that adequate preparations can be made, including having necessary parts or backup equipment on standby. For example, when a generator nears end-of-life expectancy, back up replacements should be on hand for a seamless switch-over.

7. Meeting compliance. Managers should be alert to such issues as: ADA accessibility, building code compliance, OSHA or EPA mandates, or workforce or public safety issues. Non-compliance can be costly. It also can jeopardize safety or hurt brand equity.

Plant engineering and plant maintenance teams face many pressures today. Some are operational and involve keeping assets running. Others have more to do with cashflow strategies and decisions about whether to repair versus replace or upgrade. A new mindset helps companies change the focus from reactive to prescriptive. Technology also helps managers make well-informed decisions. With advanced solutions in place, managers can take a holistic approach to plant maintenance and a long-term view of managing assets.

***Kevin Price** is a product evangelist for EAM solutions for Infor.*



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Maintenance is valued, but aging equipment puts pressure on plants.

Maintenance systems and strategies continue to slowly transition to a digital process, with greater use of technology to evaluate machine health and develop repair and maintenance schedules.

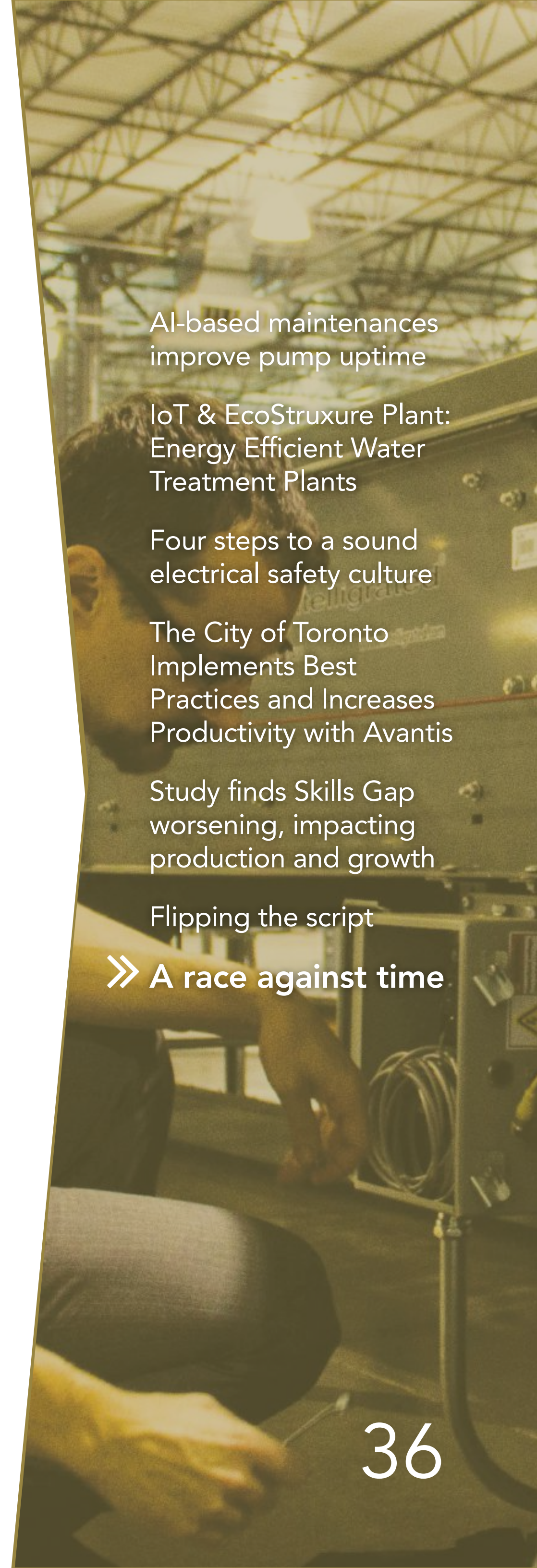
But it's a race against time. Aging equipment is the single biggest factor in unscheduled downtime, and equipment failure is a close second.

Those are the conclusions of the 2019 Plant Engineering Maintenance Report, an annual survey sponsored by Advanced Technology Services (ATS). Maintenance professionals in process, discrete and hybrid industries responded to the survey and offered their views on where their operations are today—and where they are headed.

Maintenance managers and plant leaders use a variety of strategies on the plant floor to maintain a safe and productive operation. While preventive maintenance remains the most often-employed strategy (78% of respondents utilize it in some way), the use of a computerized maintenance management system (CMMS) jumped into second place among the strategies, supplanting both reactive (run to failure) maintenance and predictive maintenance. Some combination of these maintenance strategies is used by at least 40% of respondents.

