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7 Elements of IoT for Predictive Pump Maintenance

Learn the steps to get consistent value from predictive maintenance programs.

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Much like a chain on a bicycle or a chain used to pull a lodged vehicle out of a ditch, the value chain of the internet of things (IoT) is only as strong as its weakest link. Often the results or lack of results are due to breakdowns in the people and process link of the value chain.

Take, for example, monthly based predictive maintenance routes, where the vibration technician goes to each pump or asset, connects the sensor, collects the data, goes to his or her office, analyzes the data and, if a problem is detected, writes up a report or work order. In many cases, the work order is completed and a larger failure and cost of maintenance or lost production is avoided.

It is also common for the work order to be delayed for more urgent work. The nature of a work order from a predictive or leading indicator is that the machine is still running. When the work is delayed, it is typically due to misunderstanding the report. In these cases, the report is vague, uses terms or vibration jargon unfamiliar to the maintenance decision-maker, or simply says, "Do this repair at your next earliest convenience."

All too often there is not a convenient time, the repair is not prioritized, the repair is not completed, the pump fails and the value of predictive monitoring is not realized. The breakdown in this value chain is in the people and process link.

The sensor was connected, the data was collected, the analysis was completed, the work order filled out, yet the process of prioritizing and completing the work was broken.

How the 7 Elements of IoT Help

Based on decades of experience in the industrial maintenance space, the first way the seven elements of IoT help is by defining the necessary links to get all the way to "value" or work completion. In past years with or without IoT, the common failure point in creating value from predictive maintenance has been in the people and process link. Many route-based or wired predictive monitoring deployments omitted this element.

With luck, value may have been delivered initially when there was a lot of attention to the effort, yet over time the value was lost, perhaps because of personnel turnover, or a lack of a well-defined or understood "value chain."

In starting new, or reviving predictive maintenance programs, one of the first questions to ask is, "When is value realized?" A typical answer is, "When the report is delivered, or when the alert is sent." But, the value is realized if, and only if, the recommended work gets done.

In these 7 elements, the work gets done in element No. 7 by the people and the process. The challenge to ensuring a successful predictive maintenance monitoring solution—whether it is IoT or another tool—is to work successfully,

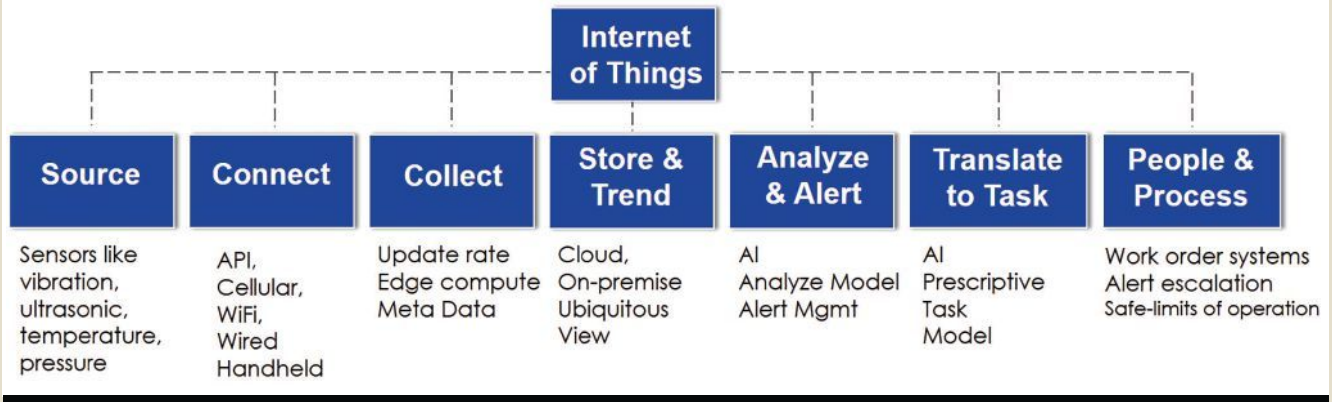

Image 1. Examples of equipment and processes in each of the seven elements of IoT *(Image courtesy of Atek Companies)*

consistently and expediently through the seven elements to get to value creation.

The Broken Value Chain

Common pitfalls in the rush to use IoT, artificial intelligence and machine learning often involve overlooking one of these seven elements, resulting in a broken "value chain." For example, many data science companies are working to bring value and the benefits of machine learning, artificial intelligence and predictive maintenance to industry, yet are unfamiliar with failure modes and the effects of industrial pumps.

In many cases, the use of anomaly detection creates nuisance alerts and unproductive tasks for the maintenance tech to check on assets or process where no problem is found. In other cases, the baseline methods used with anomaly detection miss existing failures and the new technology and programs take on an immediate hit, scoring one for the unpredictable machine.

Here is how to translate the 7 elements of IoT to industry:

1 **Source:** To establish a strong link for the source element (pump), users need to know what conditions or failures are most valuable to detect. The most common issue for pumps is seal failure. To detect and mitigate this early requires understanding the root cause. The likely root cause of a seal failure is shaft deflection or vibration; the cause of shaft deflection could be cavitation, not running at the best efficiency point (BEP), bearing fault and/or lubrication fault.

