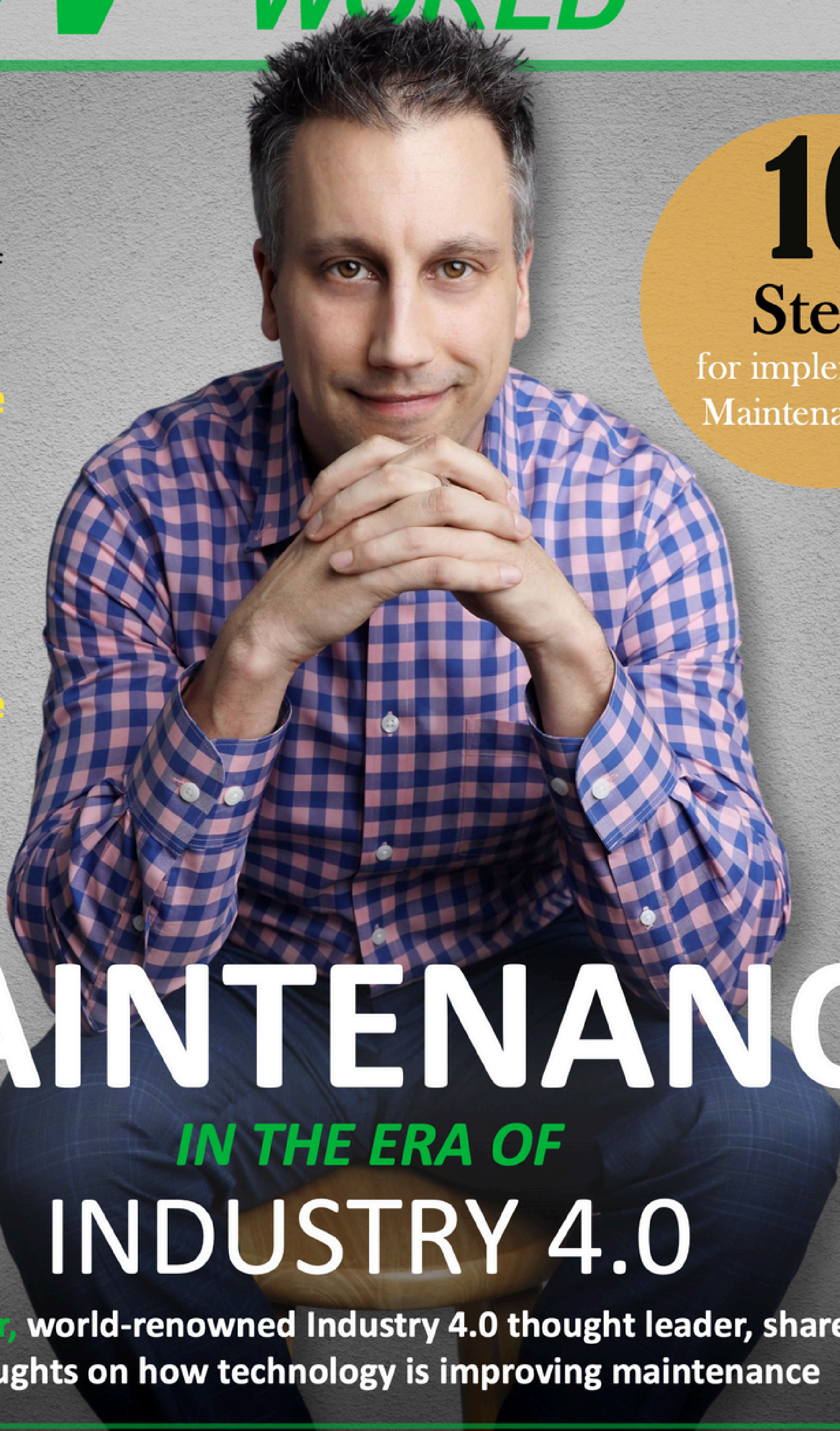
MAINTENANCE WORLD

August 2024



Industry 4.0
History and brief overview

Maintenance Landscape
Evolution of maintenance

Predictive Maintenance
Analytics considerations

10 Steps for implementing Maintenance 4.0

MAINTENANCE *IN THE ERA OF* INDUSTRY 4.0

Jeff Winter, world-renowned Industry 4.0 thought leader, shares his thoughts on how technology is improving maintenance

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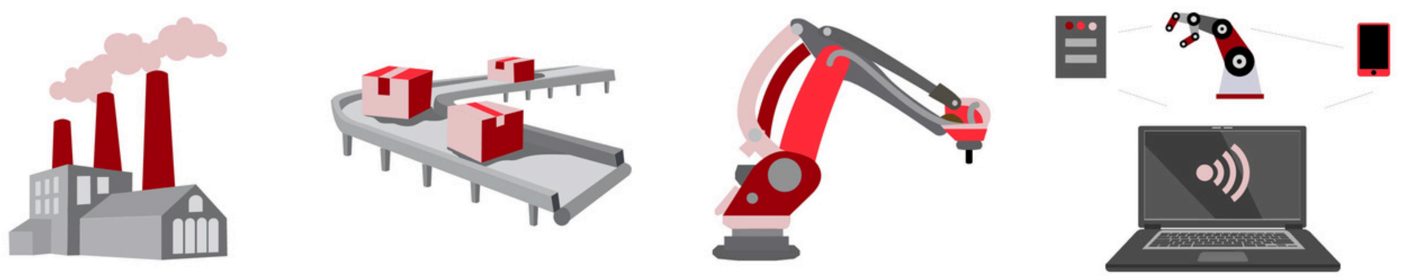
A Brief Overview of Industry 4.0

Welcome to the era of Industry 4.0, where the manufacturing world is getting a major upgrade. This isn't just about making things faster or cheaper; it's about transforming how factories operate from the ground up, using smart technology to make decisions, prevent problems, and keep everything running smoothly.

END OF THE 18TH CENTURY	START OF THE 20TH CENTURY	START OF THE 1970s	PRESENT



INDUSTRY 1.0 Mechanization	**INDUSTRY 2.0** Electrification	**INDUSTRY 3.0** Digitalization	**INDUSTRY 4.0** Autonomous Systems
Characterized by the introduction of mechanical production facilities powered by water and steam, which led to the transition from manual craftsmanship to mechanized manufacturing	Characterized by the advent of mass production with the aid of electricity, which led to significant increases in production efficiency and the development of assembly lines	Characterized by the integration of computers and automation into manufacturing processes, which led to enhanced productivity and the ability to produce more complex products with greater precision	Characterized by the convergence of physical, digital, and virtual environments throughout the entire value chain to enable end-to-end visibility and data-driven decision making
1784 – The first power loom was developed by Edmund Cartwright	**1867** – First production lines in the meatpacking industry of Chicago	**1968** – The Modicon 084 was the first programmable logic controller (PLC)	

FIGURE 1

Imagine…

A home where your thermostat adjusts itself based on your preferences and the weather forecast, ensuring optimal comfort while saving energy.