Each strategy has its own merits:

- **Preventive maintenance** is seen as decreasing downtime, improving safety and energy management, and in being a more flexible strategy,



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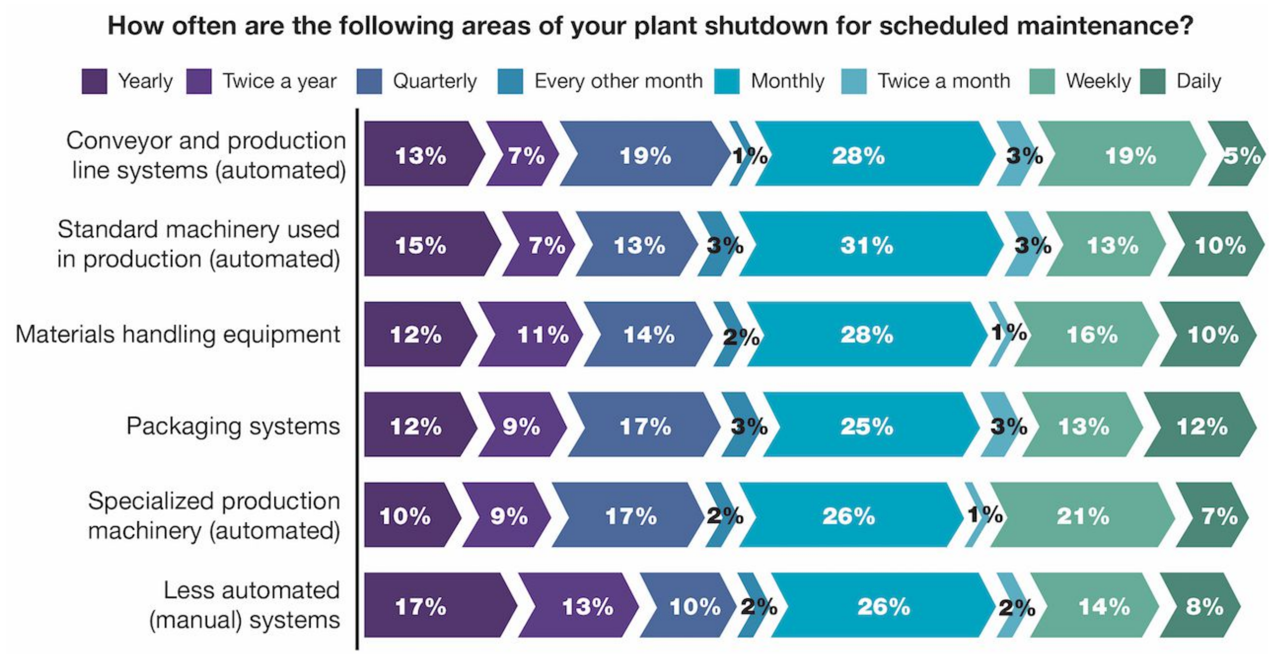

All graphs courtesy: CFE Media, ATS

- **Reactive maintenance** is seen as cost-effective and easy-to-use

- **Predictive maintenance** has a lower initial cost

- A **CMMS** reduces the probability of failure while decreasing downtime and improving overall equipment effectiveness.

Even as technology plays a greater role in maintenance in particular and manufacturing in general, there are still many barriers to adoption. The survey found that 48% of maintenance managers say a lack of resources or staff keeps them from improving their maintenance success, and 38% cite a lack of understanding of new technology options. Other issues, including training, employee buy-in, maintenance funding and a lack of

