Whitepaper

Condition Monitoring In The Age Of Industry 4.0

Eastway

Your global reliability partner

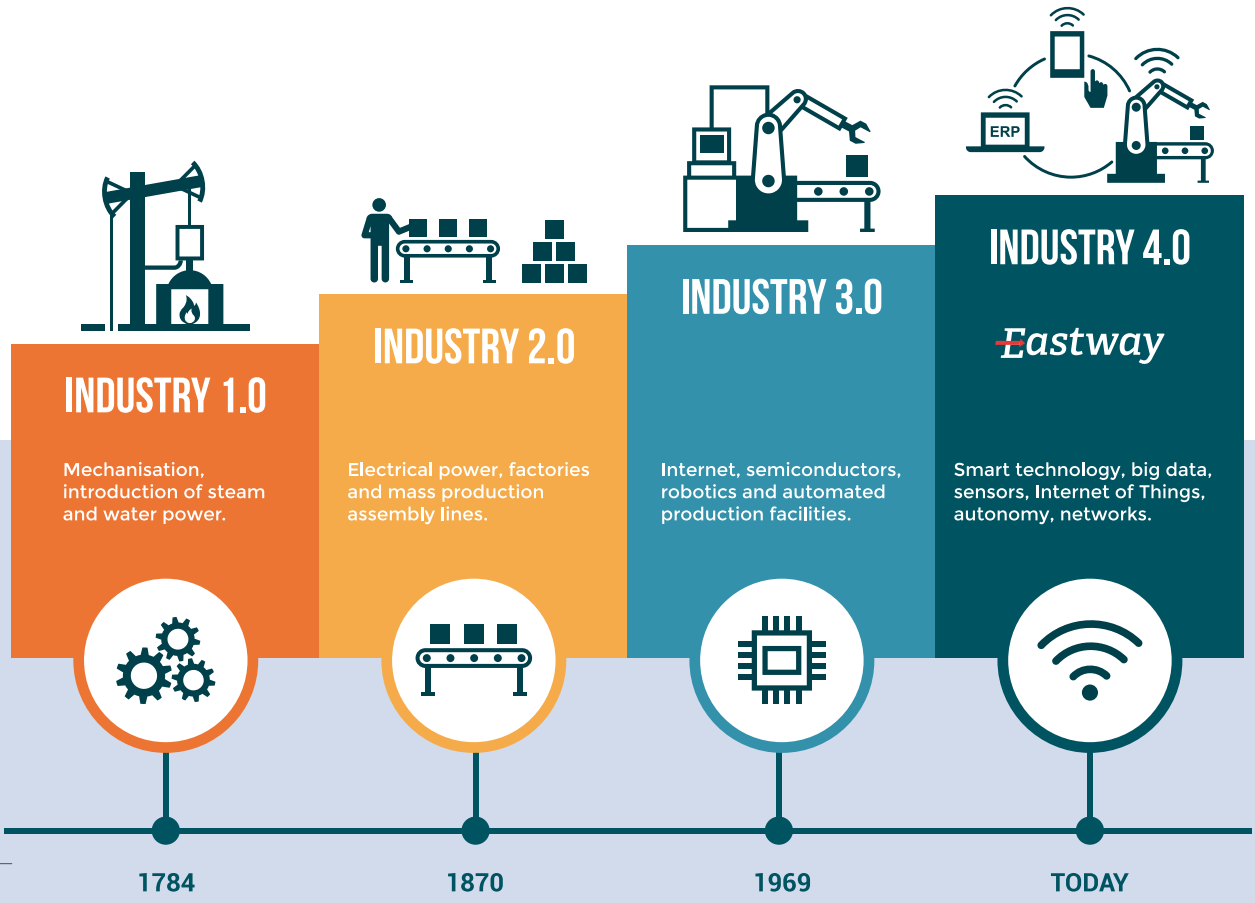
eastwaytech.com

CONDITION MONITORING IN THE AGE OF INDUSTRY 4.0

Industry 4.0 is a term you might have heard a lot of recently. In a new age of machine learning, IoT and autonomous systems, Industry 4.0 is becoming all the more prevalent.

The concept has to do with the four phases of the industrial revolution. The first industrial revolution started in the 18th century when manufacturing went from hand-production to machine-use, as well as the introduction of steam and water power. Then came the second revolution with electrical power, factories and mass production assembly lines. The third industrial revolution was driven by the internet, semiconductors, robotics and automated production facilities. Now, we have entered what people are calling the fourth industrial revolution or Industry 4.0.

When we talk about Industry 4.0, we are talking about smart technology, sensors, big data, autonomy and, in a sense, factories that can take care of themselves. Embedded into that, are advanced monitoring systems and smart preventative maintenance. In this guide we look at one area in particular, condition monitoring, and the role it is playing in the rise of Industry 4.0.



