Leveraging predictive maintenance for higher profitability

Predictive maintenance is a popular application of predictive analytics that can help businesses in several industries achieve high asset utilization and operational cost reduction. It is designed to help determine the condition of in-service equipment in order to predict when maintenance should be performed. This approach promises cost savings over routine or time-based preventive maintenance, since tasks are performed only when warranted.

Unscheduled equipment downtime can be detrimental for any business. It is critical to keep field equipment running to maximize utilization and minimize expensive, unscheduled downtime as well as health, safety and environmental risks. The goal of a predictive maintenance strategy is to extend the useful service life of equipment and prevent failures. Anomaly detection is a common approach because it identifies when a device is behaving differently than expected.

Predictive maintenance leverages data from an individual asset to predict failure. This way, repairs can be done when needed (and avoided when not).

Business case for predictive maintenance

Businesses require critical equipment to be running at peak efficiency and utilization to realize their return on capital investments. These assets could range from aircraft engines, turbines, elevators, or industrial chillers—which cost millions—down to everyday appliances like photocopiers, coffee machines, or water coolers.

- By default, most businesses rely on **corrective maintenance,** where parts are replaced as and when they fail. Corrective maintenance ensures parts are used completely (therefore not wasting component life), but costs the business in downtime, labor, and unscheduled maintenance requirements (off hours, or inconvenient locations).
- At the next level, businesses practice **preventive maintenance,** where they determine the useful lifespan for a part, and maintain or replace it before failure. Preventive maintenance avoids unscheduled and catastrophic failures.

The goal of a predictive maintenance strategy is to extend the useful service life of equipment and prevent failures.

However, high costs of scheduled downtime, underutilization of the component before its full lifetime of use, and labor still remain.

- The **goal of predictive maintenance** is to optimize the balance between corrective and preventative maintenance, by enabling just-in-time replacement of components. This approach only replaces those components when they are close to failure. By extending component lifespans (compared to preventive maintenance) and reducing unscheduled maintenance and labor costs (over corrective maintenance), businesses can gain cost savings and competitive advantages.

Predictive maintenance in business areas

This was implemented in the electromechanical shovels industry to monitor and predict the failures upfront, so as to estimate and eradicate failures for smooth machine flow.

Challenges

Traditionally, it has been difficult to apply condition monitoring and predictive techniques to these electromechanical shovels due to inadequate analysis algorithms and equipment, as well as the harsh environment. Traditional vibration analysis (the main tool for predictive maintenance on rotating machines) performed by conventional equipment is based on the Fourier transform, which assumes constant rotational speed. This is not adequate for the shovel, and hence, a different approach is needed.

Solution

Predictive maintenance as a process flow with 3 steps, as illustrated below:

Collect: First, you'll need to gather relevant data that can help you predict time-to-failure. This is often done by adding vibration IoT sensors to get “indirect” data, for example.

However, a far more direct method is to tap into the run-time data the machine uses to operate. All vehicles—and most industrial machinery—operate using a combination of transducers (sensors and actuators) and control units. The control units implement algorithms that determine the behavior of the machine. The run-time data is continuously transported, often using wires and communication protocols.

A popular transportation method is "CAN bus” (Controller Area Network) that is used in automotive to allow communication between ECUs and sensors, which is standard in all vehicles. If a vehicle or machine uses CAN bus wires for data transportation, it's often possible to safely tap directly into the run-time data stream. This can be done using an IoT CAN bus data logger, which opens up the full scope of your asset operational data. Your CAN logger can then transfer this data to the cloud via a WiFi hotspot (WLAN, 3G, 4G) in near real time.

Predict: The collected data is processed in the cloud. For CAN bus data, this includes transforming the data to scaled engineering values. Once ready, the data can be used in a predictive model. These range from simplistic single-variable thresholds to advanced machine-learning algorithms.

React: The model provides estimates of the time-to-failure for an asset and its components. From here, it's 'simply' reacting on the insight: Auto-schedule maintenance, send push notifications to warn staff of potential breakdowns and optimize your spare part inventory.

Conclusion

Machine learning is a natural fit for predictive maintenance, which involves failure classification using huge amounts of sensor data.

