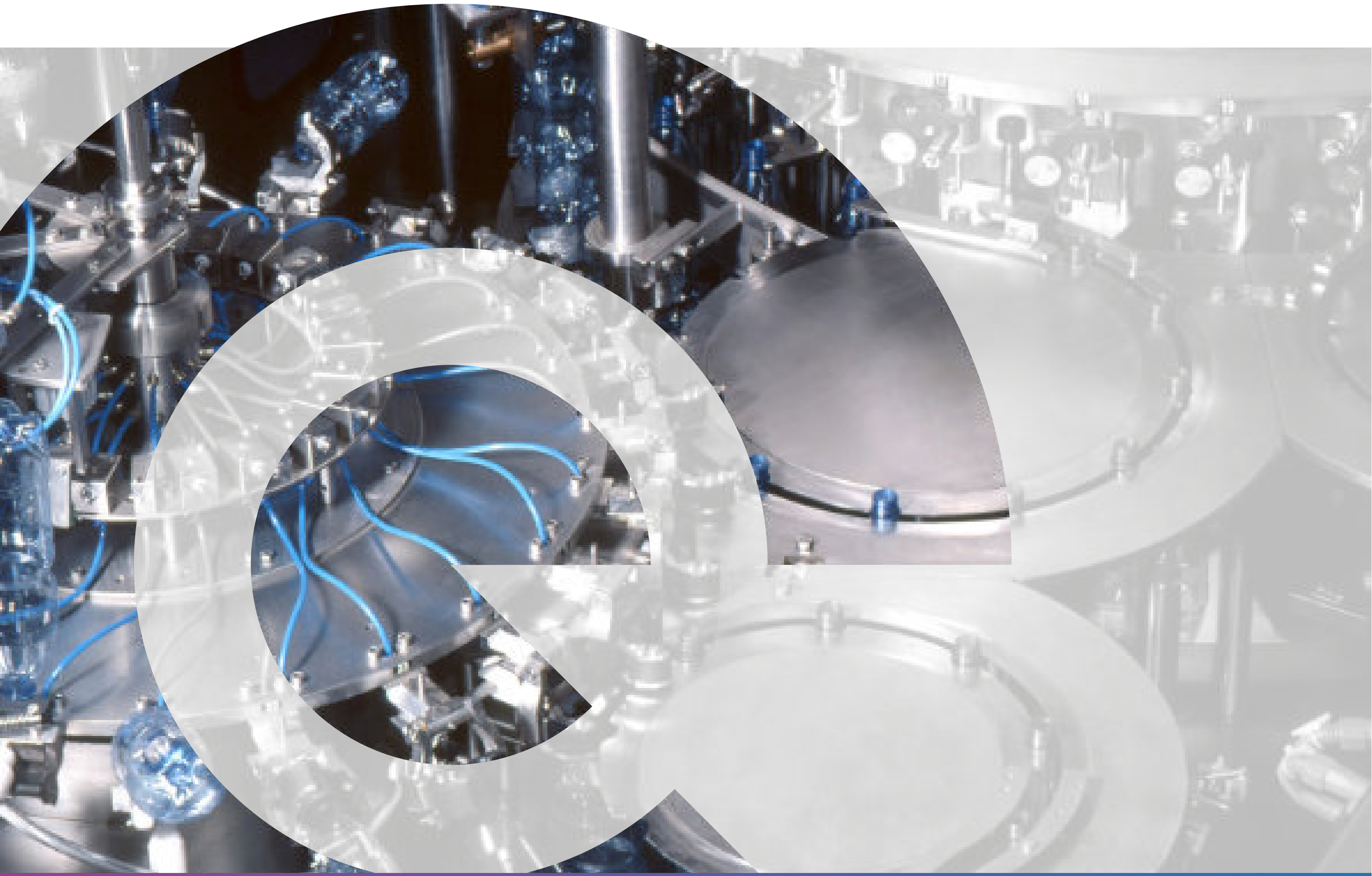
senseye.io



PAST, PRESENT AND FUTURE

CONDITION MONITORING

INTRODUCTION

Condition monitoring (CM) is the use of advanced technologies to monitor the condition of machinery and to reduce or prevent unplanned machine downtime. It uses machine data, such as vibration, acoustic emissions, and temperature, to identify changes and signatures which may indicate faults.