Eastway
Your global reliability partner

WHAT IS CONDITION MONITORING?

Condition monitoring is the process of consistently monitoring a specific condition parameter in machinery to spot potential faults. These parameters could be temperature, vibrations, ultrasonic emissions or oil condition. Any changes in these parameters could be indicative of a developing fault. Condition monitoring is therefore an important tool in the predictive maintenance of machines.

Within condition monitoring, a specific parameter is measured regularly, allowing machine operators to gain a full understanding of what would be considered normal behaviour. This is otherwise known as the 'initial baseline'. Operators then assess changes in those parameters and analyse the deeper meaning behind them. In the case of vibration, a machine operator might look at the vibration patterns. Changes over time might indicate that deterioration has occurred or maybe that a more substantial fault has occurred. In the case of serious faults, with condition monitoring you are able to analyse the root cause. You are then able to plan downtime and repairs in advance. This ability to plan downtime in advance and predict faults far in advance is what condition monitoring is all about.

Condition monitoring has come to replace, or complement, traditional maintenance methods in manufacturing. These traditional methods include breakdown maintenance, and time-based preventative maintenance.

Eastway
Your global reliability partner

DESIGN-OUT MAINTENANCE

Condition Monitoring allows for what is called 'design-out maintenance'. This is a maintenance tactic whereby changes or modifications are done to the equipment to remove the failure cause and prevent future faults from occurring. Alternatively, you might use design-out maintenance to put maintenance strategies in place that manage the consequence of the failure. With condition monitoring, organisations can therefore design-out repeat failures. Organisations can also examine whether they are predicting failures or if failures are happening unexpectedly.

Design-out maintenance aims for improvement rather than just conducting maintenance activities to ensure system functionality. Its focus is the improvement of system design to reduce the maintenance burden or even eliminating maintenance altogether (Ding and Kamaruddin 2015:1264).

Eastway
Your global reliability partner

CONDITION MONITORING VS BREAKDOWN MAINTENANCE?

Breakdown maintenance is maintenance performed on a machine that has broken down, faulted, or otherwise needs repair to resume operation. It is also called run-to-failure maintenance as it involves using a machine until it completely breaks down, and then repairing it to working order.

Breakdown maintenance is still commonplace in a number of manufacturing facilities, usually for low criticality equipment, low cost equipment. In many cases, breakdown maintenance is the default maintenance strategy, particularly for organisations that rely on reactive maintenance.

What differentiates breakdown maintenance from condition monitoring?

- **Machines are not maintained**
- **Machines run to failure**
- **No foresight as to when a machine will break down**
- **High levels of unexpected downtime**

Eastway
Your global reliability partner

There are many disadvantages of using run-to-failure strategies. When machines aren't maintained or inspected regularly, catastrophic machine failures can occur. These failures could otherwise have been predicted or prevented at an earlier stage.

Oftentimes, specialist machines need to be replaced after experiencing large failures. This occurs even when the initial fault was something much less significant such as incorrect lubrication or misalignment. When the initial problem went unseen, it led to much greater faults as the problem worsened. If an organisation had been predicting and charting parameters on a regular basis, maintenance could have been carried out well in advance.

Breakdown maintenance incurs supplementary costs also. This includes overtime paid to engineers who have to fix machinery at the last minute and costs associated with having to store a large inventory of spare parts. When organisations cannot predict when a fault will occur, they must store all parts, at all times, in case of emergency.

The Cost of Breakdown Maintenance

- High overtime labour costs
- Large parts inventory required
- Secondary costs of machine damage
- Costs associated with unexpected downtime

Eastway
Your global reliability partner

CONDITION MONITORING VS TIME-BASED MAINTENANCE

Time-based maintenance is maintenance performed on equipment based on a calendar schedule. TBM maintenance is **planned maintenance**, as it must be scheduled in advance. This means that time-based maintenance can be used with both predictive maintenance and preventive strategies.

In terms of maintenance strategies, time-based maintenance is on the right track and there will always be a place for time-based schedule interventions. However, where condition monitoring holds an advantage over time-based strategies is around the intrusive interventions that occur within it. Time-based maintenance includes annual shutdowns where engineers are brought in to overhaul equipment across an entire plant. Machines are replaced according to a schedule, even when they are working perfectly well. While this is a better strategy than allowing machines to run to failure, it is unnecessarily drastic.

Eastway
Your global reliability partner

WHY REPLACE PERFECTLY GOOD MACHINES?

Why do organisations over-repair perfectly good machines? When maintenance is carried out regardless of performance, you are introducing the potential for defects caused by human error. And yet, when this type of maintenance is carried out, it does not prevent failures during the operation period. Outside of the scheduled maintenance checks, an organisation has no insight as to how machines are performing. Thus, there is no visibility on the condition of a machine or whether a potentially catastrophic failure is likely to occur.