A garden that waters itself precisely when the plants need it, considering both soil moisture levels and weather predictions.

A health monitoring system that can predict potential health issues based on your vitals and alert you and your doctor before they become serious.

A retail experience where your shopping cart knows what you need, guides you through the aisles, and even suggests recipes based on the ingredients you pick up.

A city where streetlights adjust their brightness based on pedestrian and traffic movement, enhancing safety while conserving energy.

That's the kind of smart, connected thinking that's driving Industry 4.0.

In the manufacturing world, this revolution is about supply chains that communicate to anticipate demand spikes and shortages, machines that can predict their own maintenance, production lines that adjust on the fly, and products that can be customized in real time to meet customer needs.

In essence, Industry 4.0 is transforming the manufacturing landscape into an interconnected ecosystem where efficiency, sustainability, and customization are not just goals, but realities.

The evolution of industrial revolutions has been a transformative journey from manual craftsmanship to mechanization and beyond. The first revolution introduced steam-powered machines, the second harnessed electricity for mass production, and the third revolution brought computers and automation into the mix, digitizing manufacturing processes.

Industry 4.0, however, is a game-changer because it's centered around capturing and harnessing the power of data to revolutionize not just how things are made, but also how people work and how value is created. It leverages technologies like IoT to generate data and AI to analyze data in ways that dramatically improve efficiency, customization, and innovation, fundamentally changing the manufacturing landscape.

Jeff Winter
Industry 4.0 and Digital Transformation Thought Leader

Jeff Winter is a globally recognized thought leader in Industry 4.0 and manufacturing, with 60+ million views of his content and 115k+ LinkedIn followers.

Honored more than 25 times as a top expert in his field, Jeff excels at simplifying and communicating complex concepts to diverse audiences, from the shop floor to the executive boardroom. With nearly 20 years of experience in industrial automation, he is a passionate advocate for digital transformation. Jeff is also highly active in the Industry 4.0 community. He serves on the executive boards for the International Society of Automation (ISA), the International Board of Directors for Manufacturing Enterprise Solutions Association (MESA), is a U.S. registered expert for the International Electrotechnical Commission (IEC) as a member of TC 65, and serves as a Smart Manufacturing Advisor to CESMII.

The Current Maintenance Landscape

In the old days (and still in many places today), maintenance was like playing a never-ending game of Whack-a-Mole. Something breaks, you fix it. *Rinse and repeat.*

This reactive approach is straightforward but costly and inefficient. You're always playing catch-up, and unexpected breakdowns can cause major headaches. Then came **preventive maintenance**, the idea of doing regular replacement of parts on a time-based schedule to keep machines running smoothly. Think of it like taking your car in for regular oil changes to avoid bigger problems down the road. This method is more proactive but can still be hit or miss. You might end up replacing parts that don't need replacing or missing something that's about to fail.

Total Productive Maintenance

TPM, developed in Japan between the 1950s and 1970s, is a comprehensive maintenance program designed to increase production efficiency while improving employee morale and job satisfaction.

TPM is like a health program for your machines, aiming to boost production and keep everyone happy at work. Instead of seeing maintenance as a pesky chore, TPM makes it a vital part of the daily routine to cut down on emergency fixes and unplanned stops. The main goals are to reduce waste, maintain top-notch product quality, lower costs, and ensure products are delivered on time without defects. TPM gets everyone involved, from top management to shop floor employees, creating a culture of ongoing improvement and proactive care.[1]

TPM emphasizes cultural change and operator involvement; RCM provides a systematic approach to understanding and mitigating failures.

Reliability-Centered Maintenance

RCM, emerging in the early 1970s in the aviation industry, is a strategic approach to maintenance planning that ensures systems continue to operate effectively in the current operating context. By focusing on understanding and managing the risks of equipment failure, RCM helps boost reliability, cut costs, and improve machine uptime. It works by identifying critical functions, failure modes, and the best maintenance tasks to prevent those failures.

Implementing RCM leads to more efficient and effective maintenance plans, ensuring that machines operate smoothly and reliably. This strategy allows for all types of maintenance, such as those shown in Figure 3, to be utilized where they are most appropriate as part of the overall program.[2]

While TPM emphasizes cultural change and operator involvement, RCM provides a systematic approach to understanding and mitigating failures.

Together, they offer a comprehensive maintenance framework, balancing proactive cultural practices with analytical rigor. In the era of Maintenance 4.0, where **predictive maintenance (PdM)** is key, these strategies have evolved to incorporate advanced technologies like IoT sensors and AI. These tools help predict issues before they happen, making both TPM and RCM even more effective by providing real-time data and insights to optimize maintenance schedules and reduce downtime.

A Vision for the Future: Maintenance 4.0

As we navigate deeper into the era of Industry 4.0, the vision for the future of maintenance, aptly named **Maintenance 4.0**, is becoming clearer and more compelling. This forward-looking approach transcends traditional maintenance strategies by integrating cutting-edge technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data analytics, and machine learning. The goal is to transform maintenance from a necessary cost center into a strategic asset that drives operational efficiency, enhances productivity, and fosters innovation.

The Evolution of Maintenance Strategies

To appreciate the significance of Maintenance 4.0, it's essential to understand its evolution:

- Maintenance 1.0 focused on reactive strategies, where actions were taken only after a failure occurred. This approach often led to significant downtime and high repair costs.
- Maintenance 2.0 introduced preventive maintenance, scheduling regular check-ups based on time or usage to prevent failures. However, this method sometimes resulted in unnecessary maintenance activities, wasting resources.
- Maintenance 3.0 saw the advent of condition-based maintenance, utilizing sensors to monitor equipment and perform maintenance based on actual conditions. This strategy marked a shift towards more data-driven decisions, but still lacked predictive capabilities.

The Leap to Maintenance 4.0

Maintenance 4.0 represents a quantum leap from its predecessors by leveraging IoT to collect detailed data from a myriad of sensors installed on machinery and equipment. This data, when analyzed using AI and machine learning algorithms, can predict potential failures and suggest optimal maintenance schedules.