Reduced hardware costs and technological advancements, such as the Industrial Internet of Things (IIoT), has put large-scale CM within the reach of many organizations previously priced out. This paper looks at the current CM landscape, including technology, continuous versus manual monitoring, and implementation foundations and timescales.

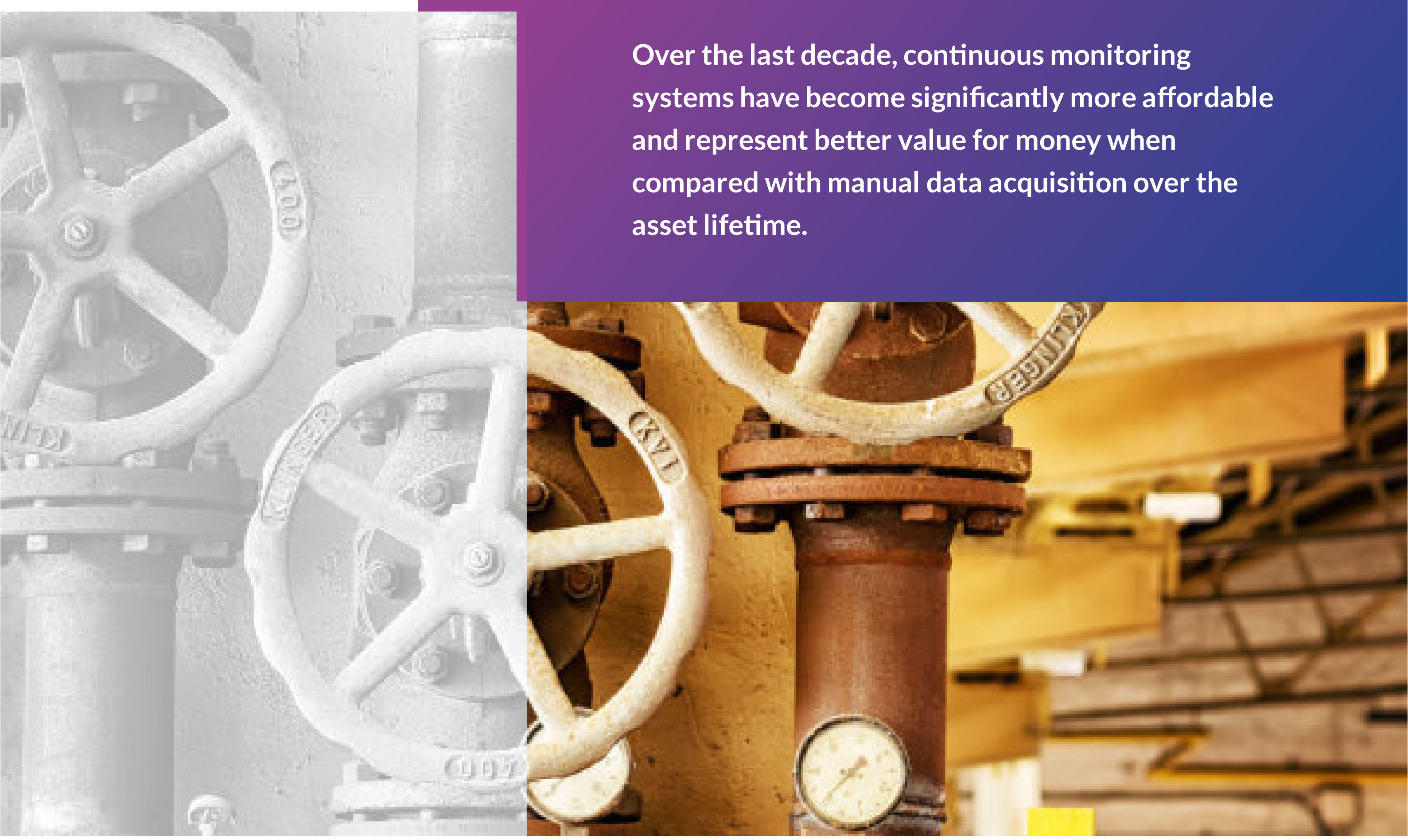
THE PAST A BRIEF HISTORY OF CONDITION MONITORING

Whilst now highly technical and adapted for specific industries, CM began with human intuition and observing machinery.