Disadvantages of Time-Based Maintenance

- **Condition of the machine is not taken into account**
- **Perfectly good machines are over-repaired**
- **Overhauls often introduce further issues due to human error**
- **Machines fail between maintenance intervals without prior notice**
- **Costly, unforeseen downtime still occurs**
- **TBM is ineffective for machines that are only used occasionally**
- **Excessive spare parts inventory required**
- **Significant labour and service contract costs associated with excessive maintenance as well as costs associated with unforeseen downtime**

Eastway
Your global reliability partner

WHY ORGANISATIONS ARE TURNING TO CONDITION MONITORING

When we look at the limitations of breakdown maintenance and time-based maintenance, we can understand why more and more companies are turning to condition monitoring. Some of the main advantages include:

- Significantly reduces unforeseen downtime
- Prevents secondary damage to equipment
- Enables maintenance to be planned
- Directs maintenance resources to the machines that need it
- Enables identification of poorly operating machines
- Reduces spare parts, labour and service contract costs

Organisations are turning to condition-monitoring so they can eliminate unforeseen downtime. They want to monitor equipment, predict failures and know how their machines are performing. With condition monitoring, organisations know what parts to order and do not have to keep an inventory of spare parts. They know what crews are needed. They can schedule maintenance at a time that suits existing production schedules, thereby causing as little disturbance as possible. Decisions regarding machine maintenance are backed by data at all times. All of these components help to reduce spare parts costs, labor costs and service contract costs.

Eastway
Your global reliability partner

VIBRATION ANALYSIS

When we talk about condition monitoring, and particularly as it pertains to industry 4.0, there's a lot of focus on vibration analysis.

Vibration analysis is a process that monitors the levels and patterns of vibration signals within a machine, structure or piece of equipment, to detect abnormal vibration events and to evaluate the overall condition of the test object.

Vibration analysis has been proven to be one of the most effective methods of identifying mechanical and electrical faults. Issues can be detected months in advance and preventative maintenance carried out in order to prevent critical failures and unscheduled downtime. Vibration is particularly effective at predicting failures in rotating mechanical equipment.

Vibration analysis sensors can be used to predict failures on any type of machinery that's driven by a motor, AC/DC, pumps, fans, gearboxes, or compressors. Vibration analysis allows you to find common faults on these equipment types. This includes bearing wear, gear wear, lubrication issues - whether it be contamination or low levels or even overfill that's causing the machine problems. Other emergency faults include imbalances or misalignment issues. These issues are a major cause of bearing deterioration, mounting looseness and electrical faults.

Eastway
Your global reliability partner

THE CONNECTION BETWEEN CONDITION MONITORING AND INDUSTRY 4.0

When we think of industry 4.0, we picture the fourth technological revolution with embedded sensors across plants, real-time data collection, increased connectivity and intelligent monitoring across the site. This can often seem futuristic, or like science fiction, but with condition monitoring, this reality is already here. Eastway has been installing sensors across plants for decades. That is why we see a clear connection between what we've been doing and what industry 4.0 is all about.

If you look at both industry 4.0 and condition monitoring, there's many common objectives. With industry 4.0, organisations are trying to drive manufacturing forward by embedding modern technology. With condition monitoring, organisations are trying to reduce unplanned downtime and increase production output, by embedding modern technology. With both, companies are looking to increase plant efficiency and increase production output. At Eastway, we see condition monitoring as the gateway to industry 4.0 for many manufacturing facilities.

WHY CHOOSE EASTWAY TO START YOU ON YOUR JOURNEY TO INDUSTRY 4.0?

- Our system was **developed by machine monitoring engineers** to provide complete reassurance and protection against machine failure.
- We have built our firm on the values of **reliability, experience and quality** and are continuously improving our systems and insights layer.
- We provide consultative analysis, **direct human support,** in-person and dial-in as needed – not a generic email with instructions, but support when you need it.
- We have a **global presence** – with 24/7 online monitoring and support, and with locations in Singapore, the US and Europe we are your global reliability partner.

Eastway

Your global reliability partner

Eastway Head Office
Mary Rosse Centre 3
Holland Rd
Castletroy
Co.Limerick V94 HRK2

t: +353 61 203933
e: info@eastwaytech.com

Eastway USA Office
1300 Clay Street,
Suite 600,
Oakland
CA 94612 USA

t: +1 510 210 0044
e: info@eastwaytech.com

Eastway Singapore Office
04-12 United House,
20 Kramat Lane,
228773
Singapore

t: +65 9232 1203
e: info@eastwaytech.com

www.eastwaytech.com