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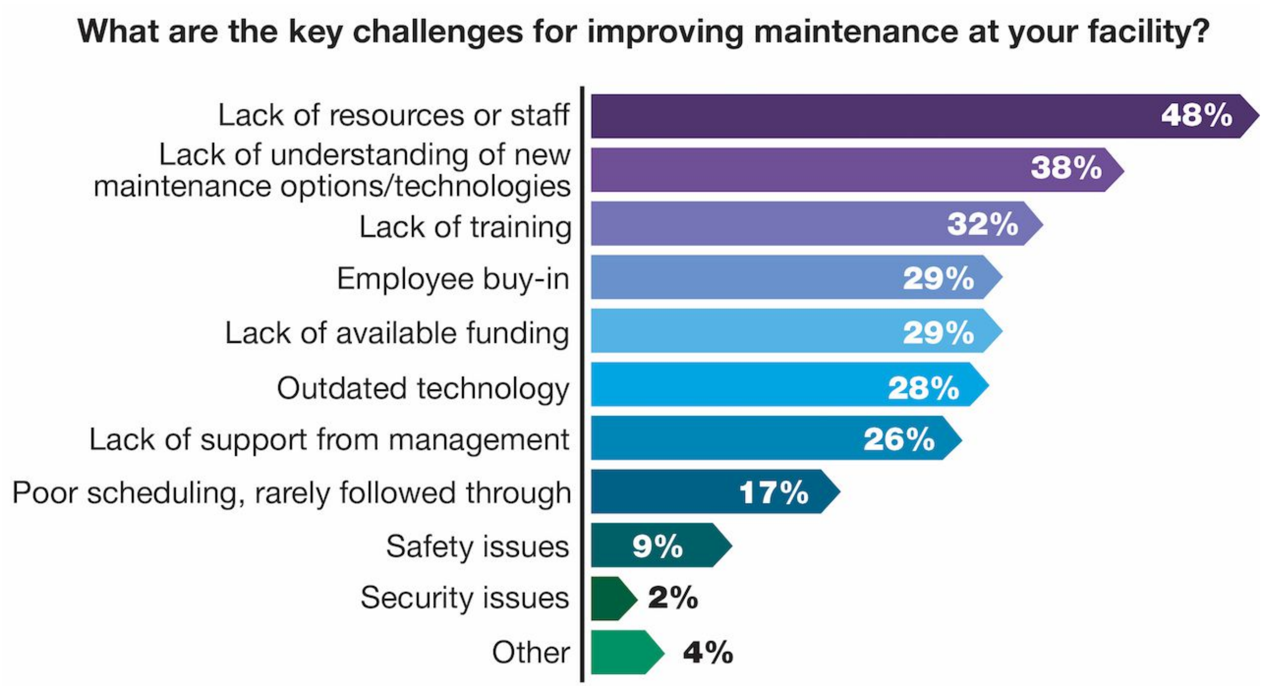
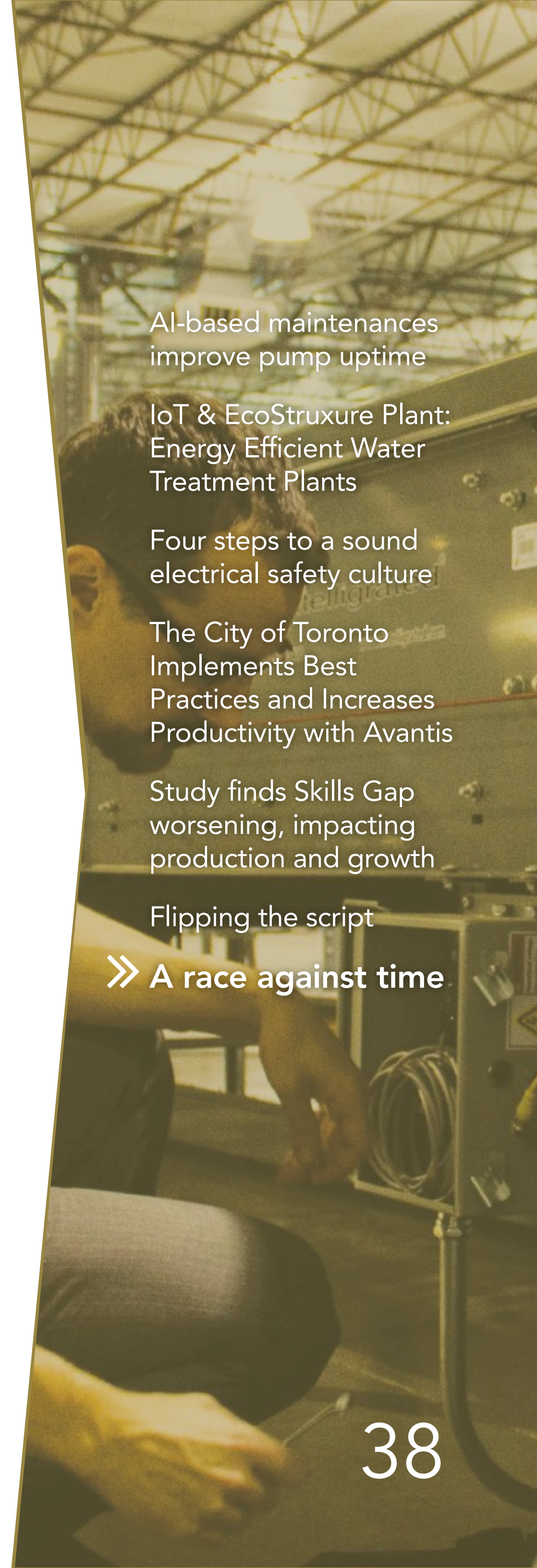


support by management were cited by at least 25% of respondents.