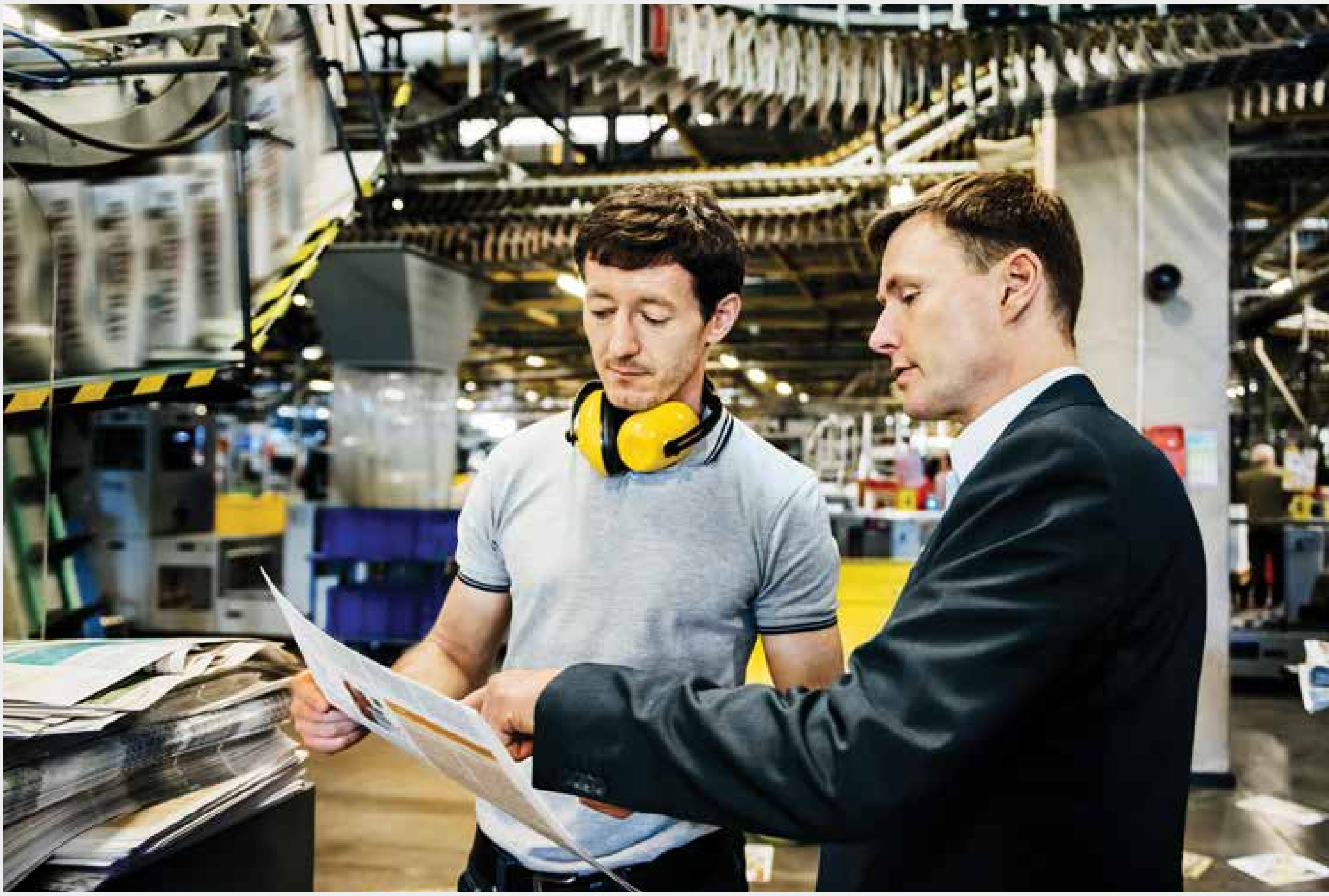
To build a failure model, we require enough historical data that allows us to capture information about events leading to failure. In addition, general "static" features of the system can also provide valuable information, such as mechanical properties, average usage and operating conditions. However, more data is not always better.

When collecting data to support a failure model, it is good to ask questions like:

a) What are the types of failure that can occur? Which ones will we try to predict?

b) What does the "failure process" look like? Is it a slow degradation process or an acute one?

c) Which parts of the machine/system could be related to each type of failure?



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Kalyani is an expert in multiple analytical tools and data mining methodologies. She has also worked on various analytics projects in Manufacturing and Technology, Energy and Utilities and Healthcare domains. Her experience includes data analysis, proposing analytical solutions, generating dynamic reports and other data preparation components like data pre-processing, profiling, cleansing, validation and transformation.

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