CONVEYOR EQUIPMENT MANUFACTURERS ASSOCIATION

Condition Monitoring Systems – What are the Advantages and how to deploy a Successful PDM Program

Bulk Belt Systems and Emerging Technologies Committee

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The Industrial Internet of Things (IIOT) commonly referred to as Industry 4.0 has been in the forefront of many industries over the past few years. Key to the development and growing interest in this methodology has been the focus on Predictive Maintenance (PdM) strategies and Condition Monitoring Systems (CMS). The affordability of sensors, improvement in components communication protocols, and accuracy of the hardware/software has changed the industry's way of doing business into the future. The concepts of each different method may make sense to some, however deploying a successful strategy utilizing PdM and/or CMS can be difficult.

To understand the concepts of PdM and CMS, it is important to first understand the customer end goal of using them. Overwhelmingly the primary goal is to prevent downtime. Downtime costs money, hurts profits, and from a supplier perspective could potentially erode the relationship with the customer. (See Figure 1) There are no positive attributes for downtime, and most companies go through extreme measures to avoid it.

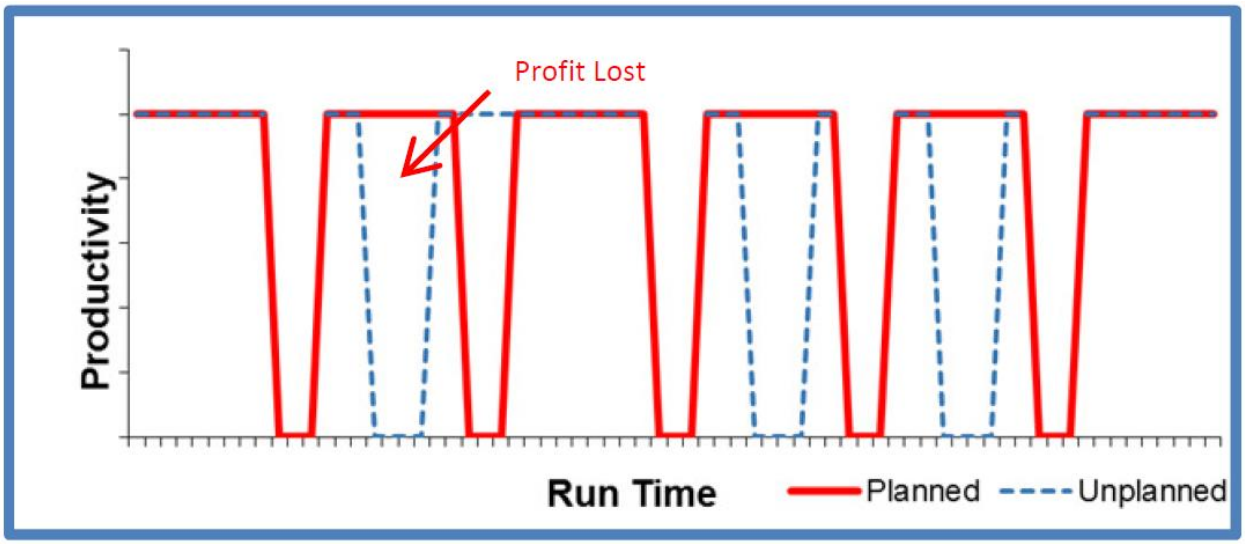

Figure 1: The impact of Unplanned Downtime

In most cases, to initially implement a predictive maintenance system, a deep dive into the applications that cause the most downtime would be required. If we take a look at a small assembly line for example, there could be one section of the line that continues to have issues. Reviewing the reasons for the downtime wouldn't confirm only that individual piece of equipment needs to be monitored, but it would be the best place to start.

The P-F Curve (Figure 2) is great way to show the value of the system. Where P is "Potential Failure", meaning the component is starting to fail and is noticed, and F is the "Functional Failure" point where the component has failed and is no longer usable. The time frame between these two points is the P-F Interval. Whereas the timeframe from the point of installation to the first sign of failure, is the I-P Interval. It is well known that all equipment has a life expectancy, and initiating a successful predictive maintenance program via condition monitoring is a vital tool in optimizing the life expectancy of key assets. A successful program affords the customer the discretion of planning a proper cost effective shutdown to decommission assets that have reach end of life