“Despite a favorable economy, many manufacturers continue to defer investments in new factory equipment,” said Jeff Owens, CEO of ATS. “Extending the useful life of legacy assets is causing maintenance to play an increasingly critical role in production efficiency, but it’s also having an impact on technology integrators who are tasked with upgrading machinery for the digital era.

“All of this speaks to the need for trained individuals who have the skills and understanding to sustain or increase efficiency at every stage in the equipment lifecycle,” Owens added.



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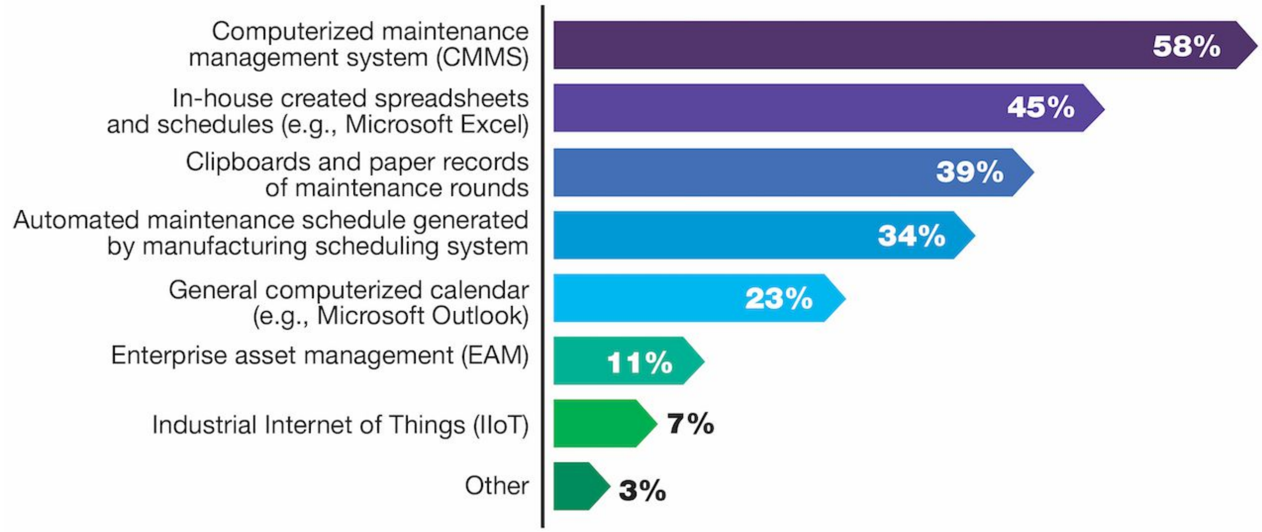
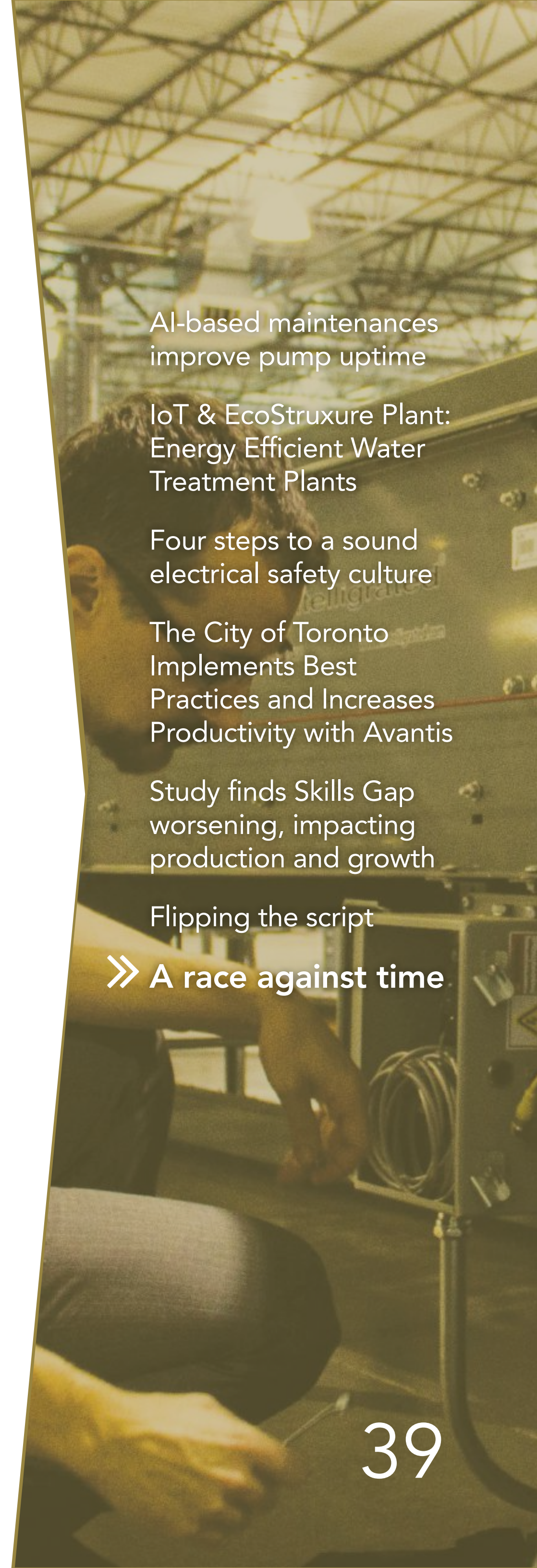
What technologies are used to monitor or manage maintenance within your plant?



