

MAINTENANCE

WINTER EDITION





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How manufacturers utilize asset management and AI tools for better results

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Asset management is a critical aspect for manufacturers and it helps turn data into actionable information that can change operations.



Left to right: Chris Barnes, senior manager, AI & IoT – maintenance & reliability, Kalypso, a Rockwell Automation business, Los Angeles; Brian Fortney, global capability manager, asset optimization services, Rockwell Automation, Cleveland; Pratibha Pillalamarri, former senior product marketing manager, Aspen Technology, Houston. Courtesy: Kalypso, Rockwell Automation, Aspen Technology



Question: What's the current trend in asset management for industrial and manufacturing facilities?

Pratibha Pillalamarri: An important trend in asset management for industrial and manufacturing facilities is the integration of advanced technologies. Embracing industrial artificial intelligence (AI) and machine learning (ML) strategies has emerged as an important component for optimizing asset performance. This shift reflects a broader recognition among companies and our customers that operational efficiency is intrinsically tied to asset management efficacy.

Central to this framework is the imperative of proactive monitoring of process health and performance. Leveraging the abundance of data available, predictive analytics and AI algorithms provide real-time insights, enabling preemptive actions to avoid potential disruptions. This departure from traditional reactive approaches signifies a strategic shift towards proactive maintenance strategies.

Additionally, there is a growing focus on sustainability, emphasizing environmentally-friendly operational practices to enhance resource efficiency and environmental stewardship.

The combination of these trends signals a new era of efficiency and cost-effectiveness in asset management. By prioritizing continuous operations, reducing downtime and adopting sustainable practices, organizations can achieve significant improvements in productivity and cost savings.



Question: What future trends should engineers, plant managers and designers expect for asset management? (Looking ahead one to two years.)

Chris Barnes: Three megatrends are shaping the future of asset management in the near- to medium-term.

The first is technological and tends to get the most hype – and that’s the accelerating accessibility of consumer-grade AI. Asset management is ripe for AI adoption thanks to the investments made over the past decade-plus equipping assets with sensors connected to the Internet of Things (IoT). With the vast and diverse datasets available from IoT-connected assets, we expect to see routine asset management tasks shift to autonomous workflows performed by AI.

The second megatrend is an increasingly hybrid workforce – both in terms of skills and work environments. AI support tools and IoT-connected sensors enable hybrid operating models for asset management teams that bring together local and remote experts, both equipped with real-time digital asset monitoring and proactive alerting. Making effective use of these tools requires a hybrid of digital and mechanical skills, driving a competitive landscape for hiring the right skills mix to match future ways of working. In fact, 94% of manufacturers expect to maintain or grow their workforce to keep up with AI adoption, according to Rockwell Automation’s 2024 State of Smart Manufacturing report.

The third megatrend is a focus on decarbonization and sustainable outcomes. As organizations prioritize sustainability goals and regulatory requirements become more



stringent, asset management teams must integrate environmental considerations into their asset management practices. This includes optimizing energy usage, reducing carbon emissions and extending the lifespan of assets through proactive maintenance and eco-friendly upgrades. Investments in renewable energy sources, energy-efficient technologies and circular economy principles will become central to asset management strategies, driving innovation and reshaping industry standards.

Brian Fortney: The biggest trend should be the increasing integration and the work into the ecosystem of tools. This will drive new thinking about storerooms/spares supply and even workforce training. Increased visibility to lifecycle also will drive new approaches to obsolescence risk.

Pratibha Pillalamarri: A growing emphasis on sustainability is reshaping operations and highlighting the interconnectedness of design decisions with operations and maintenance. Looking ahead, sustainable practices will intertwine more deeply with operational frameworks, requiring alignment between design intent and operational realities.

Moreover, there is a surge in the adoption of IoT and predictive analytics for real-time monitoring, alongside the rise of digital twins and cloud-based solutions for improved asset optimization. AI and ML will be adopted to enable more data-driven decision-making, as resilience and risk management become more important. By embracing these trends, stakeholders can navigate the changing landscape with agility, promoting efficiency, sustainability and resilience.



Question: Describe the successes from using programs and systems that incorporate asset management. This may include Internet of Things-based systems, Industry 4.0, etc.

Pratibha Pillalamarri: YPF's implementation of Aspen Mtell has led to substantial successes in asset management. Initially monitoring 11 critical pieces of equipment across three refineries, the program expanded to oversee 49 assets, including pumps, compressors, heat exchangers and reactors. Leveraging advanced machine learning capabilities, Aspen Mtell tracked 3,000 sensor tags, facilitating proactive detection of equipment abnormalities.

For example, it identified issues in a vital compressor six months before traditional methods would have, saving almost five days of production. Additionally, the solution detected increased temperatures in the hydrocracking unit, enabling timely maintenance to prevent potential damage and production loss. This success prompted a cultural shift towards proactive maintenance and efficient work prioritization within YPF.

YPF focuses on safeguarding additional assets, optimizing energy efficiency and addressing issues related to fouling and corrosion. In a significant step towards sustainability, YPF introduced agents to monitor emissions from one refinery, with plans to expand this monitoring to all 26 discharge sources. This dedication to sustainability showcases YPF's proactive stance towards environmental responsibility and drives innovation in Argentina's oil and gas industry.



Question: What tips would you offer to someone newly tasked with asset management duties?

Brian Fortney: The best advice for someone newly tasked with asset management responsibility would be to get your “blinders” off as quickly as possible and create visualizations to answer: What do you have? What do you need? Where is your risk? Think of it like a map where you have to identify current state to know the distance of your journey to desired state. Once you have these visualizations, identify your strategy to get to desired state, leveraging the information at your fingertips to support investment and action.

Question: How has the integration of artificial intelligence (AI) and machine learning (ML) impacted traditional asset management strategies?

Chris Barnes: AI and ML serve to augment the fundamentals, allowing asset management teams to monitor more assets, improve planning and execution accuracy and make more strategic decisions based on data.

There are three types of problems where AI/ML can be applied:

- 1. Known problems with known solutions** – AI agents pre-trained on asset management principles serve as a force-multiplier for human experts. By monitoring a very large number of assets to detect and prioritize known problems, human experts are freed up to focus on only the most pressing issues.
- 2. Known problems needing customized solutions** – ML can help tailor existing asset management strategies using both real-time operational inputs and sta-



tistical analysis learned over large historical datasets from in-field assets. By accounting for operational disturbances and learned failure patterns, AI agents can advise improvements to current strategies.

3. Complex problems with to-be-discovered solutions – Specific ML techniques like deep reinforcement learning can identify asset management strategies that yield optimal system-wide results. These techniques accelerate data-driven workflows like root cause analysis, leveraging large and diverse datasets of operational inputs and human decision-making, to recommend strategies that would take human operators years of analysis to achieve.

Pratibha Pillalamarri: The integration of AI and ML has transformed traditional asset management strategies, bringing in a new era of efficiency and effectiveness. Traditional practices involved a combination of reactive maintenance practices, often treating equipment and processes in isolation. However, with the emergence of AI and ML technologies, customers are realizing the interconnectedness of equipment and processes.