Today, CM often has a large focus on rotating equipment, driven significantly by advancements made in the aerospace and defense industries to improve safety and reliability. It has enabled the transformation of operations and the emergence of new business models in these sectors, to the point where entire products, such as engines, have become "servitized" (Rolls Royce, Power By The Hour).

Despite these advances, CM has not been fully embraced in industrial sectors, with offline (manual) data collection being more common despite the obvious disadvantages: poor data resolution, reliance on accuracy and knowledge of experienced engineers, and the expense of collecting data "by hand".

Over the last decade, continuous monitoring systems have become significantly more affordable and represent better value for money when compared with manual data acquisition over the asset lifetime.



THE PRESENT INDUSTRY 4.0

Industry 4.0 greatly increases the volume and availability of data on the shop floor; CM is firmly one of the most interesting use-cases.

Before rushing into buying often-costly solutions, it's important to ensure that CM is a good organizational fit.

Can CM help an organization to reduce machine downtime? Take a look at our three-point checklist:

1

INDUSTRY 4.0 SHOULD BE **INEXPENSIVE**

Retrofit solutions should cost in the order of hundreds of dollars per machine, not thousands. If possible, spend nothing and get data (current, cycle time, etc.) directly from the PLC.
The payback time of a solution should be less than 6 months.

2

IT SHOULD BE **QUICK TO IMPLEMENT**

Unplanned downtime is easy to quantify. Any solution chosen to put an end to it should be deployable as soon as possible, in case the opportunity cost of not having it deployed (machine failure) is realized.
Solutions should be quick to install and quick to supply useful, actionable information within a matter of days or weeks.

3

IT SHOULD **MAKE YOUR LIFE EASIER**

Constant phone, email and text notifications demanding your attention can become a full-time job. Wouldn't it be easier if you were only notified you when actual work needed doing?
Make sure that the solution you've chosen makes use of technologies like machine learning and artificial intelligence so that it works for you instead of you for it.

CONDITION MONITORING NIRVANA - PREDICTIVE MAINTENANCE

Being able to maintain your machines just before they are about to fail represents an ideal CM use-case for a number of reasons:

- No need to keep an inventory of spares.
- You avoid expensive over-maintenance of your equipment.
- You avoid failure and have a good idea of exactly what condition the machine is in.

IDEAL PREVENTIVE MAINTENANCE

Traditionally, a manufacturer will specify a Mean Time Between Failures (MTBF) and recommend that maintenance is carried out periodically within this timeframe. As with all servicing, this often doesn't prevent machine failure.

In the context of Industry 4.0, predictive maintenance means using constant, in-situ monitoring of condition indicators, such as vibration and current. These can be monitored inexpensively and easily, with data collection devices connected to the internet. However, analysis still needs to be performed on a mostly manual basis, so continuous CM is often only viable on high-value assets or where a safety case mandates its use.

OVERVIEW OF CONDITION MONITORING TECHNIQUES

Condition indicators can be monitored in a number of ways, from someone looking and listening to a machine, to sensors providing ongoing measurement of a set of variables. Here we discuss the key techniques.

ONLINE › CONTINUOUS

VIBRATION

TIME-HORIZON	high – weeks to months (depending on usage)
COST	high
COMPLEXITY	high
SUITED TO	rotational components (bearings, shafts, gearboxes)

As well as a raw energy content (Root Mean Square) value, this will derive peak to peak, kurtosis and even specific ball bearing health indicators. Unfortunately, it involves significant post-processing to extract value and requires a high sample rate to be most effective, making it one of the most expensive indicators.

TEMPERATURE

TIME-HORIZON	low – hours to days
COST	low
COMPLEXITY	low
SUITED TO	solid-state electrical components

This can be as simple as bolting a thermocouple onto something or monitoring using thermal imaging. It's not suitable for mechanical application as, by the time a temperature delta shows, the damage is likely profound.

CURRENT

TIME-HORIZON	medium – weeks to months
COST	low
COMPLEXITY	medium
SUITED TO	electrical motors and their attached systems

Motor behavior and any mechanical issues (gearbox, bearing) can be identified, if taken at a high enough sample rate. The cost is attractively low, but accuracy and specificity lags, although this may not be too important in many industrial applications.

ACOUSTIC

TIME-HORIZON	medium-high – weeks to months
COST	medium
COMPLEXITY	high
SUITED TO	high frequency applications

Whilst at its most basic it is inexpensive (some microphones and a system to capture data), truly accurate acoustic emission detection requires similar post-processing to vibration monitoring and has a good time horizon.