The predictive nature of Maintenance 4.0 allows for a more nuanced understanding of equipment health, leading to several transformative benefits:

Predictive Insights:

With the global predictive maintenance (PdM) market projected to grow significantly, reaching billions in value, the adoption of predictive maintenance strategies is on the rise. This growth is fueled by the ability to accurately predict equipment failures before they occur, reducing unplanned downtime. According to IoT Analytics, the median unplanned downtime cost across 11 industries is approximately $125,000 per hour. [3]

Resource Optimization:

By focusing maintenance efforts only where and when they are needed, companies can achieve substantial cost savings. Statistics show that adopting predictive maintenance can reduce maintenance costs by an average of 30% and reduce spare parts related costs by an average of 10%.[4]

Enhanced Efficiency:

The integration of Maintenance 4.0 technologies leads to improved operational efficiency. Real-time data analytics and machine learning algorithms enable the optimization of maintenance schedules, ensuring that machinery operates at peak efficiency for longer periods. This optimization can lead to an average 40% reduction in unplanned downtime.[4]

More Than Just Problem Identification

Predictive maintenance offers early warnings, enabling teams to plan repairs during scheduled downtimes and keep disruptions to a minimum. *Prescriptive maintenance* takes it further by suggesting specific actions, such as adjusting settings or replacing parts preemptively. However, recognizing problems is just the starting point.

To really make an impact, companies need to fully leverage these insights to change the way they coordinate the availability of parts and tools, schedule the right personnel, and manage shutdowns efficiently. This may require new skills, new processes, different management methods, and even new roles. This includes Maintenance, Repair, and Overhaul (MRO), which can take advantage of other Industry 4.0 technologies such as 3D printing, automation for automatic part ordering, and AI to drive added efficiency and cost reduction.

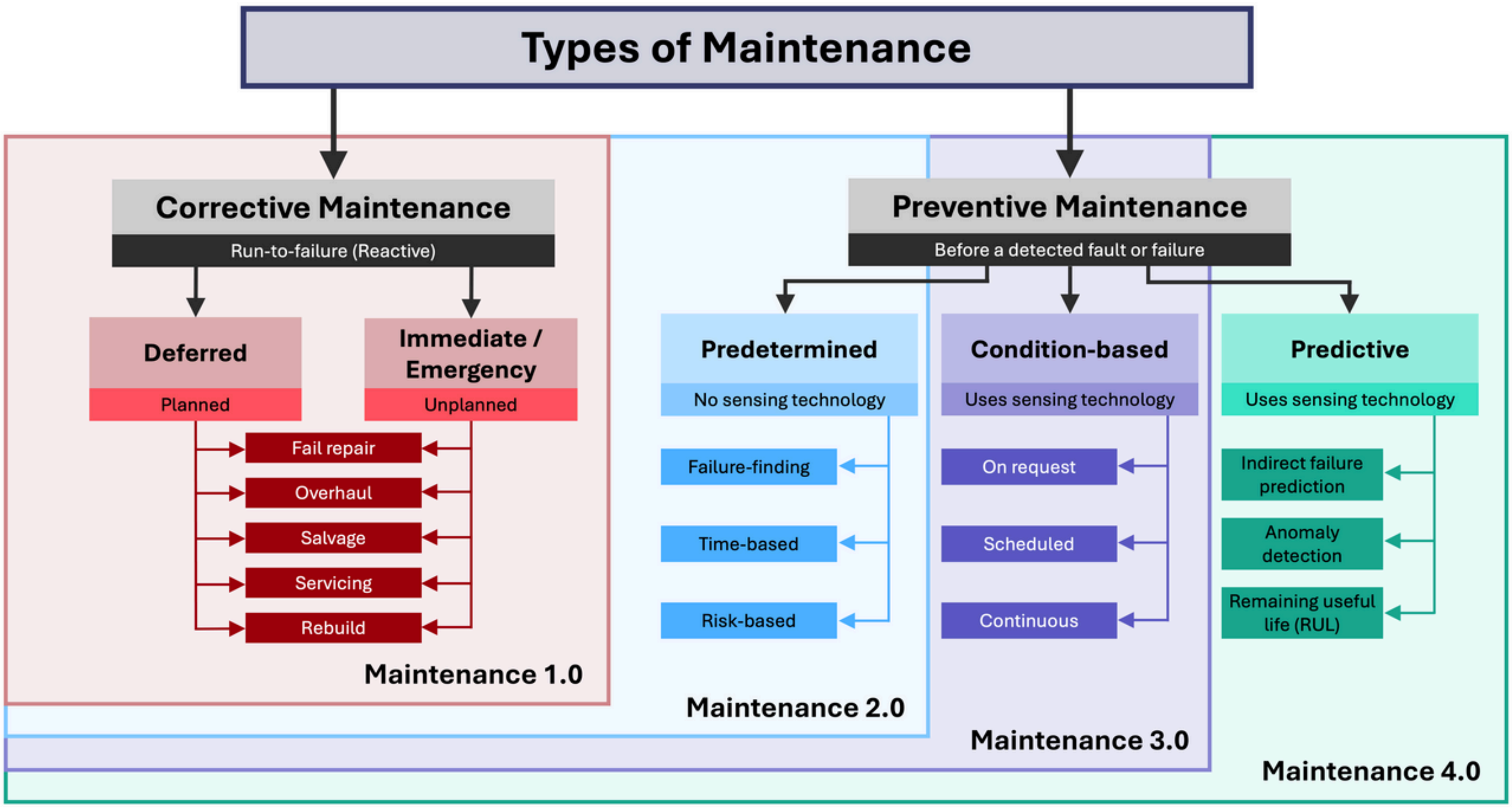
In addition, the data-driven insights provided by Maintenance 4.0 can facilitate strategic decision-making regarding equipment investments, production planning and innovation initiatives through better integration with other programs and systems, such as Enterprise Asset Management (EAM) and Asset Performance Management (APM).

This integration transforms maintenance from a reactive necessity into a strategic asset, driving productivity, efficiency, and innovation across the board.

