Why Predictive Maintenance is Driving Industry 4.0

The Definitive Guide
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Introduction

Maintenance is a strategic concern when developing and manufacturing a product – and for good reason.

In fact, a third of all maintenance activities are carried out too frequently – and, according to IBM, nearly half are ineffective.

For machine operators and factory managers, preventative maintenance and asset repairs consume unnecessary resources, eat deeply into operational costs, and present a serious impediment to efficient operations. A single hour of downtime alone can cost a large enterprise over $100,000 in lost productivity, and can be a hard hit to customer satisfaction.

For product manufacturers, this means higher field service costs, higher customer service center costs, lower customer satisfaction, and a distinct disadvantage facing the competition.

Manufacturers and asset managers are turning to Industry 4.0, also known as the Industrial Internet of Things, for a superior approach. This involves continually generating and transmitting product behavior data, capturing the data in a central repository, and applying advanced big data analytics techniques to sort through massive amounts of data and identify important patterns.

This pattern identification can lead to “just-in-time maintenance” - actionable insights that predict product failure to increase product uptime and improve asset efficiency.

Given this, it’s no surprise that the market for predictive maintenance applications is surging, predicted by one report to hit $10.9B by 2022.

Read on to learn why the advent of Industry 4.0 and predictive maintenance have become the top business objective for many manufacturers - and how to overcome the challenges of implementing such a system.
Benefits of Predictive Maintenance

“Better predictive maintenance using IoT can reduce equipment downtime by up to 50 percent and reduce equipment capital investment by 3 to 5 percent...In manufacturing, these savings have a potential economic impact of nearly $630 billion per year in 2025.”


Imagine if you received an alert from a mobile app ahead of any fault occurring. Instead of having to guesstimate when the part will be obsolete based on past observation, or hope to catch it through regular monitoring, predictive analytics tell you when to replace the part, reducing planned downtime and keeping the product running for an optimum amount of time.

Predictive maintenance also eliminates unnecessary repair costs, a large unknown for both manufacturer and end user. When an electronic component in a product fails, identifying the problem may take 5 minutes – or 5 hours. The same holds true for replacing broken or worn-down parts.

Major breakdowns are expensive, both because of lost operating time as well as secondary financial losses. Worse, the larger or more complex the machinery, the greater impact maintenance has on production and runtime costs. Even a small flaw in the system, if not caught early, can lead to unexpected and costly downtime.

With preventative maintenance, replacing parts too early also carries an unnecessary financial burden on the business.
That’s where predictive maintenance and Industry 4.0 steps in:

- **Reduce downtime and improve production yield** – Reduce unplanned downtime by catching issues before they can make a whole system fail. And reducing planned manual inspections also boosts productivity and production yield.

  ![Cost reduction chart](image)

  Respondents in a PwC survey expected to reduce operational costs by 3.6% annually through implementing Industry 4.0 initiatives.

- **Reduce repair costs by eliminating unneeded replacements**

- **Extend asset life** – IoT behavior analytics enables OEMs to perform data-driven root cause analysis of faults to improve product resilience in subsequent iterations of the product.

- **Monetize Predictive Maintenance** – When manufacturers can prove they have increased uptime and lowered maintenance costs, they can deliver a measure of predictability to their customers that can increase purchase price and be leveraged as a strategic competitive edge. The opportunity to introduce digital services to customers based on data analytics can also generate a recurring revenue stream and breakthrough growth for the company.

- **Improve customer satisfaction** – Automated alerts that remind customers when it’s time to replace parts and recommend maintenance services at specific times will both differentiate your product from others in market and keep customers happy.

To deliver these objectives, manufacturers turn to Industry 4.0 - the interconnected devices, sensors, cloud, gateways and other parts of Industrial Internet of Things system - in order to quickly collect massive quantities of data from multiple machines and locations, and then apply Big Data analytics to deliver predictive maintenance insights.
The Evolution of Predictive Maintenance

Manufacturers have been carrying out predictive maintenance for years, with different levels of maintenance activity corresponding to the company's level of maturity:

- **Reactive Maintenance** - This deals with problems after they arise, i.e. ‘fighting fires’.

- **Preventative maintenance** - This involves visual inspections, followed by regular asset inspections that provide more specific, objective information about the condition of the machine or system.

- **Rule-based predictive maintenance** - Also known as ‘condition monitoring.’ Sensors continuously collect data about assets, and send alerts according to predefined rules, including when a predefined threshold has been reached.

- **Machine learning-based predictive maintenance** - This relies on large sets of historical or test data, combined with tailored machine-learning algorithms, to run different scenarios and predict what will go wrong, and when - and then generate alerts.
Every company with products in market can identify some of the reasons for equipment failure. Product teams can confer with engineering and customer service departments to establish known causes for machine breakdown or learn which situations have a high likelihood of leading to parts failure.

With the common reasons for product failure established, product teams then set to define the IoT Model – a blueprint of the connected system of data-collecting sensors, data connectivity, applications, cloud, gateway and other system components.

The model also defines the product use cases, with “IF-THIS-THEN-THAT” rules which describe the behaviors and interdependencies between the various IoT system components. For example, if temperature and rotation speed are above certain predefined levels, the system will send an alert to a web dashboard or personal app, so the danger can be addressed in time.