OIL DEBRIS
MONITORING

TIME-HORIZON	medium-low – months / weeks
COST	medium-low
COMPLEXITY	low
SUITED TO	gearbox / motor oil applications

Uses a magnetic inspection plug which will attract particles or uses lab analysis. Online solutions also exist however most commonly a manual process. Cost drivers are time and lab analysis. Unfortunately, once debris is visible, significant damage will have occurred although this might be visible before vibration signatures are detected.

ULTRASOUND

TIME-HORIZON	high – months to years
COST	high
COMPLEXITY	high
SUITED TO	inspection of pumps/sealed systems for leak detection, monitoring of bearings and valves

Versatile, but requires significant processing and analytics to produce information useful for the end user. The speed of detection is extremely quick, with NASA stating that ultrasonic bearing monitoring can actually provide the earliest warning of failure.

TYING IT ALL TOGETHER

As sensors and processing costs reduce, hardware becomes more and more of a commodity, marking the decline of manual / offline CM. Technology that used to cost millions for aerospace and defense companies can now be purchased for use in the Smart Factory at a fraction of the price, helping to reduce unplanned downtime and operational costs.

CURRENT CONDITION MONITORING **IMPLEMENTATION**

CM project life cycles typically follow a traditional engineering roadmap and it is not until the later stages that value is achieved and ROI can be demonstrated. Often these traditional roadmaps have timelines extending to years, at odds with the 'quick ROI' necessary in most organizations.

THE FUTURE AUTOMATION AND PROGNOSTICS

Condition monitoring is a great concept and technology. The clear opportunity to gain an almost instantaneous insight into the health of your machinery is an important tool in an effective predictive maintenance regime.

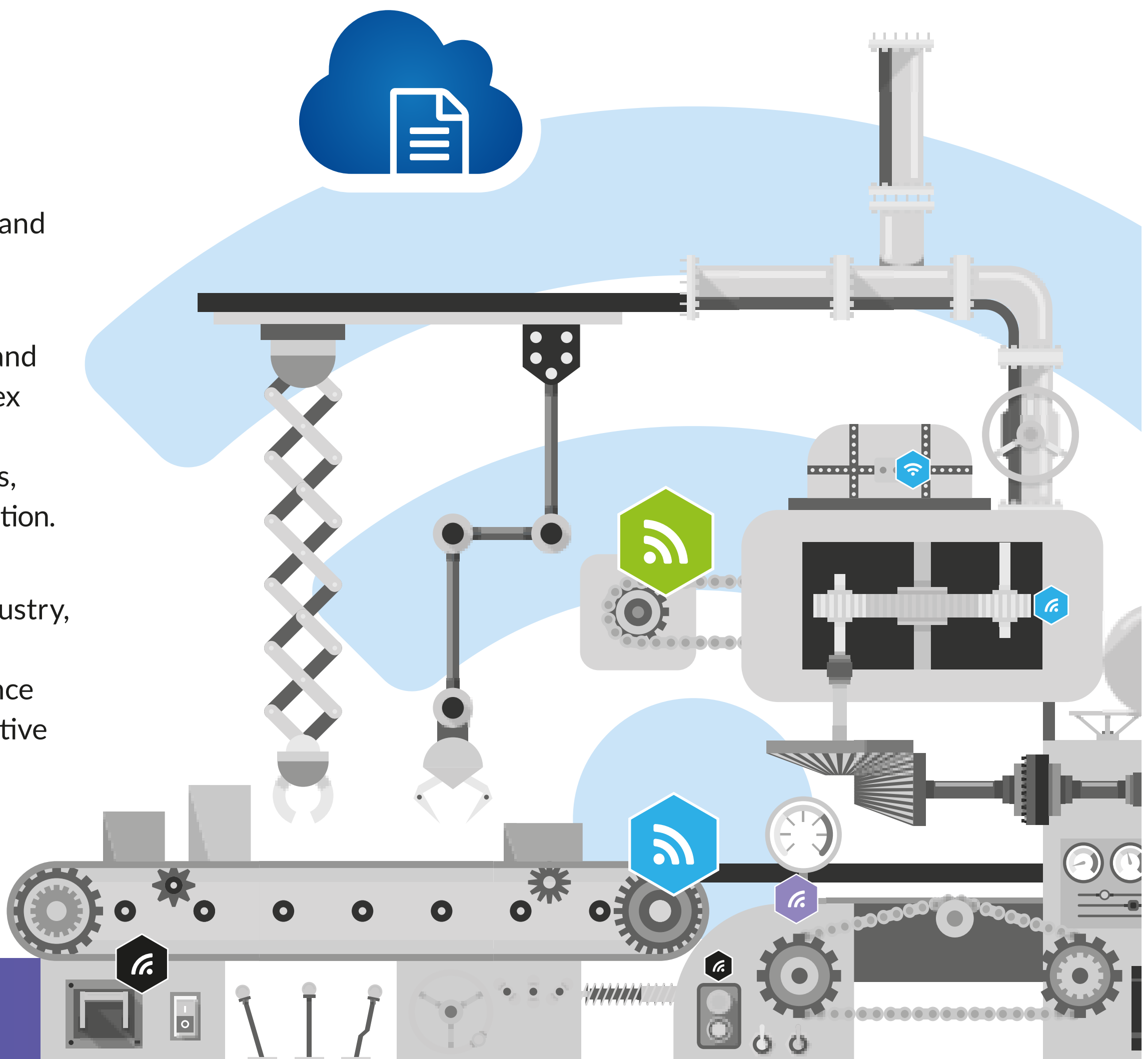
ANOTHER WAY: AUTOMATED, CLOUD-BASED SOLUTIONS