Differences in Maintenance Maturity Levels

	Maintenance 1.0	Maintenance 2.0	Maintenance 3.0	Maintenance 4.0
Management Strategy	• Run-to-Failure	Maintenance 1.0 + • Planned maintenance	Maintenance 2.0 + • Condition-based monitoring	Maintenance 3.0 + • Predictive & Prescriptive analytics
Inspection	• Visual inspection	• Instrumentation	• Continuous local monitoring	• Continuous remote monitoring • AI analysis
Data	• Historical failures • User data	Maintenance 1.0 + • Equipment data • Industry Best Practices	Maintenance 2.0 + • Digital sensors	Maintenance 3.0 + • Operational data • Environmental data • Synthetic data
Response Time	• After failure	• Scheduled intervals	• On-demand based on conditions	• Proactive and predictive
Performance Measure	• Visual norm verification • Paper-based trend analysis • Prediction by expert opinion	• Automatic norm verification • Paper-based trend analysis • Prediction by expert opinion	• Automatic norm verification • Digital trend analysis • Monitoring by CM software	• Automatic norm verification • Digital trend analysis • Prediction by AI/statistical software • Advanced decision support
Decision Making	• Experience-based	• Rule-based	• Data-drive based on conditions	• ML/AI-driven
Software	• None/MS Excel	• Basic CMMS	• Modern CMMS • EAM/APM	• Modern CMMS • EAM/APM • ERP • IoT platforms • Analytics platforms
System Integration	• No integration; standalone systems where present	• Basic integration with local databases and instruments	• Integration with equipment/SCADA systems for real-time alarming	• Full integration with enterprise systems, enabling comprehensive data analysis and decision making
Skills	• Basic mechanical skills	Maintenance 1.0 + • Advanced mechanical skills • Basic electrical/controls skills • Basic diagnostic skills	Maintenance 2.0 + • Advanced electrical/controls skills • Basic analytic skills • IoT device management skills	Maintenance 3.0 + • Advanced analytic skills • IoT device management skills • Precision maintenance skills • AI & ML proficiency skills • Big data analysis skills
Roles & Collaboration	• Technicians always on call for repairs • Minimal collaboration between departments	• Maintenance planners and schedulers introduced to organize activities • Technicians follow established schedules and procedures • Better coordination between maintenance and production departments	• Technicians use advanced diagnostic tools and techniques • Collaboration between IT and maintenance departments increases • Enhanced data sharing and communication	• Maint engineers and AI specialists work together to develop ML models • Technicians supported by AR, VR, & mobile devices • Highly integrated teams combining IT, data science, ops, and quality • Ongoing benchmarking • Long-term improvement plan • Collaborative platforms for real-time data sharing and decision making

FIGURE 2



SOURCES: ADAPTATION FROM EN 13306, RELIABILITY ACADEMY, AND IOT ANALYTICS PREDICTIVE MAINTENANCE & ASSET PERFORMANCE MARKET REPORT 2023-2028

FIGURE 3

In modern manufacturing, maintenance classifications often extend beyond the traditional definitions provided by the European Standard EN 13306, which outlines the foundational terminology for maintenance activities. While this standard categorizes essential maintenance types, practical implementations in advanced manufacturing environments show a more nuanced approach.

Predictive maintenance, for instance, is variably categorized—some firms place it under preventive maintenance for its foresightful capabilities, whereas others treat it as a distinct category due to its specific methodologies.

As we shift our focus to Maintenance 4.0 the emphasis increasingly shifts towards condition-based and predictive maintenance, which are rapidly evolving beyond the scope of EN 13306.

These advanced strategies leverage real-time data and automation to predict and diagnose system failures before they occur. The defining characteristics of these modern maintenance strategies hinge on the detection of faults—whether a fault has occurred or is about to occur, the utilization of sensors to monitor system health, and the level of automation involved in the detection process.

Particularly in predictive maintenance, a significant aspect is the level of prognostication involved; forecasting the severity, timing, progression, and evolution of potential failures. These advancements represent a transformative shift in maintenance practices, propelled by integration with IoT, AI, and machine learning technologies, heralding a new era of efficiency and precision in manufacturing maintenance.

According to MLC in their *2023 Future of Industrial AI in Manufacturing* report, predictive maintenance comes in as the second highest adopted use case (at 36%) for where AI is being applied in the manufacturing industry, and is ranked first for potential benefit.[5]

According to Limble's 2024 industry report on maintenance, preventive maintenance is the dominant strategy for both manufacturing and facility management. In the function of manufacturing, 67% of companies use preventive maintenance, supplemented by predictive technologies and quick repairs by trained operators to minimize downtime.

Conversely, 90% of facilities management teams emphasize preventive maintenance, with a growing focus on condition monitoring technologies to support their maintenance activities. This divergence makes sense, as manufacturing environments typically have many operators tending to and running machines throughout the day, which isn't the case for facilities.[6]

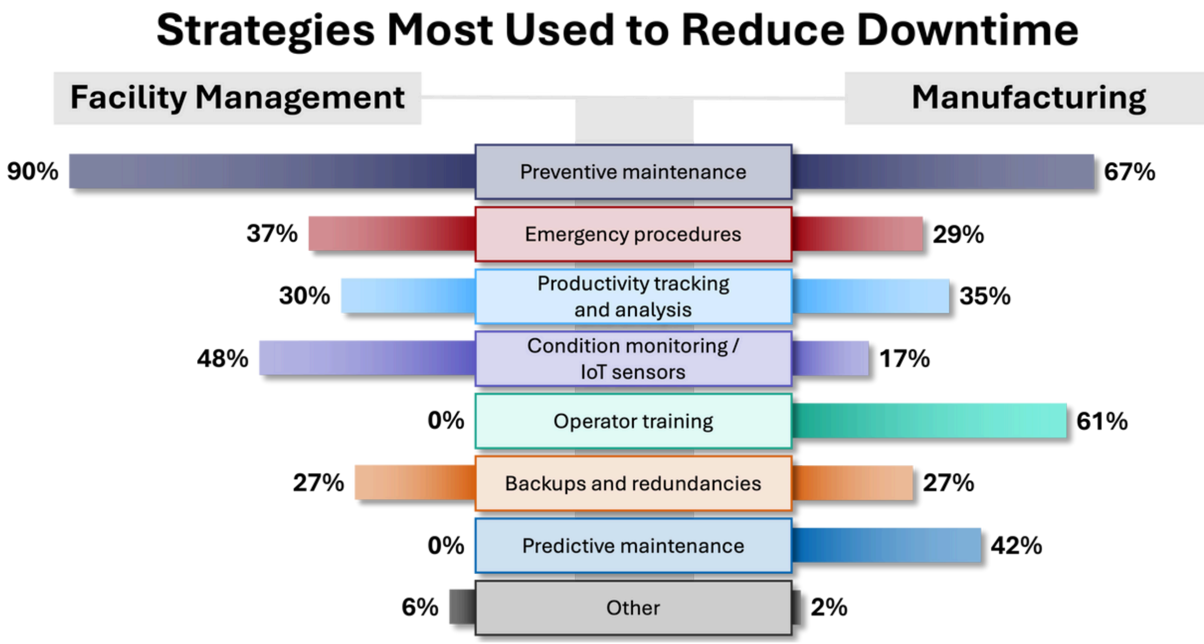
The effectiveness of these maintenance strategies often faces significant challenges, particularly from human factors, with 57% of of respondents identifying issues like staffing, training, and fostering a proactive maintenance culture as the top challenges.