Advanced technologies enable customers to optimize processes by identifying optimal operating windows, leveraging both process and maintenance data. By analyzing vast amounts of data, AI and ML can predict equipment and process issues ahead of time, providing prescriptive guidance on how to address them, including adjustments to operating regimes. This predictive and prescriptive approach shifts asset management from reactive to proactive, leading to improved reliability, efficiency, and cost-effectiveness.

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Question: How do you see the role of human expertise evolving in conjunction with the increasing use of AI in asset management?

Chris Barnes: The role of human expertise will evolve and elevate rather than diminish. AI excels at automating routine analytical workflows and producing insights from data, allowing human workers to shift from manual data-crunching tasks to strategic decision-making, planning, and action. Ultimately, AI makes many asset management workflows more accessible to equipment operators by streamlining the data-analysis tasks.

For example, AI can automate asset performance monitoring and downtime tracking to help



pinpoint bad actors, equipping operators of that equipment with the insights needed to design and execute value-adding continuous improvement initiatives.

Pratibha Pillalamarri: While AI excels at analyzing vast amounts of data and identifying patterns, human expertise remains crucial for interpreting insights, making strategic decisions, and implementing these solutions.

One evolving aspect of human expertise is the ability to understand and interpret AI-generated insights. Experts bring contextual understanding and domain knowledge to validate recommendations, assess their relevance to operational contexts and identify potential limitations or biases in data or algorithms. Additionally, they help oversee their implementation and refine AI models through feedback that enhances accuracy and relevance. Insights can then be translated into actionable strategies aligned with organizational objectives. While AI can identify issues and recommend solutions, experts evaluate feasibility, consider broader organizational goals and constraints, and ensure successful implementation.

The expanding role of AI complements human expertise, driving informed decisions, optimizing asset performance, and ensuring operational excellence.

Plant Engineering



Complete care of your safety applications



Heat transport network in good hands

Regular maintenance of your safety loops ensures increased safety and availability of your processes.

Challenge for the customer

The challenge of VWS Pipeline-Control is to ensure continuous and sufficient hot water supply delivered in a safe manner to the hospital, offices and houses in Rotterdam area via safe and healthy pipeline.

For VWS Pipeline-Control safety is a paramount. With hundreds of kilometers of pipeline in The Netherlands, gas or liquids are transported in both urban and rural areas. Any changes to the product specifications or the capacity can damage the pipeline and potentially bring people at risk. Therefore it is of great importance to have an optimum maintenance plan. Its execution ensures the

safe operation of the pipeline so that any unsafe product/capacity changes can be detected and unsafe operation prevented.

Safety Instrumented Systems (SIS) are designed to prevent hazardous events to ensure human safety, prevent damage to facilities, and protect the environment.

Realization of proof test

To ensure a required Safety Integrity Level (SIL) of the safety loop is achieved, all the instruments in the safety loop need to be checked timely and with an appropriate assessment. The assessment differs per application requirement and is defined as either a full functional proof test or a partial proof test.

A full proof test returns the PFD Average back to/or close to the loop's original targeted PFDavg. Probability of Failure on Demand average (PFDavg) represents a probability that the system will fail and that its safety function will not succeed in bringing it back to safe operating mode.

VWS Pipeline-Control

Responsible for the maintenance of the installations of their client Warmtebedrijf Rotterdam.

Since 2014 VWS Pipeline-Control is responsible for the maintenance and the availability of the installations to transport hot water to the operators of district heating networks which distribute it to thousands of houses in Rotterdam area. With this hot water, the households can heat their houses as well as use it for the kitchen and the bathroom.

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A partial proof test brings the loop's PFDavg back to a percentage of the original PFDavg. PFDavg is in direct correlation with the SIL rating, therefore the quality of the functional proof tests and their frequency are ensuring that the required SIL is achieved and maintained (i.e SIL2).

Yearly Functional Proof testing of the SIS

Functional Proof tests were performed in 3 different locations where in total of 22 SIL loops were tested.



One inlet SIL loop consists of 2 pressure transmitters, PLC and a pump (1oo2 rating). The outlet SIL loop consists of 3 pressure transmitters, PLC and a pump (2oo3 rating) as presented in the picture.

This configuration is chosen to increase the process safety and production availability (compared to single channel systems) and to ensure that required SIL2 is achieved. The pressure transmitter used in this application is the Cerabar PMP51 with a SIL2 rating according to IEC 61508 and IEC 61511, therefore designed to fit in SIL2 applications.

Safety loop tests were performed during the planned annual maintenance shutdown. All the pressure transmitters were firstly calibrated to confirm that their working accuracy matches application requirements.



☑ The results

- Functional proof test performed by functional safety specialist according to the procedure in place
- Partial or full proof tests performed dependent on the application
- Redundancy tests performed for 1oo2 and 2oo3 rating configurations
- Work performed in a planned and timely manner
- Extensive and detailed reports readily available

The process was put in operation and full and/or partial proof tests were performed per SIL loop.

The unsafe conditions were then simulated in order to observe the response of the Safety Instrumented Function (SIF), i.e the pump stops working to prevent the unsafe operation within a given number of seconds. Subsequently the SIS is returned to its safe operating mode. Additionally, the redundancy tests were performed for all 1oo2 and 2oo3 ratings. Reports were created and results were discussed with VWS Pipeline-Control Maintenance team and DWG Automation.

☑ Benefits

- Increased safety and process availability of the safety instrumented systems are ensured with a maintenance plan in place and the performance of regular functional proof tests
- The city of Rotterdam is supplied with sufficient hot water!



'It was the first time that I had to work with Endress+Hauser as a subcontractor in relation to test the safety SIL loops. I had no idea or experience in testing these kind of instruments. So therefore I needed the knowledge and experience of specialists. The cooperation between companies was excellent. During the preparation of the SIL proof validation, we have exchanged several information and have had a few meetings to discuss the substantive and supplementary questions on both sides and explain the system and the instruments. Especially the knowledge, both on physical and electrical level, was great, whereby at the end the safety interlock circuit of a complete operational process installation was successfully Full Proof validated. For me it is only one of the yearly maintenance work I have to do, but I feel comfortable by doing this kind of work together with Endress+Hauser.'

Marc van den Heuvel
Installatiebeheerder Pipeline Control



Predictive or preventive maintenance: Which strategy is right for you?

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Learn to blend predictive and preventive maintenance practices to achieve the right business balance.

In today's high-tech manufacturing facilities, where precision and reliability reign supreme, maintenance emerges as a linchpin of operational success. It is the meticulous attention to detail, the strategic planning and the technical expertise of plant managers and engineers that ensure the seamless functioning of machinery and the uninterrupted flow of production.

Within this realm, two distinct yet complementary strategies — predictive and preventive maintenance — stand as indispensable methodologies, demanding both oversight and strategic allocation of resources.

Predictive maintenance, the mark of forward-thinking engineering, relies on a sophisticated blend of data analytics, sensor technology and machine learning algorithms to anticipate and preempt potential failures. Plant managers, in collaboration with maintenance engineers, orchestrate the deployment of sensor networks across critical equipment, capturing real-time data on performance metrics, such as temperature, vibration and fluid levels. This data serves as the essence of predictive maintenance, fueling predictive models that forecast impending issues with remarkable accuracy.

However, predictive maintenance alone cannot solve all a facility's operational problems. It requires a synergistic partnership with preventive maintenance to strengthen



Predictive or preventive maintenance: Which strategy is right for you?

