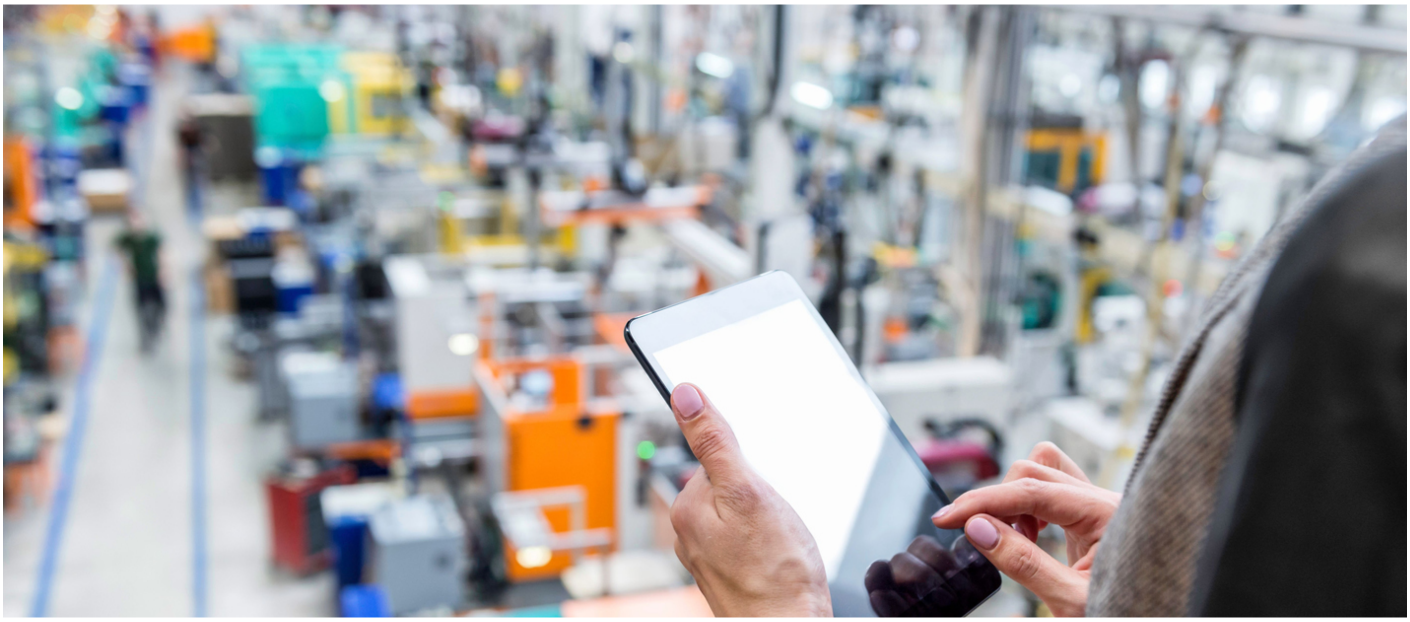
TOMORROW'S CHALLENGES



PUTTING ADVANCED ANALYTICS TO WORK

The predictive maintenance sweet spot

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Within the burgeoning field of Advanced Analytics, there is an application that holds particular potential: Predictive Maintenance (PM). The promise of PM is that, by using predictive analytics, companies can probabilistically anticipate which equipment is in need of repair, new parts or otherwise at risk of failure. This helps managers shift their upkeep programs from being reactive and routine to being proactive and fixing problems before they arise.

Leveraging the ongoing huge investments in Internet of Things (IoT), companies are developing the capability to collect vast data sets of conditions from connected assets ranging from environmental variables like ambient temperature to process variables like pressure, vibrations and product flow. Tetra Pak, for example, invested in sensors to monitor every step in the manufacture of its packaging materials to fully capture all of the potential areas of production disruption. The amount of data being collected is staggering. Per Dmitry Smolin, Director of the Smart and Connected Factory Program noted: *"We record, on a daily basis, one billion data points from all of our machines. For example, a laminator has 400 sensors which are constantly recording information."*

Combined with more direct data like production speeds, line stoppages and breakdowns, analytics and machine learning are then applied to the data to generate predictions of equipment failure, for example of an automotive manufacturing line. Rather than perform routine maintenance, over-maintaining or wait until the failure occurs, the predictions are used to anticipate issues and resolve them before they escalate.

The potential benefits of anticipating equipment maintenance or repair needs becomes apparent when one considers equipment difficult to access, such as an offshore wind turbine, or equipment with very high stakes of failure, like an oil pipeline or a gas turbine. Assets that can be repaired before they fail are safer for people and the environment, and the overall maintenance costs can be considerably lower by having less and shorter downtimes, lower technician time and fewer spare parts in stock. The opportunity for savings are staggering, with a recent report from McKinsey estimating that by 2025 the annual benefits of predictive maintenance could be as much as $US 630 billion by increasing asset availability by up to 18% and reducing maintenance costs by as much as 25%.

The predictive maintenance sweet spot

PM seems like the perfect real-world opportunity for Industry 4.0. The benefits are visible and measurable, and it rests on a foundation of some of the most prominent Industry 4.0 technologies that otherwise may seem nebulous, like machine learning and Internet of Things. But closer consideration leads to the realization that there is a set of circumstances that must come together for PM to be effective; a 'sweet spot' of conditions that will enable PM to be a true game-changer. PM will be either difficult to implement or will not fully harvest benefits should one of the key elements be missing.