Process improvements and the integration of new technologies are also notable hurdles, with 51% finding planning and scheduling processes moderately challenging, and 21% viewing technology implementation as a significant struggle. Despite these obstacles, there is a positive trend in technology adoption, reflecting a broader shift towards more sophisticated, data-driven maintenance operations as part of the industry's move towards Maintenance 4.0.[7]

Value and Maximizing Savings

Predictive maintenance (PdM) can be a game-changer when it comes to saving costs. It helps reduce labor costs by cutting down the frequency and scope of maintenance work. Instead of doing regular checks regardless of need, PdM allows you to replace parts only when they actually show signs of wear, saving money on spare parts.

One of the biggest benefits is avoiding unexpected breakdowns, which minimizes unplanned downtime and the associated production losses.



SOURCE: LIMBLE 2024 INDUSTRY REPORT - THE STATE OF MAINTENANCE IN MANUFACTURING AND FACILITIES FIGURE 4

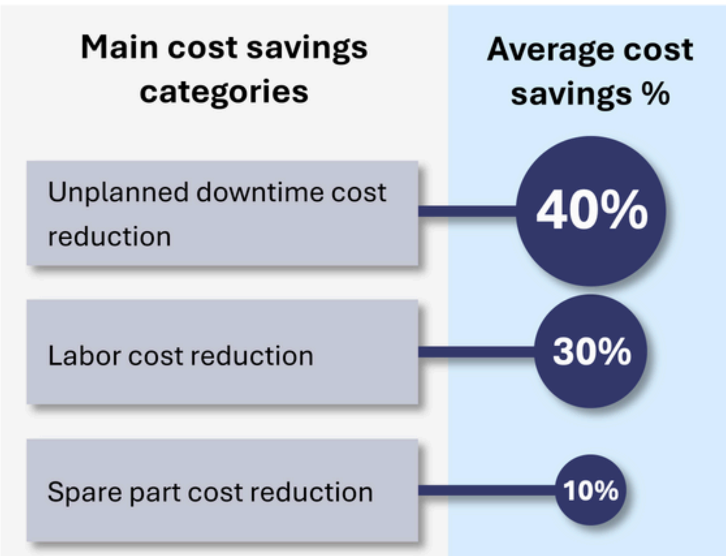
To understand how PdM impacts costs, let's look at the typical maintenance cost equation.

This equation breaks down the total maintenance-related costs into a few key components:

Total maintenance-related cost =
Cost of regular maintenance +
Cost of PdM +
Cost of repairs +
Cost of production losses caused by failures

The goal is to find the optimal point where these combined costs are minimized. PdM helps achieve this by balancing these factors, reducing excessive repairs and failures without overspending on unnecessary maintenance.

When PdM is effectively implemented, it ensures you spend less on emergency fixes and unplanned downtime, leading to smoother and more efficient operations. This balance results in significant savings and keeps your operations running efficiently without unnecessary expenditures.[3]



SOURCE: IOT ANALYTICS PREDICTIVE MAINTENANCE & ASSET PERFORMANCE MARKET REPORT 2023-2028

FIGURE 5

Diverse Approaches to Predictive Maintenance

Predictive maintenance is being adopted in various forms, reflecting its versatility and potential for enhancing asset management. According to IoT Analytics research, the PdM market is highly fragmented with the top 10 companies only representing around 18% of the market size in 2022, which is quite different than a lot of the mature software markets where there are a few clear dominant players. Part of this is because of the varying approaches companies take toward PdM.

Three Ways to Look at Predictive Maintenance

- **Evolutionary Step from Condition Monitoring:** Many see predictive maintenance as a natural progression from condition-based monitoring, leveraging advanced analytics to anticipate equipment failures more accurately and timely.
- **Component of Asset Performance Management (APM):** In this approach, predictive maintenance is integrated as a new, advanced feature within broader asset performance management systems. It's seen as a tool that not only prevents failures but also optimizes asset performance to a new level.
- **Standalone AI-Based Initiative:** Some organizations treat predictive maintenance as a separate, data-driven project, typically spearheaded by data scientists. This approach often involves developing custom AI models tailored to specific maintenance needs and scenarios.

Each approach presents unique advantages and challenges, and the choice depends on the organization's existing infrastructure, expertise, and strategic goals. By understanding these frameworks, manufacturers can better navigate the complexities of implementing predictive maintenance and choose the path that best suits their needs.

When PdM is effectively implemented, it ensures you spend less on emergency fixes and unplanned downtimes, leading to smoother and more efficient operations.

The Cultural and Knowledge Divide

Predictive maintenance is transforming industrial maintenance strategies, but its integration is fraught with challenges. A prominent issue is the cultural and knowledge divide between traditional maintenance teams and AI experts. Maintenance personnel often lack a nuanced understanding of artificial intelligence (AI) and data analytics, which are crucial for predictive maintenance.

Conversely, AI specialists may not fully appreciate the practical, day-to-day challenges of maintenance operations. This disconnect can lead to miscommunications and inefficiencies in deploying predictive maintenance solutions effectively.

To bridge this gap, manufacturers should consider the following strategies:

- **Cross-disciplinary Training:** Implement training programs that help maintenance staff understand the basics of AI and data analytics, and similarly educate AI professionals on the operational specifics of maintenance work. This mutual understanding can foster better collaboration and integration of predictive maintenance systems.
- **Collaborative Solution Development:** Involve maintenance personnel in the development and rollout of predictive maintenance technologies. Their firsthand experience can provide valuable insights that enhance the functionality and effectiveness of predictive solutions.
- **Incremental Implementation:** Start with small-scale projects to integrate predictive maintenance within the organization. This allows both maintenance and AI teams to adapt to the new technologies and processes gradually, minimizing resistance and enhancing learning opportunities.

Analytics Considerations when Implementing Predictive Maintenance

Predictive maintenance fundamentally redefines traditional maintenance practices by integrating sophisticated analytics into its core processes. Unlike condition monitoring, which primarily focuses on using alarms to signal deviations from expected performance thresholds, predictive maintenance leverages in-depth analytics to foresee and mitigate potential failures before they manifest.

According to IoT Analytics, the accuracy of many predictive maintenance solutions is lower than 50%. This low accuracy can erode trust and create frustration as maintenance teams spend time chasing false alarms.[3] As a result, this approach necessitates a different set of considerations, many of which are novel for maintenance teams accustomed to conventional methods.

1) Data Sources:

The use of diverse inputs such as operational data, sensor outputs, and historical maintenance records is vital. These sources enrich predictive models by providing a comprehensive view of equipment performance and behavior over time. Are you capturing a wide range of data types to maximize your predictive accuracy? For example, have you considered integrating sensors' temperature and vibration data with operational logs to enhance failure prediction?

2) Types of Analytics:

Employing a range of analytical methods—descriptive, diagnostic, predictive, and prescriptive—ensures a thorough understanding of both current conditions and future risks. This multifaceted approach allows for more nuanced decision-making and strategic planning. What mix of analytics does your organization currently use, and how can these be optimized to improve maintenance predictions? For example, could you implement diagnostic analytics to pinpoint the specific causes of equipment anomalies detected by your sensors?