Why pay for consultants to slowly analyze data and try to forecast machine failure when all of that could be done automatically, in the cloud and without manual intervention?

With the constant need to improve factory efficiency, removing a human bottleneck and introducing automated CM and prognostics makes sense. This provides the opportunity to reduce operational costs, identifying failure signatures and predicting future machine failure more accurately.

KEY CM CONSTRAINTS

1. Expertise is expensive and doesn't scale well.
2. Condition monitoring and prognostics are complex pattern-matching and mathematical problems, ideally suited to automation.
3. It's a service-based industry, with ongoing training, analysis and maintenance fees proving very lucrative for vendors.

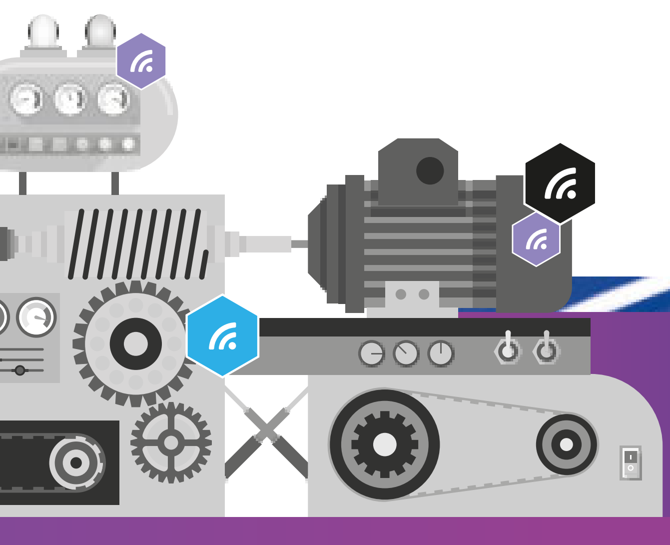


SENSEYE

INTELLIGENT, AUTOMATIC CONDITION MONITORING AND PROGNOSTICS

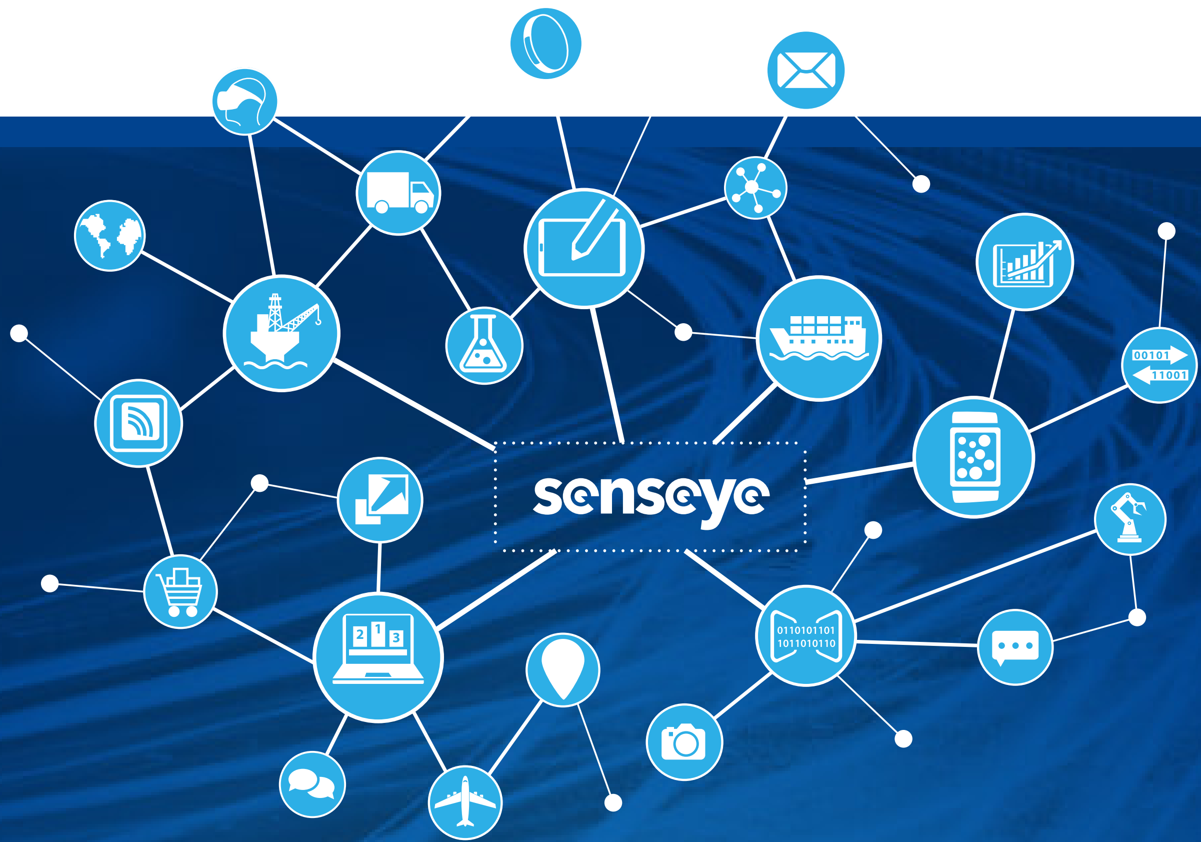
Senseye is an intelligent and easy-to-use automatic CM analysis and prognostics (Remaining Useful Life analysis) product, using advanced technology to deliver an award-winning solution without the limitations of traditional slow and costly CM projects. Harnessing advances in machine learning, prognostics techniques and artificial intelligence, Senseye can provide actionable results in just two weeks and clear ROI evidence in months rather than years.

SENSEYE	Traditional CM	
Model built automatically from data analysis of short- and medium-term data streams during short onboarding period.	Identify failures	1
Focus on the data that is readily available to get the initial evidence for capability. As value is proven, enrich Senseye with more sensors and measures.	Specify data	2
