Introduction

To gauge IIoT impact on maintenance-related activities, it helps to revisit higher-level concepts related to maintenance maturity and associated definitions. ARC's recent review of current maturity models uncovered many different versions of it as well as many internal inconsistencies. The industry lacks a true standard to build upon. This lack of clarity makes it difficult to compare solutions, leading to confusion among potential users and delaying the application of solutions.

While industry participants generally have a good understanding of both reactive and preventive maintenance, we've encountered a variety of interpretations for condition-based, predictive-maintenance and prescriptive-maintenance approaches, and where IIoT comes into play. A clearer definition of these upper maintenance-maturity levels is needed for users to be able to better assess the available alternatives.

Credit: https://industrial-iot.com/2017/02/iiot-expands-the-maintenance-maturity-model/

Reactive maintenance

Reactive, or run-to-failure, maintenance is the most common approach for equipment, since most assets have a very low probability of failure and are non-critical. This approach helps control maintenance costs, but is only appropriate for non-critical assets.

Preventive maintenance

Here, maintenance is performed based on either time (analogous to replacing the batteries in your household smoke detectors once a year), or usage (changing your car's oil every 5,000 miles). Preventive maintenance applies to assets with an age-related failure-pattern, where the frequency of failure for the asset increases with age, run-time, or number of cycles.
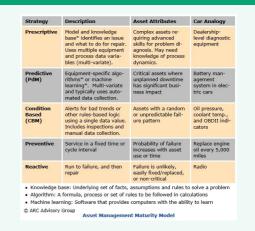
Condition-based maintenance

CBM involves monitoring a specific asset parameter. The focus tends to be the amplitude of the value, with vibration monitoring being the most common. CBM typically applies to production (rotating equipment) and automation (instruments and the control system) equipment. For stationary plant equipment, such as steam boilers, piping and heat exchangers, periodic inspections and condition evaluations are often used.

Asset Maturity Models

Strategy	Description	Asset Attributes	Car Analogy
Prescriptive	Model and knowledge base* identifies an issue and what to do for repair. Uses multiple equipment and process data variables (multi-variate).	Complex assets requiring advanced skills for problem diagnosis. May need knowledge of process dynamics.	Dealership-level diagnostic equipment
Predictive (PdM)	Equipment-specific algorithms* or machine learning*. Multi-variate and typically uses automated data collection.	Critical assets where unplanned downtime has significant business impact	Battery management system in electric cars
Condition Based (CBM)	Alerts for bad trends or other rules-based logic using a single data value. Includes inspections and manual data collection.	Assets with a random or unpredictable failure pattern	Oil pressure, coolant temp., and OBDII indicators
Preventive	Service in a fixed time or cycle interval	Probability of failure increases with asset use or time	Replace engine oil every 5,000 miles
Reactive	Run to failure, and then repair	Failure is unlikely, easily fixed/replaced, or non-critical	Radio

- Knowledge base: Underlying set of facts, assumptions and rules to solve a problem
- Algorithm: A formula, process or set of rules to be followed in calculations
- Machine learning: Software that provides computers with the ability to learn

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Asset Management Maturity Model

Predictive maintenance

PdM uses engineered algorithms and machine learning with multiple input parameters to provide higher accuracy (fewer false positives or missed issues) and more advanced warning before failure. It combines "small data" from a device or system with algorithms that model that type of equipment (sometimes called virtual equipment or a "digital twin") to monitor-condition and raise an alert when appropriate. This provides the more advanced notice needed to schedule and execute the maintenance during planned shutdowns..

Prescriptive maintenance

Builds on PdM with alerts that provide diagnostics and guidance for repair. Information for determining the timing and impact of failure is also included to help assess priority and urgency.