3) Class Imbalances:

Addressing the imbalance where failure events are significantly outnumbered by normal operation data is crucial for model accuracy. Techniques such as synthetic data generation or advanced sampling methods can help models learn to recognize rare but critical failure patterns. How does your predictive maintenance system handle class imbalances, and what methods could be implemented to improve this? As a specific instance, have you considered using SMOTE (Synthetic Minority Over-sampling Technique) to artificially enhance your dataset with synthesized examples of rare but critical failures?

4) Data Quality:

Ensuring data is accurate, complete, and timely is critical for effective predictive maintenance. High-quality data leads to more reliable predictions, fewer false alarms or missed failures, and higher overall uptime. How does your organization validate and clean its data, and what improvements could be made? What steps are taken to check sensor accuracy and recalibrate them if necessary to maintain data quality?

5) Model Evaluation:

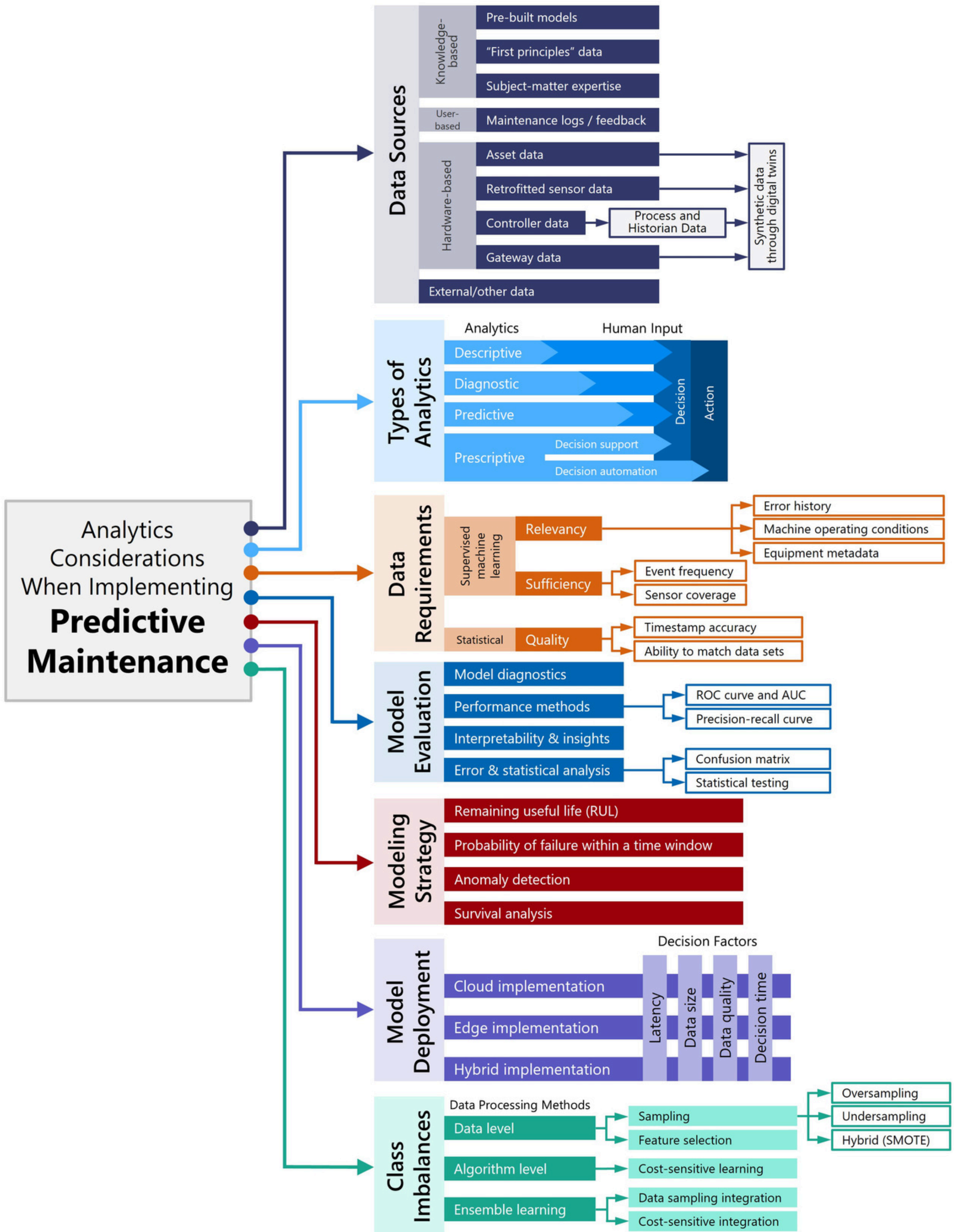
Regularly assessing the performance of predictive models through metrics such as accuracy, precision, and recall ensures that they remain effective even as conditions change. Continuous model evaluation is key to adapting predictive maintenance strategies to new data and operational shifts. Which evaluation schedule and metrics are most appropriate for your models, and how often should retraining occur? Could you use a confusion matrix to more clearly understand where your model's predictions go wrong?

6) Modeling Strategy:

Selecting the appropriate modeling strategy involves deciding whether to focus on anomaly detection, failure prediction, or life expectancy estimation, among other options. This choice should align with the organization's specific maintenance goals and operational needs. How do you choose the right modeling strategy for your operations, and could this approach be refined? For example, if reducing downtime is a priority, how might focusing on real-time anomaly detection improve operational efficiency?

7) Model Deployment:

The deployment of predictive models, whether in the cloud, on-premises, or in a hybrid environment, significantly impacts the timeliness and effectiveness of maintenance actions. Each deployment strategy offers different benefits and challenges related to scalability, speed, and security. What is the most effective deployment strategy for your organization's needs, and how can it enhance predictive maintenance performance? Specifically, how might moving to a cloud-based platform improve your ability to scale predictive maintenance efforts across multiple facilities?



SOURCES: ADAPTATION FROM IOT ANALYTICS PREDICTIVE MAINTENANCE & ASSET PERFORMANCE MARKET REPORT 2023-2028

FIGURE 6

Advice for Manufacturers

Jumping into Maintenance 4.0 is super exciting, but it does come with its challenges. Here are some big ones to keep in mind:

Initial Investment and Equipment Needs:
One of the biggest challenges in adopting Maintenance 4.0 is the high upfront cost. Technologies like AI, big data, and IIoT devices can be pricey, especially for smaller companies. Plus, you'll need extra equipment, such as sensors and communication devices, to gather and transmit real-time data. These costs should be viewed as strategic investments to prevent unexpected failures and boost overall efficiency.