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manufacturing operations. Plant managers and engineers collaborate to establish comprehensive maintenance schedules based on historical performance data, manufacturer recommendations and industry best practices. Leveraging their technical expertise, they design preventive maintenance protocols tailored to the unique requirements of each asset, encompassing tasks such as lubrication, alignment checks and component inspections.

Consider a high-speed conveyor system within an assembly plant. Plant managers, in consultation with maintenance engineers, meticulously craft preventive maintenance schedules, dictating the frequency of tasks such as belt tensioning, roller alignment



and motor lubrication. These routine maintenance activities, though seemingly mundane, play a pivotal role in safeguarding the reliability and efficiency of the production line. By adhering to preventive maintenance protocols, plant managers and engineers mitigate the risk of equipment failures, ensuring smooth operations and safeguarding the well-being of personnel.

It is the seamless integration of predictive and preventive maintenance strategies that unlocks the full potential of maintenance excellence in manufacturing plants. Plant managers and engineers navigate the intricate interplay between these methodologies, leveraging predictive information to inform preventive actions and fine-tuning maintenance schedules based on real-time performance data. This holistic approach not only minimizes downtime and maintenance costs but also fosters a culture of continuous improvement, where each maintenance activity serves as a catalyst for operational excellence.

Maintenance in manufacturing plants transcends the realm of routine tasks, emerging as a strategic imperative demanding the expertise and foresight of plant managers and engineers. Through the meticulous implementation of predictive and preventive maintenance strategies, these professionals uphold the operational integrity and resilience of manufacturing operations, navigating the complex terrain of technological advancements and operational challenges with precision and efficiency. It is their unwavering commitment to excellence that ensures the continued success and sustainability of manufacturing enterprises in an ever-evolving landscape.

Amara Rozgus

Amara Rozgus is the Editor-in-Chief.





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Benefits of unlocking AI-powered maintenance for manufacturers

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The rise of AI-powered CMMS presents an urgent opportunity for organizations to adopt fully digital solutions, but it needs reliable data capture of yesterday's actions to fully realize its potential.

According to a recent ABB report, outdated maintenance and reliability practices are a trillion-dollar problem for manufacturers, with unplanned downtime alone costing a staggering \$125,000 per hour. This financial burden underscores the critical need for AI-powered predictive maintenance solutions that can proactively address issues before they escalate. However, most maintenance teams face significant data-related challenges in implementing these advanced tools.

Root causes of maintenance data challenges

Traditional maintenance practices, ranging from pen and paper to emails, spreadsheets and whiteboards hinder efficiency and increase risk. Consider the Boeing incident earlier this year. The maintenance records were irretrievable, making it difficult to ascertain if the issue was preventable and conduct a root-cause analysis (RCA).

While many manufacturers have deployed legacy computerized maintenance management systems (CMMS), shop floor technicians struggle to adopt these systems as they often work offline and away from a desktop computer. Their inputs are captured using pen and paper, and are often added manually after tasks are completed, causing delays, data gaps and inaccuracies. This drives the perception CMMS solutions are cumbersome and not worth it.



However, some of the industrial software systems have neglected the needs of mobile, deskless workers, whose input is crucial for success. This results in systems defaulting backward into paper or manual-dependent processes with, at best, marginal computer-based guidance. This disconnect results in a lack of valuable maintenance and enterprise asset management (EAM) data, which rely on two-way data flow to optimize recommendations.

For example, such a system might have a record of all downtime events but not include machine conditions just before or in the weeks leading up to the downtime event, preventing condition-based maintenance analysis. The system might record all maintenance procedures for a specific repair but not include SKUs utilized and the resulting impact on inventory. There might be a record of the procedures for planned maintenance, but a lack of an audit trail of the instances and ways those procedures were adjusted and why.

The rise of AI-powered CMMS presents an urgent opportunity for organizations to adopt fully digital solutions and capture as much data as possible. AI-enabled, end-to-end CMMS promises to improve predictive maintenance today, but the accuracy of its predictions depend on reliable data capture of yesterday's actions to power AI training. If organizations applying the manual-based processes mentioned above don't recalibrate, they won't have the data foundation required to act on the AI innovations.

Today, even organizations behind on their digital strategy can leapfrog to mobile-first CMMS, turning cost centers into performance drivers. Many of those first to deploy CMMS built customized applications with in-house teams building them off of existing enterprise software solutions, such as enterprise resource planning (ERP) modules or SharePoint. These teams might have extensive maintenance data and metadata recorded, but in static formats where utilization can require engineering expertise or deploy-



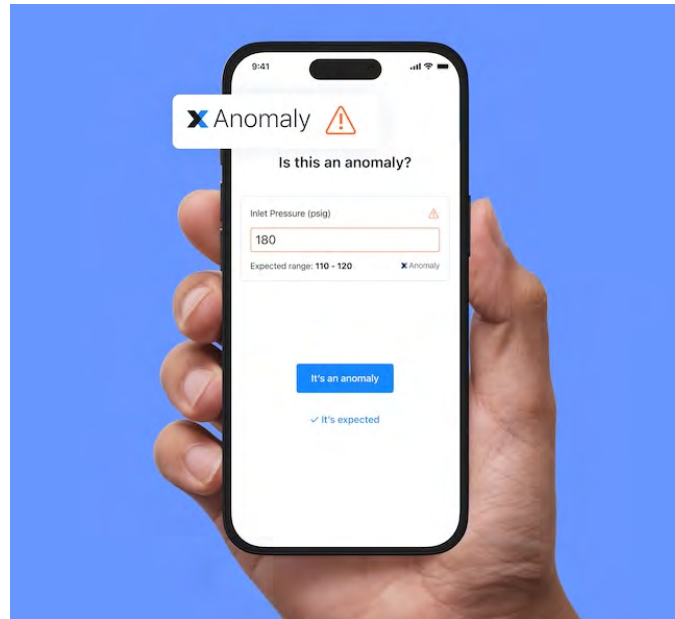
ment of a business intelligence solution to help visualize and activate the stored information. The in-house team also must continually update, patch and maintain the system.

Companies adopting CMMS today benefit from systems with built-in visualization, collaboration tools, pre-built integrations and access to expert support. There also is an opportunity to capture invaluable institutional knowledge before longtime team members head for retirement while also enriching their organization's training data for the future. A user-focused, technology-driven maintenance approach in this environment becomes more than an opportunity; it's a corporate and fiduciary duty.

CMMS isn't new. What is?

For those using CMMS, ask a simple question: Do you trust the quality of the data in your CMMS today? A negative answer likely indicates the field team lacks the tools or motivation to accurately capture data.

Frontline technicians are inundated with too many disconnected and unprioritized alerts, alarms, and work orders across multiple apps and documentation sources, with complicated interfaces and long load times. This leaves them with a simple choice: Do the work and move on to the next task, or spend 30 minutes figuring out how to record their work most accurately, thereby reducing wrench time.



Organizations behind on their digital strategy can leapfrog to mobile-first computerized maintenance management systems (CMMS), turning cost centers into performance drivers. Courtesy: MaintainX



Benefits of unlocking AI-powered maintenance for manufacturers

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This may sound hyperbolic, but it's a reality on shop floors around the world every day. The friction leads to a situation where most operational data remains unlogged, hindering its use for future organizational improvements.