Another significant trend is the outsourcing of maintenance to third-party providers. On average, about 20% of maintenance functions are outsourced, with a lack of existing staff skills cited as the primary reason to outsource these functions. That issue has continued to increase over the past three years of the Maintenance Study: it accounted for more than 40% of responses in 2017 but rose to more than 50% in 2019.

"We continue to see a bright future for technicians, reliability engineers, programmers, and system integrators, especially those who understand the technologies and power systems that are common in manufacturing," said Owens. "The industrial skills gap and the never-ending evolution in digital technology are creating huge opportunities for young, growth-minded workers to see the advancements a career in manufacturing offers."



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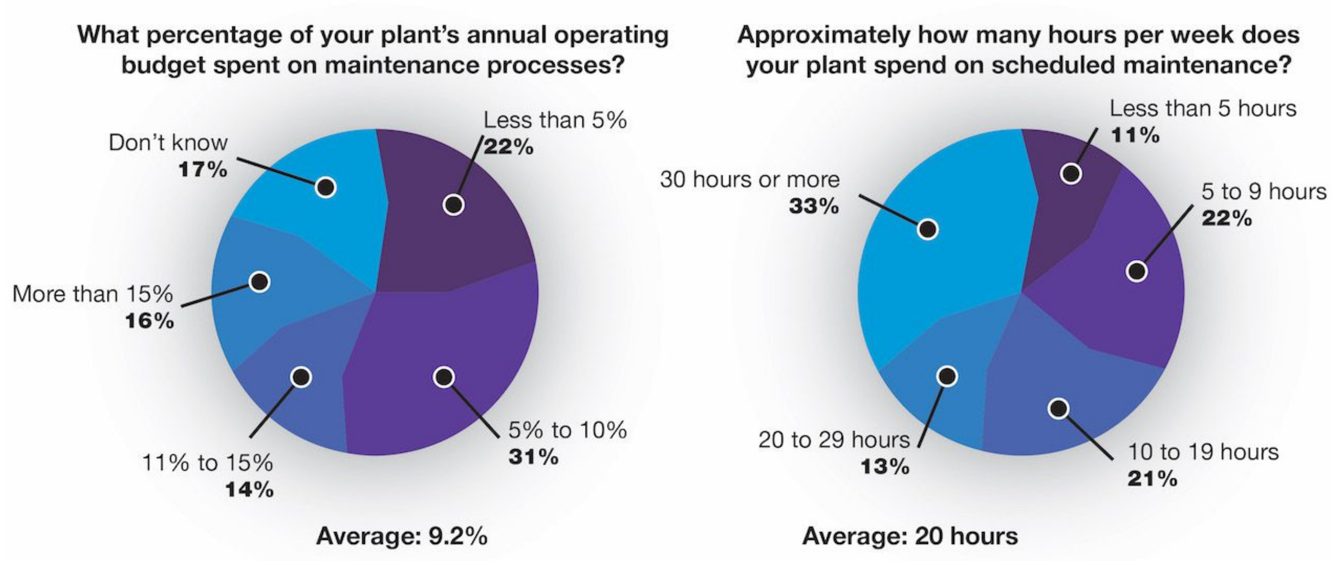

The technology employed in maintenance is varied—and may not even be all that technical. While CMMS and in-house designed spreadsheets and schedules are the two most often used systems, paper and clipboards are still employed in 39% of respondents' plants. The use of the in-house technology did drop over the past year, from 55% in 2018 to 45% in 2019.