None required. The Senseye platform is developed to learn rather than be configured with the analysis and modes of abnormal behavior.	Design system	3
Adding new data types is covered in the on-boarding process.	Implement solution	4
As simple as receiving an email and reading it. Clear, natural language output is key to the way Senseye communicates its findings. No need for costly training and familiarization projects to educate your teams in the use of the system.	Rollout	5
You get to this stage on day one and then through an iterative cycle; the functionality of Senseye is enriched with more data and feedback.	Operate	6



WHAT AUTOMATION MEANS TO **THE END USER**

The less you need to rely on manual expert input and analysis, the quicker, more accurate and more efficient your predictive maintenance program can be. Crucially, this translates to reduced downtime (up to a 50% improvement is not uncommon) with dramatically-reduced operating costs and a longer asset lifespan.



CONCLUSION

Starting as a system of manual checks, CM has technologically evolved to become increasingly cost-effective. With next-generation automated solutions embracing Industry 4.0 to deliver fast, accurate results, organizations can now benefit from advanced CM and prognostics with measurable results over a relatively short timeframe, breaking down the barriers of high costs, expertise requirements and long ROI.

The result is reduced downtime through cost-effective predictive maintenance and remaining useful life alerts – and future advancements in Industry 4.0 technology and the availability of useful data can only improve the opportunities for effective CM.

Find out how it can help you by booking a demo at:

senseye.io