Digital maintenance technology, especially AI-powered tools, offers the most value when they're designed with technicians in mind. If the software is user-friendly, helps them do their jobs better and fits naturally into their existing workflows, users are more likely to adopt it. Companies create a valuable foundation for AI models by consistently capturing data through this software. These models can then better learn ideal and non-ideal operating conditions and maintenance procedures and analyze the data to uncover risks that need to be addressed, as well as opportunities for streamlining operations and making improvements.

To build a solid foundation for AI training data, companies must focus on capturing comprehensive daily work execution and asset data. This includes logging every maintenance task, tracking equipment performance, inventory, time and procedures utilized in repair. They also need to record contextual environmental conditions for a site's most critical assets and processes.

When teams use a CMMS, every job, interaction and other maintenance touchpoint produces valuable data that can provide the groundwork to better understand maintenance cycles. While logging every work order might seem tedious, investing in streamlined data practices can yield significant savings in downtime, resource planning, anomaly detection, safety and more.

For example, building materials producer Titan America deployed CMMS to help establish a reliability-centered maintenance (RCM) program in its Florida plant and drive



measurable O&M savings. A key requirement was user experience. With an intuitive CMMS, its technicians could easily follow digitized inspection checklists from their mobile devices, enter work order data in real time, and escalate issues to supervisors via instant messaging within seconds. The solution brought new access and ease, which helped drive adoption and increase data capture. In less than a year, not only did the team eliminate over 30% of unplanned downtime, but they're also building a data foundation for AI-enabled predictive maintenance.

Businesses that don't capture data everyday results in a loss of potential efficiency and the opportunity to improve future AI and related use cases. Building AI models that understand a business's, plant's and team's maintenance needs is vital. The best digital maintenance solutions today enable the better solutions of tomorrow.

Capturing institutional knowledge quickly

AI is entering just as the industry faces massive workforce changes within maintenance teams. The U.S. Bureau of Labor Statistics projects 3.1 million jobs in maintenance and repair occupations will be added between 2021 and 2031 due to retirements and new growth requirements for maintenance. More urgently, the 2023 National Association of Manufacturers' (NAM) report, "The Skills Gap and Workforce Needs Survey," found 28% of manufacturers expect more than 25% of their workforce to retire within the next five years.

New generations integrating into the workforce come with a technological background and expectation they will be digitally enabled. There is little time to ensure they are personally trained across each procedure or piece of equipment by the folks about to retire.



In a recent Harris Poll survey of working Baby Boomers, 57% said they have shared half or less of the knowledge needed to perform their job responsibilities with those who will assume them. Senior technicians must impart decades of experience while doing their day job – to train both new employees and the AI solutions that will enable them and future teams.

A CMMS is a knowledge hub that enables all stakeholders to input and access critical data. It helps solve urgent near-term issues around onboarding for frontline professionals and knowledge capture before experienced technicians leave while creating a more trusted and complete data lake that powers AI training.

A comprehensive CMMS platform must excel at making work easier today and having its features offer scalability to meet business needs as they grow and change.

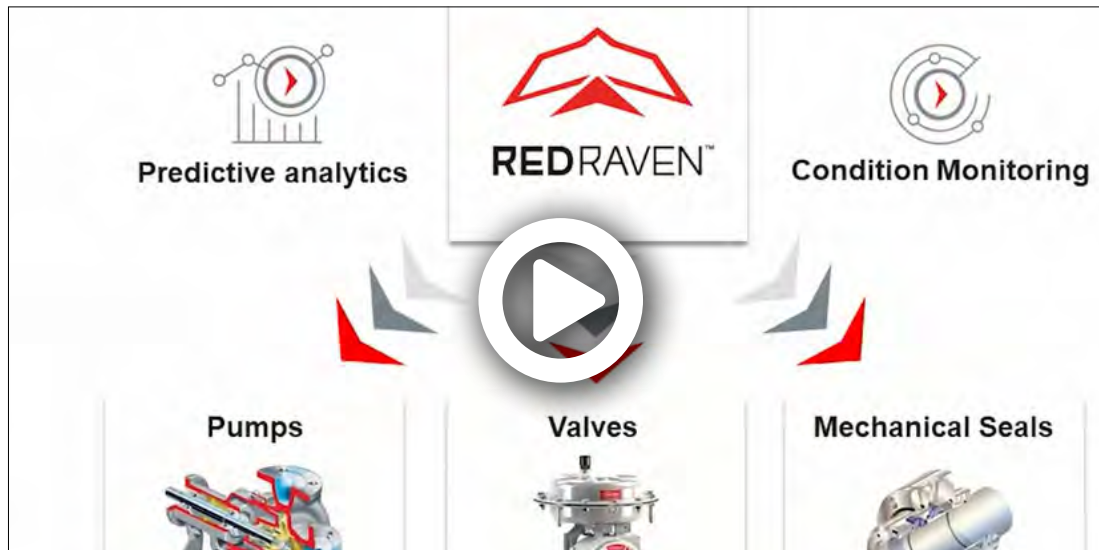
Future winners are being determined now

The challenges posed by legacy maintenance systems, coupled with the looming workforce changes and the rising expectations of stakeholders, underscore the urgency for a digital transformation. However, the potential of AI at this juncture means CMMS adoption is not just a solution to these immediate challenges; it's a strategic imperative for long-term growth and viability. The future of maintenance is being shaped today. Companies that embrace digital transformation and AI-powered solutions will not only survive but thrive in the evolving industrial landscape.

Nick Haase

Nick Haase is a MaintainX co-founder and he has built several companies over his career and actively advises early-stage companies on marketing and sales strategies.





What is RedRaven? – RedRaven from Flowserve

RedRaven is an IoT solution for industrial meant to change the way plants operate. By collecting data through condition monitoring, and analyzing that data with predictive analytics, RedRaven can improve your plant's operations and the health of all your assets.





Predictive maintenance improves UK water utility's operations

Anglian Water, one of the largest water utility providers in the UK, was facing increasing pressure to improve the reliability of their equipment and change their employees' mindset towards reliability-centered maintenance. To address these challenges, they decided to embrace digital transformation and implement a Condition-based Monitoring (CBM) pilot and, eventually, a broad program across their operational sites. Anglian Water was looking for innovation to help them be more efficient and proactive in predictive maintenance. Anglian Water measures their performance against 32 commitments, or Outcome Delivery Incentives (ODIs) — serviceability metrics, leakage, and pollution incidents (among many other operational aspects). They wanted to better understand the behavior of their rotating machinery, as any unplanned maintenance or breakdown resulting in loss of supply would affect the company's ODI score and could lead to potential fines.

RedRaven, Flowserve's predictive maintenance service, provided a solution for Anglian Water; they were very much impressed by following "end-to-end service" features:

- **Portal:** Simple and clear dashboard, but accurate and detailed

- **Flowserve Monitoring Center (FMC):** 24/7 support, with clear and concise explanations
- **Predictive Maintenance:** Integration of RedRaven monitoring and analytics contract with existing frame agreement between Anglian Water and Flowserve for pump repairs

RedRaven combines wireless sensors and an advanced visualization portal to help proactively identify and address issues before they cause downtime and disruptions. Wireless sensors collect vibration, temperature and pressure data from assets and make that data securely available on Flowserve's Insight Portal. With the Insight Portal, assets can be monitored from anywhere. The portal can be configured to provide immediate alert/alarm notification emails and/or PDF reports. The Flowserve RedRaven Monitoring Center is readily available to provide technical insights and recommendations to help operators make more informed decisions to improve plant efficiency, productivity, and reliability.