This IoT model provides much-needed clarity to data gathering from the get-go.

**With all its benefits, data collection is only useful when you collect the right data, control the collection, and make the right business decisions in response to that data.**

Use simulation to validate the model use cases - including data simulation to validate the dashboards and alerts and ensure that the necessary data is collected. This helps teams catch errors early on, before spending a penny on development and production.

Simulating how the smart machine, product, or system will function in ‘real life’, helps teams catch errors early on - before spending a penny on development and production.
Later, the same dashboard can be integrated with insight from machine learning to provide a visually understandable heatmap of asset conditions in real-time.

With the validated model in place, we can proceed to delivery. Use an IoT Development Platform to enable collaboration between internal and external teams and keep the model in sync with the developed product at all times.

Your IoT Development Platform should also (automatically) translate your IoT model into predictive maintenance dashboards and alerts in accordance with the use cases defined in the model.

While rule-based predictive maintenance provides some level of automated, predictive maintenance, it is still dependent on a product team’s understanding of what parts or environmental elements require measuring, as well as their ability to predict what can break down.
Machine learning is crucial for acting on insight, rather than hindsight. When properly designed and implemented, a machine learning algorithm will learn your normal data's behavior and identify deviation in real-time.

This is what the standard machine learning process looks like:

- **Data collection** - sensors implemented in machines gather data on the machine and its environment
- **Feature Extraction and Reduction** - Elements for measuring are chosen and extracted - for example, temperature levels or motor rotation speed.
- **Model creation** - An algorithm runs all the data multiple times in a learning model
- **Model validation** - the model with its data is tested against the real world variables or ‘output’ that manufacturers are testing for - for example, alarms when the system stops working.
- **Deployment** - the model is deployed, and if it shows anything but the desired behavior, the discrepant behavior is relayed back to the model to improve the system's future performance.
This system requires both input (historical or a training set data) along with output (the desired result). A machine monitoring system would include input on different temperatures, engine speed, etc. and the output would be the variable in question - a warning of future system or parts failure. The system will then be able to predict when a breakdown will likely occur.

Challenges in implementing machine learning for industry 4.0

We’ve established that predictive maintenance provides tremendous business benefits, and that machine learning is an advanced approach to implementing predictive maintenance. Yet according to a survey by PWC, only 11% of surveyed companies have ‘achieved’ machine-learning-based predictive maintenance.

What is keeping industrial manufacturers from implementing machine learning?

“Industrial companies produce a massive amount of data on a daily basis. However, by and large, [they] fail to systematically collect, store, analyze and use such data to improve process efficiency or meet other goals.”

Mika Tanskanen, SAS Finland, “Applying machine learning to IoT data”

There are three primary challenges in implementing machine learning for predictive maintenance:

1. **Identifying the necessary data to collect** - Manufacturers who have never launched a connected system or machine begin blindfolded - without clear evidence of which data will prove valuable, or which data to collect.

2. **Obtaining the necessary data set** - Without this input, it’s impossible to start running a machine-based algorithm. Time is not on your side - it takes a significant amount of time and resources to develop a machine learning solution or select the right algorithm, and choosing the wrong one leads to massive losses in costs and deadlines.
3. **Advanced data science** - Understanding a pile of often messy historical data requires not only the right algorithms - there are dozens of possible machine learning algorithms to choose from - but also a method of presenting the data-driven insight clearly after it has been analyzed. If the algorithm is unsupervised, it will also require data-labelling - a manual, time-consuming task which relies on skilled data scientists. And not every company has the resources for such personnel.

Due to these challenges, predictive maintenance is often restricted to the minority of companies whose machines have been collecting data for years, and now utilize advanced analytics platforms to sort through that data.

Companies implementing a connected system for the first time, with the goal of implementing machine learning for predictive maintenance, will find it difficult to cross the starting line.
A pragmatic approach to bypass the need for a large historical data set, and advanced machine learning algorithms at the very outset, is to begin with rule-based predictive maintenance.

This gives companies quick business results and a stepping stone into machine learning. Instead of requiring a large data sets ahead of time, you can start with basic assumptions or ‘rules’. Over time, as the system aggregates historical data, the company can experiment with and apply machine learning algorithms for more accurate predictions.

Because the predictive, rule-based model can be designed without live sensors or historical data sets, it democratizes predictive maintenance - making it viable both for companies who have already implemented IoT and for those who haven’t yet designed their connected system.

Rule-based predictive maintenance is not the be-all and end-all for predictive maintenance. The approach is based on ‘what if’ scenarios that you can define, rather than a machine algorithm running possible scenarios. It’s not foolproof, but it is achievable, affordable, and delivers business benefits.

The ideal solution is to start with a rule-based model, defining and simulating use cases and required alerts. Once you have collected enough data, implement machine learning algorithms and iteratively refine them based on the accuracy of the predictions attained.
About Seebo

The Seebo Platform makes it easy for manufacturers to plan and deliver smart, connected products that drive outstanding customer value. Seebo's cloud-based software combines IoT Modeling, Simulation, and Behavior Analytics into pre-packaged business solutions. Manufacturers from dozens of industries are using these solutions to accelerate new product innovation, improve product resilience, and introduce data-driven services.

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