Selecting a leading indicator or measurement is key to building a strong link for the source element. A best practice for monitoring a leading indicator for seal health is to use ultrasonic and vibration monitoring. Ultrasonic is a less known measurement and is a strong leading indicator of cavitation, bearing and lubrication faults. Vibration is a tried-and-true measurement that detects late-stage issues like misalignment, looseness, pipe resonance or late-stage bearing failure.

2 **Connect:** A strong link for the connect element means flexibility for wired, Wi-Fi, cellular and application program interface (API) connectivity for a wide range of assets in-plant, utility room, roof-top, tank farm and off-site assets. A connecting device that can edge compute high frequency data to 100 kilohertz (kHz) for ultrasonic sensors is a benefit, as well as the onboard memory to time-stamp, store and forward data if a wireless connection is down. Lastly, power flexibility for battery or line power make for a strong connect link.

3 **Collect:** Flexible update rates, adding metadata, and cloud and on-premise storage options make a strong collect element. When resolving intermittent issues like cavitation related to operations, a faster update rate of 15 minutes or less

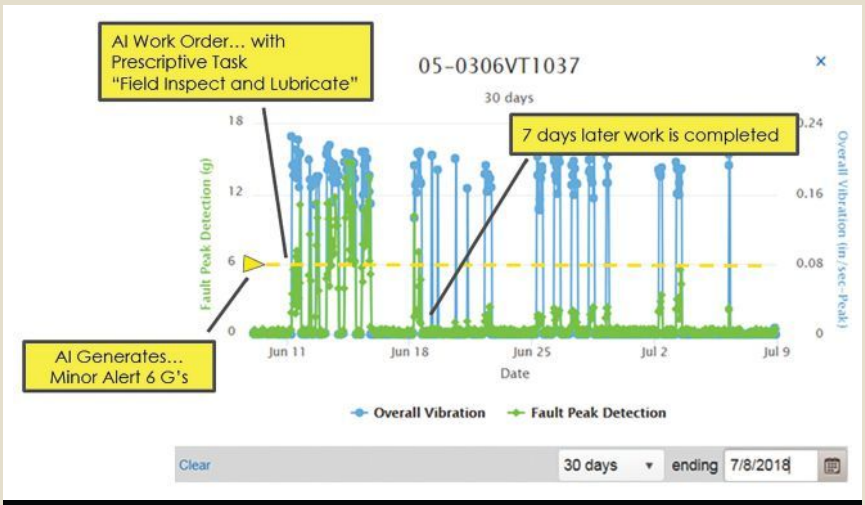

Image 2. Case study showing IoT value chain for predictive maintenance

is a benefit. For continuous monitoring of pumps, an option to line power the sensors will further improve the strength and capability of this link in the value chain. Capability to add or include metadata will be necessary for success along the value chain. For example, a computerized maintenance management system (CMMS) ID for the monitored asset will be required to tie out a sensor alert to an automated and intelligent work order in link No. 7, the people and process link. Another example is having metadata on the lubrication type can help create a more descriptive and detailed work order.

4 **Store & Trend:** Having responsive and ubiquitous access to historic data, display trends, overlay trends, zoom tools and export tools to other programs like Excel or other API-compatible applications makes for a strong link. Using a cloud application and avoiding software or app installs and maintenance, while having unlimited and tiered users, is another aspect that makes for a strong link. Lastly, having device diagnostic trends for battery voltage, signal strength and connection attempts further strengthens this link.

5 **Analyze & Alert:** Having equipment expertise and artificial intelligence models based on decades of data to pre-set alerts without baselining makes for a very strong link. On the other hand, baselining without domain or pump and failure mode expertise is the single biggest cause for missing existing failure conditions. Automated baselining techniques used with anomaly detection is the single biggest cause for nuisance alerts and results in unproductive use of the maintenance tech's time. Using an artificial intelligence model to pre-set alerts is essential for a strong link here.

6 **Translate to Task:** The most common question asked when a new alert is received is, "Now what?" Having an artificial intelligence model or rules-based model to translate the alert to a "prescriptive maintenance task" is critical to connect to link No. 7—people and process. With this link and strong previous links we can take a "real" alert on a leading indicator and transcribe an "English" or textual-based task that needs to be completed in response to the alert. A popular example is a minor or first level ultrasonic alert that is translated to "field inspect and lubricate within 10 days."

7 **People & Process:** The people and process link is where the value is realized. With the strength of the previous links, the correct work can be completed by the right person, with the right tools, the right materials, at the right time. If there is a weak link in any of the previous links, a less desirable and less valuable outcome is achieved.

On June 11, 2018, ultrasonic/vibration sensors were deployed to monitor two problematic assets at a Midwest plastics manufacturer. The sensors were battery powered and easily and quickly connected to the bearings using a magnetic ultrasonic/vibration sensor. With cellular embedded in the sensor, and using existing cellular and smartphone infrastructure, the hardware and system was all in place.

Using alert thresholds that were pre-set using the artificial intelligence model and the artificial intelligence or rules-based model for translating an alert to a prescriptive task, the application specific settings were also in place.

Upon connecting the magnet to the bearing of the machine, a minor alert was issued and an intelligent work order was emailed stating "field inspect and lubricate within 10 days." Seven days later during a planned and scheduled maintenance task, the work was completed and the alert condition subsided. This completed the value chain for predictive maintenance by avoiding the larger failure of permanent bearing damage, increased shaft deflection and a seal failure. ■

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