The Insight Portal can be configured to send email notifications to



any mobile device. In addition, Flowserve remotely monitors equipment performance and provides intelligent improvement opportunities, including access to a knowledgeable team of technicians, analysts, project managers and engineers for trend analysis. Flowserve's services offer remote monitoring, portal access and email alerts. The wireless sensors, installation supervision and cloud database and system maintenance are all included with the service.

Flowserve's IoT solutions follow a comprehensive and proven process to advance operators' existing capabilities and improve reliability. The solutions are scalable, so they'll grow with ongoing production needs. Their approach includes solutions for critical, key and balance-of-plant equipment, and it is in continuous evolution and expansion.

RedRaven's cloud-based wireless condition monitoring was demonstrated on some pumps at Anglian Water for a one-month trial, which showed its capabilities and range. After the trial, Anglian Water deployed the RedRaven solution on 11 more pumps at 4 sites, giving valuable information about the pumps. Anglian Water then further expanded the RedRaven deployment to include the CBM Framework, monitoring clean water & recycled water operations for up to 900 sites over a 5-year period. Insights gained through RedRaven are helping Anglian Water change their culture and thinking in how maintenance should work, saving the company time in man-hours and fines, and making them more efficient in how they work.

RedRaven gave Anglian Water timely notice when one of their pumps was not behaving as expected. During the second day of commissioning on the live system, Flowserve Monitoring Center (FMC) noticed high vibration values. The system integration



engineer went back on site to conduct additional analysis with a handheld vibration analyzer. Given the alert from the FMC, he chose to investigate further, even though the pumps were working properly at the time of inspection.

From an equipment standpoint, they appreciated the non-intrusive fitting of

RedRaven sensors and the range and quantity the gateway can handle. They liked how easy the dashboard was to use and how Flowserve overlaid their reports onto their SCADA details. Furthermore, the customer was happy that sensors can be installed during the operation of the pumps/motors. They were satisfied that the sensors were easily mounted in the proper places, as close as possible to the bearings, even though it was a real challenge to find spots on all pumps/motors. During commissioning, the Flowserve team faced a lot of additional technical challenges, but they solved them in a brief period that exceeded Anglian Water's expectations.

Innovative sensors

Wired and/or wireless sensors collect vibration, pressure and temperature data for analysis. Long-range wireless sensors enable cost-effective monitoring of thousands of assets over sprawling facilities.

Application-specific analysis

Equipment performance data is analyzed with technology designed specifically for pumps, valves and seals, so you can gain a clearer understanding of how to increase the efficiency, productivity and reliability of the particular equipment you use every day.



Flowserve's innovative sensors (wired and/or wireless) reliably and securely collect and transmit detailed performance data from equipment, even over long distances. They collect key equipment parameters such as vibrations, temperatures, pressures and more, allowing for more opportunities to evaluate assets and address equipment problems before they negatively impact operations. This encrypted data is transmitted to the cloud, where it can be accessed in an easy-to-interpret format from anywhere via the Insight portal. From data collection to analysis to reporting, the tools and insights to make it easy to monitor and respond to equipment performance issues.

Flowserve is unique in the industry, because they develop data analysis software and algorithms based on their unmatched fluid motion expertise. Unlike other offerings, their software and analytics are based on physics and engineered models to identify the most critical failure modes, diagnose equipment problems at a very early stage and recommend the next steps to fix them. Their dedicated team of specialists focused on monitoring and data analytics. When critical and noncritical assets deviate from standard performance threshold limits, Flowserve will alert the operator of a potential problem via the Insight Portal. Working together, they can help diagnose the issue and recommend necessary repairs.

When it comes to repairing and maintaining pumps, seals and valves, you need access to qualified engineers, technicians and parts — and you need it fast. Flowserve engineers and technicians who have experience servicing flow control equipment can not only help customers around the world solve equipment-related problems, but also identify ways to get the most out of their rotating equipment and reduce operating costs.



Predictive maintenance improves UK water utility's operations

With RedRaven, Anglian Water is changing its culture and thinking around maintenance, leading to a predictive maintenance approach with increased efficiency and reduced maintenance expenses. The solution has also enabled the company to save time and man-hours, making them more productive and effective. The end-to-end service provided by Flowserve, including the simple and clear dashboard, 24/7 support, and predictive maintenance integration, is already proving to be a valuable asset for Anglian Water. They appreciate the concise explanation of the analysis and the clear evidence provided. They were happy with the work done to ensure the successful completion of the installations and recommend RedRaven to operators who are looking for next-level system performance.

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How to enhance plant performance using controls

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How bridging the gap between building utility controls and process controls enhances plant performance.

A cohesive control system manages and optimizes interactions between machinery and utilities for efficient production. The lack of adequate coordination between the machinery and utilities can lead to interruptions or inefficiencies in a manufacturing system.

A unified control strategy can harmonize the communication between the traditionally segregated control systems in the plant to ensure that the disparate systems are running in an integrated fashion. The integration enables centralized communications and trend logging capability across seemingly independent systems that, in fact, are interdependent for optimal plant operations.

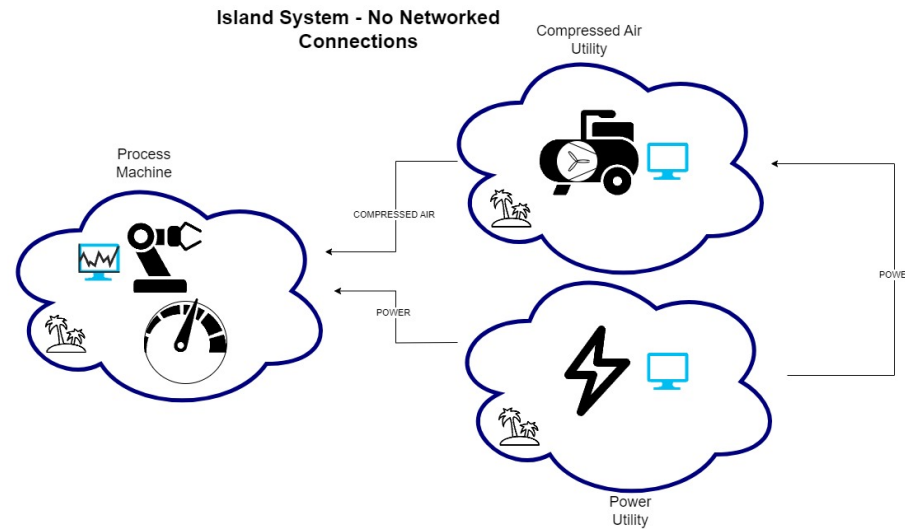
Planning control strategies

The primary barrier to an integrated architecture is not one of a technical nature but rather a lack of upfront planning. To facilitate the communication between the building utilities control and process automation control systems, a well-thought-out plan is essential.

This plan involves a carefully strategized and integrated operational technology (OT) network, supervisory control and data acquisition (SCADA) system and IT system. Additionally, it provides a roadmap for vetting original equipment manufacturer (OEM) machines that would enable control and data to be centralized in a redundant and high-availability system.