Cybersecurity Concerns:
With more connected devices and systems, cybersecurity becomes a critical issue. Maintenance 4.0's increased connectivity brings higher cyber threat risks. Investing in robust cybersecurity measures is essential to protect your data and ensure the smooth operation of your systems.

Cultural and Organizational Changes:
Implementing Maintenance 4.0 is a part of broader Industry 4.0 initiatives that are happening simultaneously in many factories. Effective change management is crucial. Upskilling and reskilling employees to use new tools and technologies is essential. Training, clear communication, and recognizing those who adapt well can foster a culture of innovation and accountability.

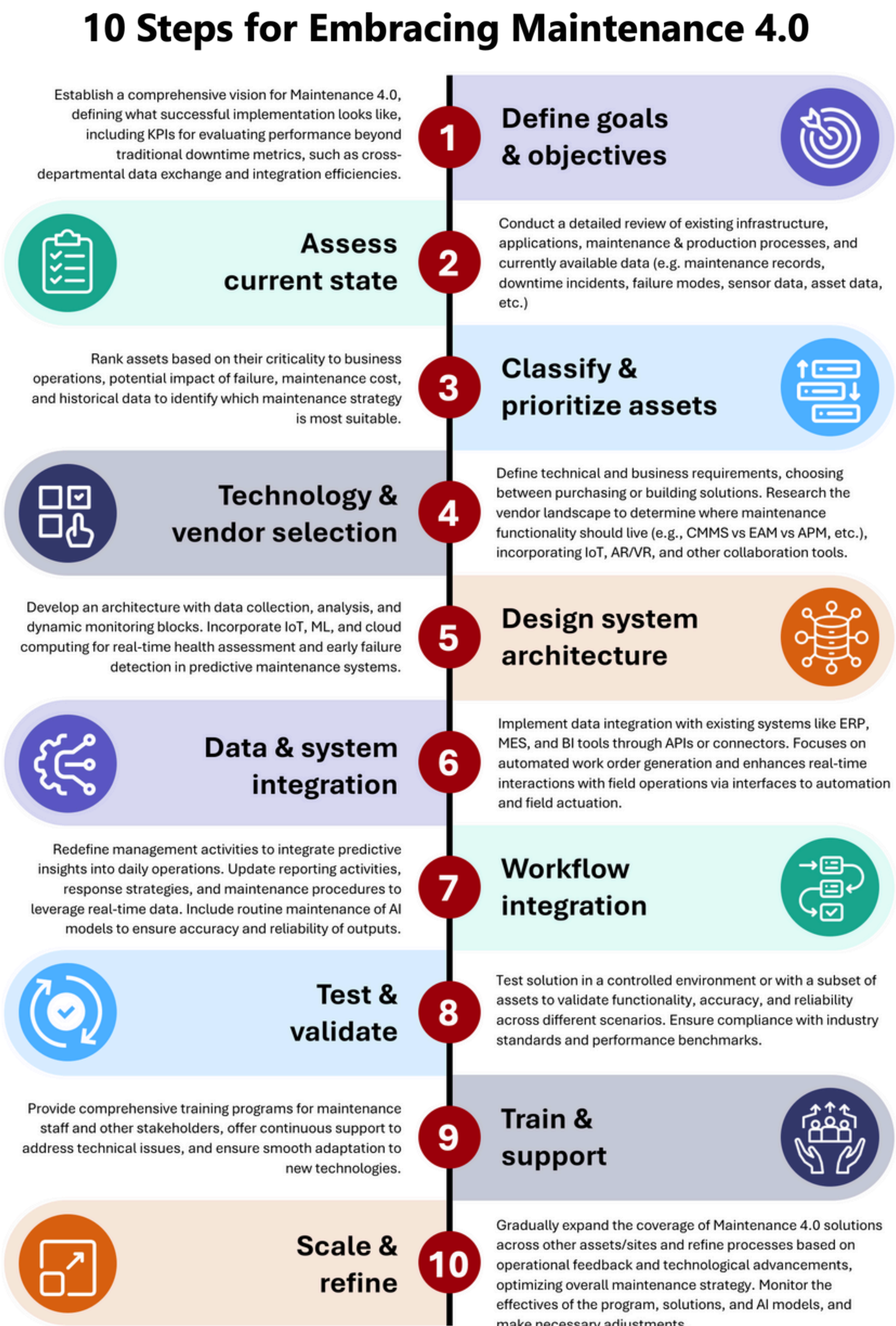


FIGURE 7

What to Expect in the Future

As we look to the future, the field of maintenance management will continue its evolution, driven by advancements in technology and increasing demands for efficiency and sustainability. We can expect further integration of artificial intelligence and machine learning to enhance predictive capabilities, making maintenance strategies even more precise and effective.

The rise of digital twins—virtual replicas of physical assets—will enable real-time simulations and more accurate predictions of equipment behavior. Additionally, augmented reality (AR) and virtual reality (VR) technologies will transform training and maintenance procedures, allowing technicians to perform complex tasks with greater ease and accuracy.

Moreover, the focus on sustainability will drive the development of maintenance practices that not only optimize operational performance but also minimize environmental impact. Predictive analytics will play a crucial role in reducing waste and energy consumption by ensuring that equipment operates at peak efficiency.

Jeff Winter

Industry 4.0 is a game-changer because it's centered around capturing and harnessing the power of data. It revolutionizes not just how things are made, but also how people work and how value is created.

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What is Autonomous Maintenance?

A PRACTICAL GUIDE TO IMPLEMENTING OPERATOR BASED RELIABILITY

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IDCON INC

What is Autonomous Maintenance?

The term Autonomous Maintenance is most known as one of the eight pillars in TPM - Total Productive Maintenance. The main idea in Autonomous Maintenance is that operators are responsible for performing minor maintenance tasks. You may also have heard of terms such as Operator Essential Care, Operator Based Maintenance, Operator Based Reliability, etc. in short, all these terms ultimately try to describe the same idea.

Autonomous maintenance can be implemented in many ways. The hope is that this practical guide will describe key concepts and challenges you may encounter when implementing an autonomous maintenance program. But keep in mind to modify the approach so that it fits your plant. We will be using both the terms autonomous maintenance (AM) and operator-based reliability (OBR) interchangeably throughout this guide.

As always, contact me if you need support to implement an autonomous maintenance program (operator-based reliability) at your site.

Tor

Operators doing a detailed cleaning

Operators taking a temperature reading

The reminder of this guide will focus on inspections, cleaning and operational practices since these tasks are usually included in an AM/OBR program. However, you and your organization should take time to think about getting operations involvement in the scheduling and prioritization of maintenance work and root cause analysis.