Among the other results from the 2019 Maintenance Study:

- **Scheduled maintenance:** The average facility spends 20 hours each week on scheduled maintenance, with 53% allocating up to 10% of their annual operating costs to maintenance processes and 30% devoting more than 10% of this budget on maintenance.

- **Attention to systems:** Rotating equipment (motors, power transmission, etc.), fluid

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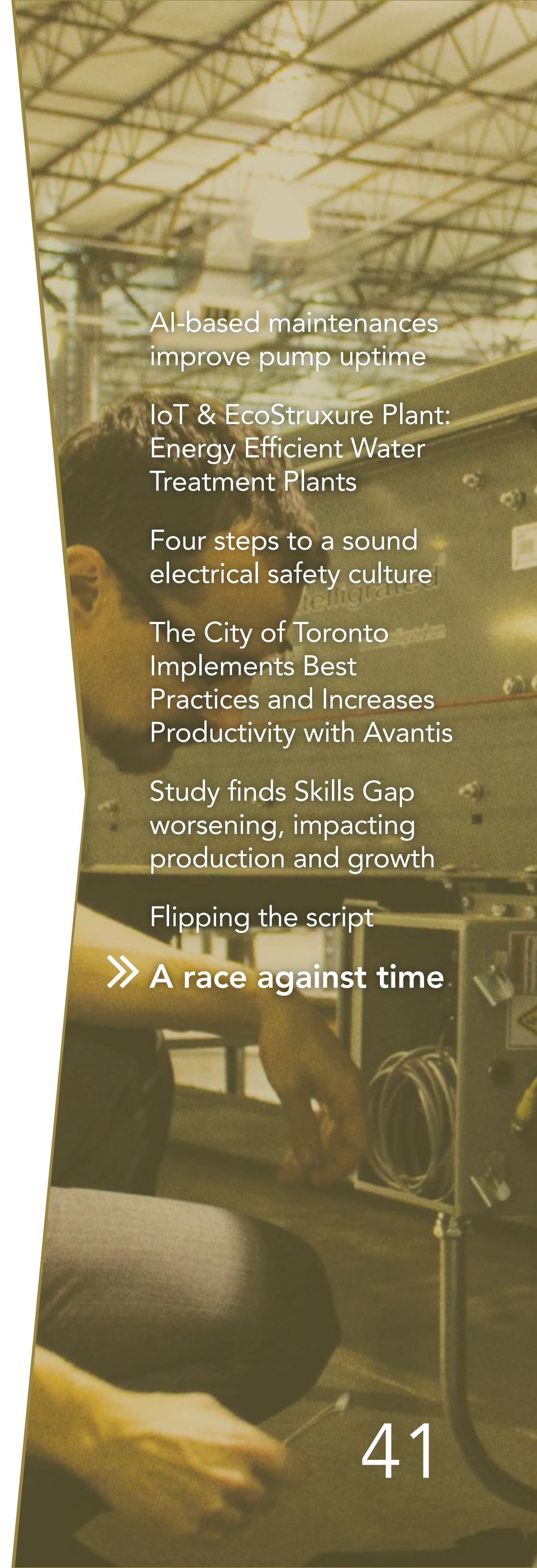
power systems (air, hydraulic, etc.) and plant automation systems are the three areas where facilities dedicate the most maintenance support, followed by internal electrical distribution systems and material handling equipment.

- **Training:** Maintenance teams are mostly trained on basic mechanical (73%) and electrical skills (72%), as well as safety (72%). Other types of training include lubrication and motors (55%), gearboxes and bearings (52%).

Whether maintenance is seen as a cost center (59% said spending keeps equipment running even while managing costs) or a profit center (34% said maintenance delivers greater capacity to the plant), it remains crucial to plant uptime, productivity and operational excellence.

Bob Vavra is the former content manager for Plant Engineering *and Amanda Pelliccione is the Director of Research for CFE Media.*



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We would love to hear from you!