Figure 1: Graphical representation of standalone equipment with no networked communications. Courtesy: Barry-Wehmiller Design Group



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A carefully thought-out and well-documented roadmap is the most critical step to having an integrated architecture. Without this, plant managers risk increasing the cost and complexity in integrating these two systems in the future. Human machine interfaces (HMI) and controls are usually localized at each machine and logging the data that exists on these standalone machines becomes more challenging. It is doubtful that maintenance staff manually pool this data together with the rest of the facility's devices in a central location. Even if they do so, the next question is whether it is in a manageable format for analytics and optimization.

Not having a clearly defined and communicated roadmap can lead to equipment purchases that cannot support cross-platform integration. Achieving this integration would require adding intermediate communication gateway devices or replacing the equipment all together. Both options are more expensive than initially procuring equipment that supports the upfront plan. Without a plan, it is likely that the network infrastructure is not easily expanded, has more security vulnerabilities and is more susceptible to network failures. Chances are that the equipment ordered will be from various vendors making maintenance and support more difficult.



It is crucial to take the time to develop a long-term OT network, SCADA and IT strategy. This is the most critical step to both building new sites and to deliberately upgrading existing sites. A vision and standards document must be in place for all and it must be driven to ensure all major players and contractors are aware of it.

Any equipment purchases or any project plan has to be validated to align with this long-term plan. Particularly in the beginning, effort will need to be placed on enforcing the plan. If in-house expertise is not present, it would be recommended to partner with trusted and proven outside consulting partners to create this plan. This document will set the foundation for an organized digital transformation, enabling the integration of the manufacturing process systems and the building utility system controls.

OT network control

The OT network is arguably the most important section of the upfront plan. The OT network will serve as the backbone of the whole process and enable communication between all systems. Once this has been thought out, it provides sites with the flexibility to establish reliable, secure and widespread communication paths to all areas and devices. A cohesive network plan ensures that all purchased and installed equipment follows a unified strategy. Unfortunately, many sites overlook having an organized OT network, yet it is the most critical component that enables a digital factory or Industry 4.0.

Not having a network plan in place can introduce many complications. Networks built without much foresight typically end up being flat networks. Expanding on a flat network or adding new equipment without proper planning can be dangerous. A single network issue can potentially disrupt the whole plant.



Security is nearly nonexistent on flat networks. If devices and machines are purchased without external network capabilities, there is no way to enable their communication path to a central SCADA system. Attempting this after the fact will be cost-prohibitive and might require purchasing from another OEM altogether.

With a robust network plan in place, all equipment, whether building utility or process, should possess the necessary network capability to integrate into the overall system. This ensures that all new equipment will not be constrained to its own communication island. The plan dictates how plants divide their areas using virtual networks with managed switches. This approach prevents any network issues affecting one area from impacting other areas within the plant. A well-designed communication backbone leaves manufacturing plants well-prepared for expansion and the addition of new equipment.

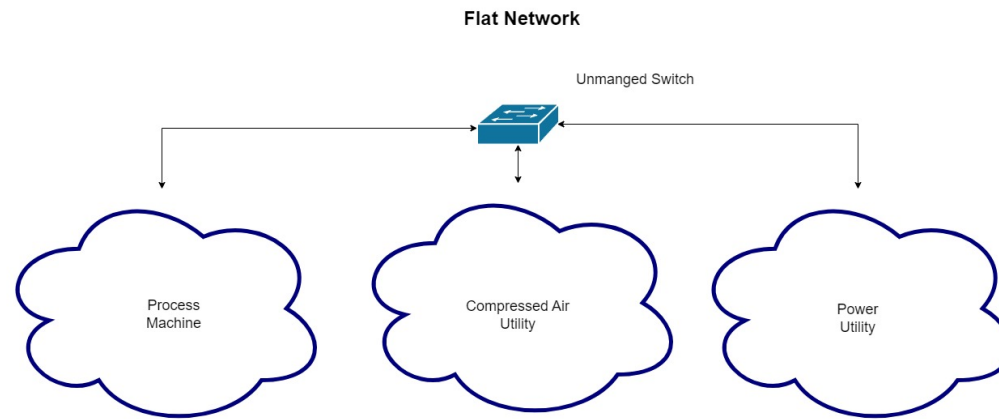


Figure 2: A graphical representation of a flat network. All devices on this network are susceptible to network issues. Courtesy: Barry-Wehmiller Design Group

Selecting a SCADA system

To pave a clear path forward, establishing a standard for the SCADA system is essential. The choice of a SCADA system involves weighing the pros and cons of each

option. When vetting OEM equipment, selecting an OEM system that seamlessly integrates with the existing SCADA system facilitates easier maintenance and upgrades by the controls team.

Other things to consider when selecting a SCADA platform:

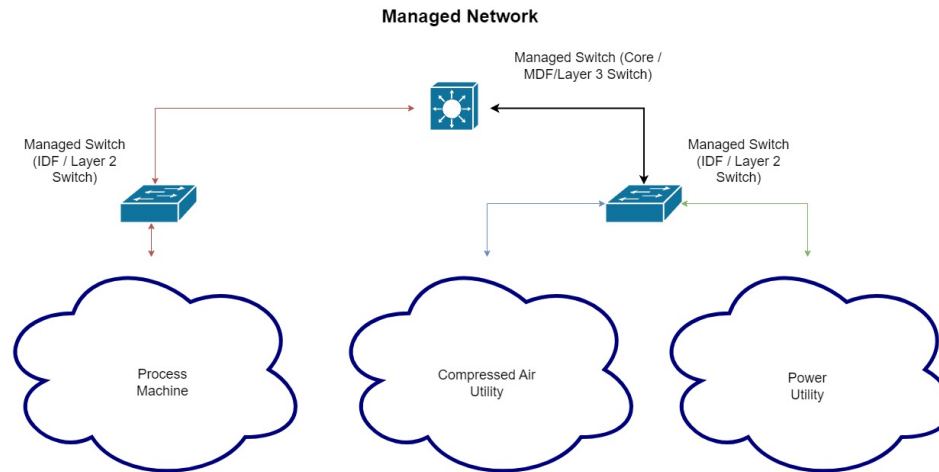
- Cost
- How well it integrates with third-party or other external software on the IT side (e.g., enterprise resource planning, or ERP).
- Internal maintenance capabilities.
- Scalability
- Third-party support.

The other problem typically seen with unplanned SCADA systems is that the SCADA system has one application that treats each system as completely separate applications. As a result, there is no visual interface to quickly and accurately pinpoint issues in large facilities.

During the early phases of selecting a SCADA system, it is crucial to understand which protocols it supports. Some common protocols include Modbus, OPC UA or BACnet. Additionally, one also needs to understand the industrywide support for these protocols among OEMs and their troubleshooting complexities in the SCADA selection process. This knowledge drives requirements when choosing OEM devices.



Figure 3: A basic graphical representation of a managed network. In the image, process machine cannot communicate with compressed air utility and power utility but can still reach the supervisory control and data acquisition system. Courtesy: Barry-Wehmiller Design Group



In SCADA system design, simple and effective navigation and plant overview should be prioritized. A holistic view of the entire site is enabled by connecting utility systems and plant processes to the same central SCADA system.