Implementation Plan for Documenting Autonomous Maintenance Tasks

The implementation plan describes the tasks, timeline, and responsible parties to achieve the future state. Most implementation plans usually exist of many small tasks; I have provided some important example tasks to consider in this guide.

Key Tasks

1 A simple, yet structured documentation process

This documentation process should consider:

- Clear description of what to do (training should cover how to do it, don't describe this in the task)
- Exactly where to do the task
- ·How often to do the task
- Tools needed to do the task
- Measuring points (if applicable)
- Who should do the task
- Tasks need to be coordinated with other departments to avoid overlap and missed equipment

There is not enough room in this guide to explain IDCON's full documentation process, so, we have opted to list a few key points. Feel free to email us at info@idcon.com or call me +1 919 723 2680 to discuss if you have questions. You can also watch my three part **Preventive Maintenance video series.**

2 Have a logical approach to your maintenance method. Methods include:

- Operate to breakdown
- Fixed Time Maintenance
- Condition Based Maintenance

Sometimes it is most cost effective to operate equipment to breakdown (OTB), sometimes do fixed time maintenance (FTM) and in many cases to do Condition Based Maintenance (CBM). If an autonomous maintenance program is designed by adding as many tasks as possible, it will become expensive, hard to manage, and almost impossible to execute. It is therefore key to coordinate between departments to avoid overlap and do tasks that add value

3 Develop and standard cleaning and inspections for components

Developing an autonomous maintenance system is a lot of work. It's recommended to use standard tasks for common equipment.

For example, a typical air cylinder will be inspected in the same way 99% of the time regardless of location or application. The same goes for most components such as pumps, motors, filters, couplings, and more. Set points such as temperatures and pressures may differ, but the same point will be measured and inspected. Therefore, it is key to develop a database of standard tasks and align it with the training materials.

4 Explain the "how" and "why" an inspection is done for operators.

Our Condition Monitoring Standards are designed to do this for you! You can download two examples from our website: **AC MOTOR and COUPLING GEAR**

5 Inspection routes should be designed in logical walking order.

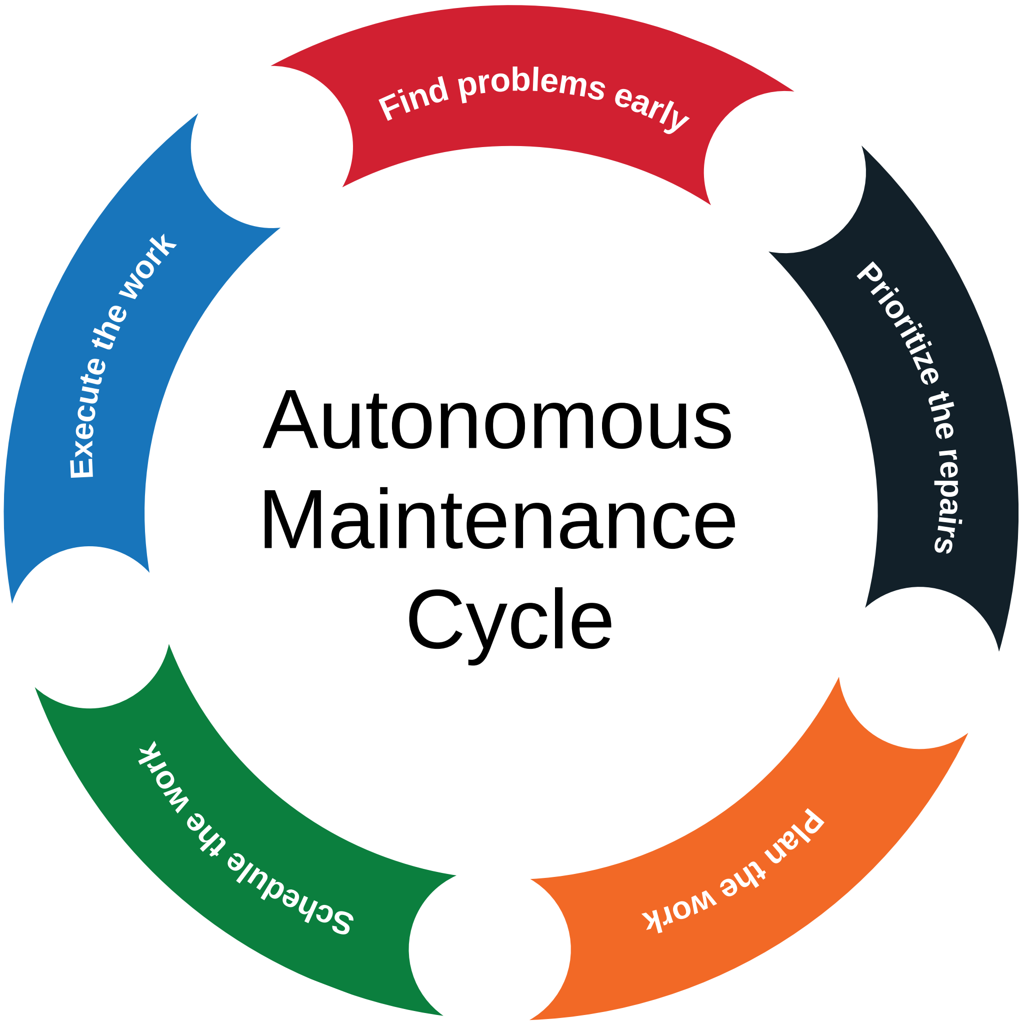
Do not make a route of only pumps for example. If you do it by component, the operator will have to walk the same area many times. Once for pumps, once for valves, once for hydraulics, once for piping, once for tanks, once for regulators, once for vacuum pumps, etc. In reality, the operator will never walk the area several times, so if you don't mix many types of equipment in one route, you will miss many critical pieces of equipment and end up with only motor inspections, or only valve inspections.

What about resources?

Deal with the Resource Issues Before Implementing the OBR program

Before you launch any AM process, you must be aware of what is going to happen to resources and cost. The process will save money, increase production output (through reliable equipment), and reduce the workload long term, but in the short term; it may do the opposite. **Why?**

If X number of operators are sent out to do detailed inspections, they will find problems. The whole idea of this program is to:



The backlog of maintenance work will increase once the AM system is launched. If it works well more problems will be found and the maintenance work will increase. It will cost both money and resources to repair all the problems found. Once the backlog is fixed, reliability starts to improve (assuming you prioritized correctly). Once the reliability starts to improve, costs will go down since the plant will have fewer repairs, use less parts, and have reduced interruptions in the production schedule.

ARE YOU READY TO IMPLEMENT AUTONOMOUS MAINTENANCE AT YOUR PLANT?

IDCON can help you get your program off to a great start with our coaching support, training, and reference materials.

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