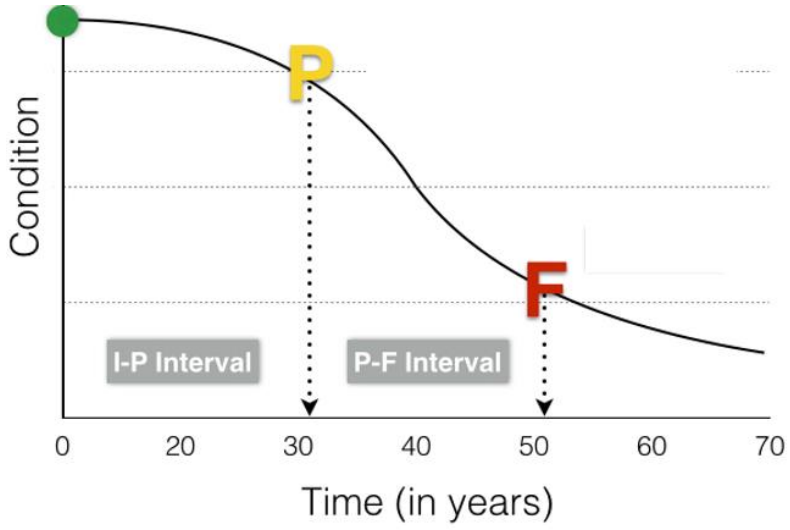

Figure 2: Typical P-F Curve

Launching a beta CMS/PdM program on a small scale is one of the best ways to learn what type of system can work for you, without it being overly complicated (Figure 3). If the beta is deemed successful, it can then be scaled up to the rest of the facility on a logic-based plan, thereby, mitigating disruption to the day-to-day operations. This gradual approach allows time for more testing/training of maintenance personnel so that the program can be successful. Starting small allows the workforce to adopt the new technology without completely changing the way the current maintenance practices. Adopting a new methodology of predictive vs traditional methods of preventive maintenance is a cultural shift, and the key to the long-term success of the program is the acceptance of and trust in the data being provided from the technology to the existing reliability maintenance staff. It is important that they know these types of systems are not designed to replace any technicians or mechanics. The systems are simply tools to help them in the pursuit of asset optimization, which with the ongoing skilled workforce shortage, the more tools the mechanics have in their toolboxes, the better off they will be.

Figure 3 Beta Test on Assembly line section

In some cases, executive level approval is required for capital investment in such systems. It's typical for executives to ask, "Why is it worth the investment?" As addressed earlier, the systems can prevent downtime, but there are other advantages as well. Advantages such as 24/7 data monitoring allows no "incident" to go unnoticed. This is especially noted in facilities that do not have a fully engaged maintenance staff during all operating hours. With a CMS, the staff can trend the data on a routine basis, eventually becoming a normal part of daily activities. Successful implementation of a predictive maintenance program with proper data trending protocols in place will optimize maintenance resources. Since the monitoring systems operate on a continuous basis providing real time data, the mechanics can be proactively alerted to a potential issue. They no longer have to function reactively. Making more time for other reliability tasks.

Other key factors to consider are Mean Time Between Failure (MTBF) and Mean Time to Repair (MTTR). These two performance factors help validate how well a system is producing/operating. If an operations MTBF is very low, that means failures are happening often and limiting production. The same logic is applicable with MTTR, when specific assets are frequently being repaired reducing productivity, and preventing the company from maximizing revenue and profitability due to operational reliability challenges. A CMS or PdM program is a great way to leverage your assets by using MTBF and MTTR to validate that the systems are keeping the downtime to a minimum.

Energy Savings is also a factor in showing the value of a new CMS or PdM system. A properly installed and monitored system can aid in monitoring the overall efficiency of the asset. If monitored correctly, system loading levels can be optimized. Performance output below the optimized levels can be a direct indicator of future system issues. Frequent failures could be a sign of many issues, with one being undersized for the job being performed. If an asset is showing signs of early failure in its life, it could be a either a vendor warranty or an installation issue. Getting ahead of these issues can avoid wasted energy and extend equipment life. Without a system monitoring the performance, years could go by and the user would never know that it was working twice as hard to perform the same function.

A CMS/PdM program is a key strategy to keep assets running at their peak performance. For comparison, most cars are equipped with a condition monitoring system to alert the driver/operator of when to perform maintenance tasks such as an oil change or tire rotation, which are all aimed toward optimizing the life of the vehicle. Moreover, vehicles are equipped with predictive maintenance features such as an alert to check the engine.

It's all about alerting the correct people of pending issues that previously went unnoticed until failure. It just has to be implemented correctly into the current maintenance strategy to be successful and adopted by all parties.

So, you've decided to go with CMS System on a critical piece of equipment. What type of system would be best? What data do you monitor? Unfortunately, the answer to this question is, "it depends". But here are some key points to consider for a Conveyor application:

> Wired? Or Wireless? – Wireless is definitely the "easiest" from an installation perspective, mainly due to absence of requiring long distance wire runs. However, wireless has its own set of challenges depending on the application you are trying to monitor. Most wireless systems require a clear "line of site" between sensors and data hubs. In most industrial/factory applications, it is very difficult to find a clear line of site. So, you can run into signal and data integrity issues. If the system starts having connectivity challenges, the mechanics will not trust the system or the data output.
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> What data do I monitor? This boils down to the end-user specific system and subsequent components. Some options include, Vibration, Temperature, Oil level, Motor performance. To narrow that list down, it would depend on the potential failure mode. On a conveyor, options would be vibration for motor, gearbox, and pulley bearings. One item to remember with all CMS and PDM programs, there is such thing as "Too much data". The first thought is to collect every piece of data possible. But in most cases, roughly only half of the data collected is used for any type of maintenance decision. The remainder is wasted data. A deep dive into the application will help determine what data is the most useful to monitor.
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> What do I do with the data/alarm information? – There are so many options on the market, and in the end, it is an end-user preference. Systems can transmit data to existing industrial Ethernet protocols. With that option it can be stored into a database. The data can then be reviewed as needed by maintenance staff. If a simpler approach is desired, a system that is just wired to a local tree would be an option. When an alarm limit is triggered, a light is illuminated near the equipment bringing the users attention to a potential problem. No database is required for this, as it's just turning on a light.

In Closing, CMS and PdM Strategies can be successfully implemented when selected correctly for the operation. Starting small scale with a "proof of concept' or a "beta test" is a proven way to make it successful and to allow all stakeholders to adopt the system. The stakeholders would range from the mechanics working on the equipment up to the executives that may have to approve the capital investment in the system. Once they are all comfortable with data the systems can provide, it will be a long term success. Successful implementation will not happen overnight. 6+ Months is normal and almost expected in most cases. Implementation can be a big undertaking depending on the scale but will prove itself to be worth the time and money invested.