IT/OT convergence

This is a key factor in enabling powerful analytics for manufacturing. What this means is that the OT/plant floor systems/SCADA system are in some way shape or form, integrated with IT software like ERP systems. For an even more comprehensive system, especially for companies with multiple sites, this entails pooling information from all sites for analytical purposes.

The whole purpose of Industry 4.0 is to facilitate the flow of data from both plant floors and business processes. From there, its purpose is to then allow businesses to make informed decisions or implement dynamic improvements based on the analysis of this data.



Both IT (primarily from a business side) and OT (from operations side) need to understand each other's goals and find the right software solutions to accomplish them. Fundamental tools such as barcode tracking/serialization and other production metrics provide insights necessary for accurate forecasting.

To bring this full circle, adding the utility systems to the overall SCADA system is another part of gauging overall plant performance with IT/OT convergence, businesses can track performance across their enterprise. Just as pain points can be pinpointed by a single facility, insights can be funneled by the corporate team to various other facilities to target the next project.

Compressor control case study

A prime example from one of Barry-Weh-miller Design Group's clients' factories where air compressors are confined to a small room with localized controls could serve as

a noteworthy illustration of the challenges posed by isolated systems in manufacturing. Air compressors, crucial for supplying compressed air to the entire plant, are placed in a small room with a local control system isolated from the external world.

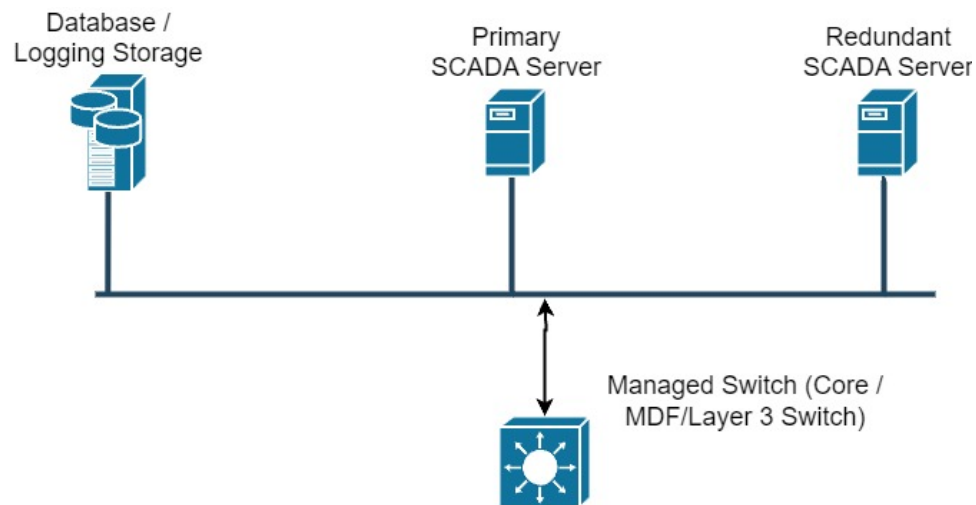


Figure 4: Simplified supervisory control and data acquisition architecture design, typically drawings like this can be very helpful in establishing a common architecture across all plants. Courtesy: Barry-Wehmler Design Group

These large bedroom-sized compressors are typically monitored locally and the manufacturing process eventually starts experiencing quality issues. Could the suboptimal operation of the air compressors, due to their isolated controls, be adversely affecting the manufacturing process and causing an unreliable air supply? Is there a connection between the performance of these compressors and the overall performance of the manufacturing process?

If these compressors were integrated into a central SCADA system combining utilities data and control with the manufacturing process, plant professionals could have analyzed plant and line performance along with compressor performance. This data-driven analysis on logged points would have enabled the optimization of compressor performance, the balancing of supply and, if needed, modification of production for optimal system operation with the compressors. Achieving such dynamic optimization is not possible if the building utility system is not tied in with the manufacturing process control system.

Long-term planning

In the evolving realm of manufacturing, harmonizing the controls between both the building utilities systems and manufacturing processes is not just a technological modernization — it's a strategic imperative. It enables a holistic view of the health of plants, enabling business owners to navigate complexities with foresight, agility, insight and efficiency.

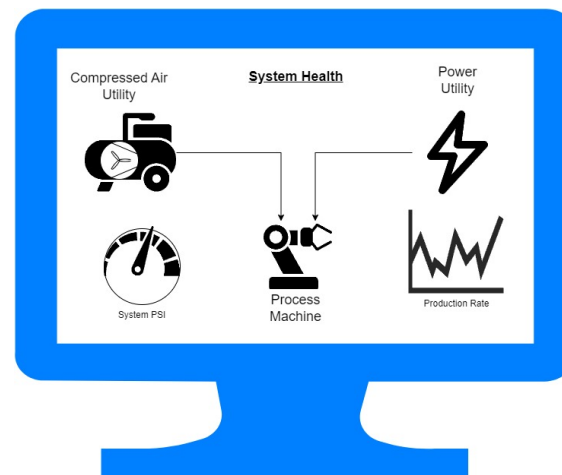


Figure 5: A simplified view of what a whole plant overview screen can contain.
Courtesy: Barry-Wehmiller Design Group

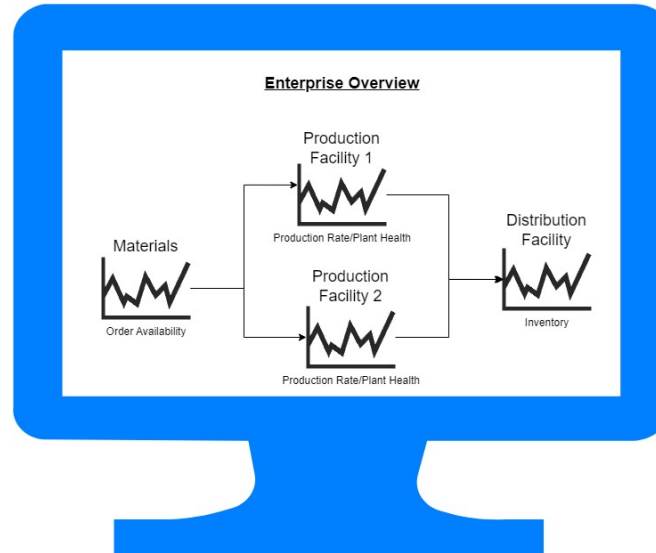
Figure 6: A simplified representation of what an enterprise system might look like. Courtesy: Barry-Wehmiller Design Group

The future of the industry lies in the seamless orchestration of building utilities and process controls. Establishing a long-term plan for network, SCADA and OT/IT convergence can help keep an organization on track to achieve this operational synergy.

Glossary

The industry is full of specialized terms and phrases.

- **Building management system (BMS):** A combined software and hardware system that enables control of building infrastructure and collection/visualization of associated plant data.
- **Direct digital controls (DDC):** A system that uses digital devices to monitor and control building mechanical and electrical systems.
- **Enterprise resource planning (ERP):** A software system that helps businesses coordinate activities including finance and operations such as manufacturing.
- **Flat network:** A network where all components fall under the same broadcast area.



TAKE PREDICTIVE MAINTENANCE TO NEW HEIGHTS

RedRaven is Flowserve's complete end-to-end IoT solution for the industrial space — a turn-key offering from sensors to cloud architecture, condition monitoring and predictive analytics services — so you can reliably and cost-effectively monitor thousands of assets over sprawling facilities.