The first element of the sweet spot is that *the necessary data be collectible and connectable*. Data sources may include IoT connected sensors, soft data like repair logs and local root cause analysis trees. In almost any sort of data collection there is a challenge of standardization of data (some may be in local units, handwritten or in a different language!). Data availability is far more likely when the organization already has a culture of discipline in lean or kaizen to push for continuous improvement. From there, cloud capability and data lakes are needed to store the data, so the asset must have opportunities for connectivity. Oil pipelines, for example, might be a challenge and require more investment for connectivity.

As with other machine learning applications, PM will have a difficult time developing reliable, actionable predictions if there are too many variables or too many potential root causes of failures. The system will be too complex to develop algorithms economically and each discrete failure cause will lack a sufficient training dataset. Yet if there are very few variables or root causes, the asset may not warrant inclusion in a PM program, since failure predictions could likely be done by traditional statistical methods without turning to more expensive machine learning. To be a candidate for PM, then, the asset must have *a moderate quantity of impacting variables and failure root causes*.

The final element of the sweet spot is that the economic stakes must be sufficiently high. Designing and implementing a PM program will require mapping out a strategy, investment in sensors and connectivity, recruiting and training to develop expertise in machine learning and managing a transformation initiative. *The benefits of PM must warrant the investment*, be they in the form of preventable equipment down time, increased efficiency, lower labor and diminished safety or environmental risk. For this to be the case, the targeted asset must either be highly strategic, such as a critical production line, or there must be multiple, very similar assets that can benefit as a whole from a single PM program, such as turbines in a windfarm.

The predictive sweet spot in action

Fabrice Lebeau, the Head of Big Data Analytics at Dassault Aviation helped illustrate the sweet spot of PM in action in the aviation industry.

Fabrice explained how PM is becoming commonplace in aviation. "*PM emerged five years ago, along with Big Data technologies and machine learning algorithms, on the new planes equipped with powerful onboard recorders; it all started with the Airbus A380. Manufacturers like Airbus and airlines like Air France KLM are paving the way with maintenance of commercial aircraft. The private aviation market is ramping up and closing the gap but there are fewer business jets in service, which means less breakdowns, which means less data available to feed the machine learning algorithms that power PM. This stretches out not only the learning curve and the ramp up time, but also emphasizes the importance of simulations that are fed by and supplement real data for training PM algorithms. This is called a 'Digital Twin' and at Dassault Aviation, we are pioneers in this field*."

The objective for Dassault and other plane manufacturers in their PM program is not to eliminate routine, scheduled maintenance. As Fabrice puts it, "*Our goal is to increase the availability of the plane while waiting for repair and parts by avoiding unscheduled maintenance. All this data also helps us optimize scheduled maintenance and product robustness through better knowledge of its condition and environment*." For commercial aviation, the economic consequences of having a grounded plane due to an unplanned breakdown can run into the several hundreds of thousands of US dollars per day, as airlines scramble to find alternate transportation for passengers and allocate technicians to diagnose the problem and send urgent, often expensive parts to the grounded aircraft. For private aviation, unscheduled maintenance is mostly associated with reputational cost in a market where the clients are business executives or public officials with high service expectations.

Fabrice laid out the staggering amount of data available to feed their PM program. "*There are thousands of discrete pieces of equipment on each airplane, generating tens of thousands of continuous data streams recorded by onboard computers. In fact, the newest business jets can easily generate 20GB of data for every hour of operation*." The connectivity opportunity to load this data occurs when the plane lands and finds either a 4G (soon 5G) signal.

With all of this data, it would be too complex to build PM algorithms for all systems, and choices must be made for prioritization. Fabrice explained that priority is to look for non-redundant equipment that would cause a plane to be grounded in case of breakdown. He cited the engine, air, fuel, braking and hydraulic systems as prime targets for PM. These systems offer the most compelling savings if their repair needs can be sufficiently anticipated as to integrate them into routine maintenance. As to what elements are poor fits for their PM program, Fabrice mentioned structural issues such as corrosion and cracks. "*To date, there's simply no way to capture and collect data. We need to inspect planes visually by highly trained technicians during scheduled stops*."

Interestingly, when asked about challenges to implementation and attaining this goal, Fabrice explained that for some people there is a lack of confidence in the reliability of the PM algorithms, particularly in the case of false positives. This can create a perception of unnecessary costs, should the technician replace a part that is not yet broken. Some are skeptical that the repair was warranted and the PM risks eroding trust.

The example of Dassault illustrates the PM 'sweet spot' in action. Not all maintenance requirements on a plane can be modeled with capturable data. But for those that can, the complexity and volume of data has led Dassault to prioritize where to target their PM efforts, which they are doing by analyzing the high economic stakes and likeliest causes of a breakdown with their engineering expertise.

Takeaway

PM is a powerful use case that brings together some of the key elements of Industry 4.0: machine learning, IoT and cloud computing. The example of Dassault shows how there is a 'sweet spot' where the combination of data availability, manageable prediction variables and economic stakes create an opportunity for PM to add real value for operations in any vertical with physical assets to manage, be it in factories or elsewhere.

As much as technology, the identification and leveraging of these 'sweet spots' will help move forward adoption and industry satisfaction with Industry 4.0 and supply chain digitalization solutions.

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