

How Predictive Maintenance Supports Resilient Manufacturing

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Manufacturers are navigating a tempestuous landscape, wrestling with the intertwined challenges of pandemic-induced disruptions, potential tariffs and evolving policy shifts that strain global supply chains. During these volatile times, maintaining consistent and optimized production within manufacturing plants has become not just a goal but a necessity for survival.

Future-proofing production will require a manufacturer's proactive strategies and actions to ensure that operations can withstand future challenges, adapt to changes and remain competitive over the long term. It's about anticipating disruptions and trends while implementing measures to mitigate risks and capitalize on opportunities.

In such an environment, ensuring consistent and optimized production within manufacturing facilities will become paramount over the next five to 10 years. Predictive

maintenance—a critical component for operational stability—can serve as a powerful tool for manufacturers to not only minimize disruptions but also build resilient, future-ready operations.

For manufacturers seeking to navigate these challenges and optimize their production processes, let's look at how predictive maintenance of machines and equipment works and some best practices for implementing it.

Why Manufacturers Are Adopting Predictive Maintenance

Unplanned downtime costs industrial manufacturers approximately **\$50 billion annually**, with equipment failure causing 42% of these interruptions.

These costs and challenges have fueled significant investment in technology and automation, evidenced by the global supply chain management application market's projected growth to almost **\$31 billion** by 2026, and the predictive maintenance market's rapid **CAGR of 30%**, expected to reach \$19.3 billion by 2028.

Minimizing unplanned downtime can deliver an impact that becomes amplified when external supply chains are unreliable. Unexpected breakdowns can halt production entirely, leading to missed deadlines, penalties and dissatisfied customers—issues that are hugely impactful and hard to recover from.

Unlike reactive maintenance (fixing things after they break) or preventive maintenance (fixing things on a schedule), predictive maintenance allows manufacturers to schedule maintenance only when it's truly needed, optimizing resource allocation and minimizing disruptions.

The Role Of Predictive Maintenance For Resourceful Manufacturing

In practice, predictive maintenance involves deploying various sensors on critical machinery and equipment. These sensors collect real-time data on parameters such as vibration, temperature, acoustic emissions, pressure and fluid levels.

This raw data is then transmitted via the industrial Internet of Things (IIoT) to a centralized system. Advanced analytics, often powered by artificial intelligence (AI) and machine learning (ML) algorithms, process this data to identify anomalies, trends and patterns that indicate impending equipment degradation or failure. For example, a subtle increase in vibration frequency or a consistent rise in motor temperature might signal an imminent bearing failure.

This data-driven insight allows plant managers and head engineers to schedule maintenance tasks proactively, addressing potential issues before they escalate into costly breakdowns.

This fits into current workflows by providing maintenance teams with targeted alerts and actionable insights, enabling them to transition from a "break-fix" mentality to a "predict-and-prevent" approach. Maintenance windows can be scheduled to coincide with periods of lower demand or planned production pauses, ensuring minimal impact on production schedules.

Predictive maintenance can also enable better allocation of maintenance personnel, resources and spare parts inventory. By addressing potential issues early on, predictive maintenance can significantly extend the lifespan of valuable machinery, minimizing the need for premature capital expenditures on replacements—a crucial advantage when economic uncertainty is high and investment decisions are under greater scrutiny.

Malfunctioning equipment can lead to defects and inconsistencies in product quality, so predictive maintenance is also intended to help ensure that machinery operates within optimal parameters, contributing to higher quality output and reducing waste. Maintaining customer satisfaction and minimizing the costs associated with rework or recalls is key.

Similarly, identifying and addressing potential equipment failures before they occur can significantly improve workplace safety, preventing accidents and injuries, protecting employees and avoiding potential legal liabilities.

The Four Tenets Of Predictive Maintenance

To achieve best practices in predictive maintenance, start with these four fundamental tenets, each a critical step in building a reliable, scalable and sustainable predictive maintenance program:

1. Determine asset criticality for predictive maintenance investment.

Start with a risk-based asset management approach aligned with your business priorities. Identify assets with a high consequence of failure, considering their impact on production, operations, safety, compliance and repair/replacement costs.

These high-risk, high-criticality assets are prime targets for predictive maintenance strategies.

2. Choose the right parameters or conditions to monitor.

Select indicators that directly reflect an asset's performance, wear and potential failure modes.

These parameters should serve as early warning signals, allowing for intervention before major damage occurs. They must be consistently measurable and accurately trackable over time.

3. Decide how to monitor those parameters and conditions.

When selecting monitoring technology, prioritize risk, value and practicality. High-criticality or hard-to-access assets often justify remote, real-time solutions (e.g., IoT sensors), while less-critical assets might only need handheld tools or periodic checks.

You can also leverage existing infrastructure (like production or ERP systems) if their data can be repurposed for predictive maintenance. Choose technologies that integrate with existing CMMS or PdM platforms.

4. Create rules for parameter data collected that indicate impending faults or failures.

Establish rules and triggers for machine condition monitoring based on clear thresholds or patterns that signal potential faults before they occur. Rules should minimize false alarms by accounting for normal process variability.

Once you've created these rules, create actionable alerts to provide sufficient lead time for effective intervention without overwhelming your team. Define actions and remediations for triggered rules, including notifications and workflow decisions for relevant stakeholders.

Conclusion

Predictive maintenance will shift focus from reactive fixes to proactive prevention, helping manufacturers reduce costs, avoid unexpected downtime and improve equipment reliability.

As external pressures continue to shape the manufacturing landscape, operational stability becomes increasingly important. Predictive maintenance supports this by enabling data-informed decision-making and better resource allocation.

Adopting these practices allows manufacturers to build more resilient operations, better prepared to adapt to evolving challenges.