Discover what predictive maintenance can do for you.

flowserve.com/iot

**Predict.
Act.
Protect.**



- **High availability:** A server setup that enables quick recovery to another server.
- **Human-machine interface (HMI):** A user interface, typically a touch screen used for interfacing with plant machines and devices (common for both SCADA and BMS).
- **Industry 4.0:** Fourth industrial revolution, characterized by the integration of smart technologies like internet of things and artificial intelligence to enhance automation and efficiency in manufacturing.

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- **Information technology (IT):** In this article it specifically refers to business side software that sits on a network separate from the plant network.
- **Operational technology (OT):** In this article these are network or computer components that are on a plant-side or manufacturing network. Think of OT as plant floor/SCADA and IT as business systems.
- **Programmable logic controller (PLC):** Used to control manufacturing and building automation equipment.
- **Supervisory control and data acquisition (SCADA):** A combined software and hardware system that enables control of plant equipment and collection/visualization of associated plant data.

Hafiz A. Rafey and Strahinja "Strah" Sopcic

Hafiz A. Rafey, EIT, PMP, serves as a Senior Mechanical Designer at Barry-Wehmiller Design Group. **Strahinja "Strah" Sopcic** is an Automation/Software engineer with Barry-Wehmiller Design Group

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Developing the right MRO plan for a manufacturing facility

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The right maintenance, repair and operations (MRO) plan can save manufacturing facilities a lot of trouble in the long run if companies take ownership and find the right resources.



Left to right: John Gaddum, FA service manager, Bosch Rexroth, Hoffman Estates, Ill.; Lance Gilbert, managing partner, Net Results Group, Louisville; Pratibha Pillalamarri, senior product marketing manager, Aspen Technology, Houston. Courtesy: Bosch Rexroth, Net Results Group, Aspen Technology

Question: What are the key challenges faced by organizations in managing MRO activities effectively?

John Gaddum: Taking ownership and finding dependable resources for reliable repairs. Most companies don't put much analysis into their repairs and end up losing a lot of time and money from substandard repairs.

Lance Gilbert: The key challenges faced by organizations in effectively managing MRO activities include an aging workforce and the subsequent turnover, where there is a need for younger, technologically savvy resources. The aging workforce often possesses inherent knowledge and experience crucial for MRO activities, and as they retire or leave, organizations face the risk of losing valuable institutional knowledge. The challenge lies in bridging the gap by attracting and retaining younger talent with the requisite technological skills to ensure continuity and proficiency in MRO operations.

Question: How do you prioritize maintenance tasks to ensure optimal equipment performance and longevity?

Lance Gilbert: To prioritize maintenance tasks for optimal equipment performance and longevity, companies often grapple with the challenge of insufficient visibility into their storerooms, particularly across the entire enterprise. A crucial aspect is gaining a comprehensive understanding of available inventory, ensuring accurate and up-to-date records of spare parts and essential components.

This visibility enables informed decision-making, allowing maintenance teams to prioritize tasks based on criticality, availability of resources, and overall impact on equip-



ment performance. Addressing the challenge of inventory management is foundational to implementing an effective and strategic approach to prioritize maintenance tasks and enhance equipment reliability.

Pratibha Pillalamarri: Maintenance tasks can be prioritized by evaluating equipment criticality based on production, safety and environmental impact. These include:

- Prioritizing critical assets to minimize disruptions
- Utilizing predictive maintenance solutions to detect issues as they form
- Scheduling proactive tasks guided by predictive alerts
- Assessing risks associated with maintenance and prioritizing accordingly to ensure safety and continuity
- Considering resource availability for efficient task completion
- Performing cost-benefit analyses to prioritize tasks that result in highest performance and reliability improvements while reducing downtime.

This cohesive approach enhances equipment reliability and efficiency by leveraging solutions that assess criticality, quantify risks, provide prescriptive guidance and optimize maintenance scheduling.



Question: In your experience, what role does technology play in streamlining MRO processes and reducing downtime?

Lance Gilbert: In my experience, technology plays the paramount role in streamlining MRO processes, positioning it as the number one priority. MRO is a significant contributing factor to achieving operational efficiency and maintaining a competitive edge in the market. Leveraging technology in MRO processes is instrumental in reducing downtime by optimizing asset performance, enabling predictive maintenance and ensuring efficient inventory management.

The integration of technologies such as predictive analytics, condition monitoring and robust enterprise asset management (EAM) systems enhances decision-making, minimizes unplanned downtime and contributes to achieving cost-effective and competitive operations.

Question: Can you share examples of successful MRO cost reduction initiatives that you've implemented or witnessed?

Pratibha Pillalamarri: In one case, OCP Ecuador utilized a prescriptive maintenance solution to enhance the availability and reliability of pumps and generators. Within six weeks of implementation, they achieved impressive results, including a 20% increase in uptime and a 25% reduction in annual maintenance expenses. The solution also extended the camshaft lifespan from 20,000 to 50,000 hours, leading to substantial cost savings.

In another, a large chemical company in Asia implemented a prescriptive maintenance solution across two complexes, deploying over 200 live agents to protect various



equipment such as compressors, pumps and reactors. The solution provided early warnings to prevent unplanned shutdowns, enabling production loss avoidance and shutdown prioritization for maintenance planning. The estimated annual value protected by avoiding downtime reaches up to \$3.6 million.

Question: What metrics do you consider most important for measuring the effectiveness of MRO operations and what role do analytics play?

Lance Gilbert: The key metrics for measuring MRO effectiveness include improved capacity, equipment availability and cash flow. Analytics play a crucial role in interpreting these metrics, providing insights for data-driven decision-making and optimizing MRO strategies.

Question: What challenges do you encounter when managing MRO for a diverse range of equipment and assets?

Lance Gilbert: Managing MRO for a diverse range of equipment and assets presents challenges such as unplanned outages and decreasing maintenance productivity. The varied nature of equipment requires a strategic approach to ensure timely and effective maintenance, minimizing disruptions and optimizing overall productivity. Addressing these challenges involves implementing proactive maintenance strategies, leveraging technology and adopting a holistic MRO approach tailored to the diverse asset portfolio.

Question: How do you ensure effective communication and collaboration between maintenance teams and other departments?



Lance Gilbert: Ensuring effective communication and collaboration between maintenance teams and other departments involves implementing team-building exercises and fostering an understanding of each other's operations. By promoting a collaborative culture and facilitating opportunities for teams to interact and comprehend the nuances of different departments, organizations can enhance communication channels and strengthen the synergy between maintenance and other functional areas.

Pratibha Pillalamarri: Encourage cross-training initiatives to familiarize employees with different departments' functions and promote knowledge sharing. This facilitates better understanding and collaboration between teams. Implement solutions that consider equipment within the broader context of processes, rather than viewing it in isolation. A comprehensive maintenance strategy encompasses not only the equipment itself but also its upstream and downstream processes.

Such a solution evaluates the impact of processes on equipment and offers a dashboard to facilitate task management and insight sharing, thereby enabling cross-departmental collaboration. By implementing these strategies, organizations foster effective communication and collaboration, leading to improved efficiency, productivity and overall success.

Plant Engineering



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