# HYDROCARBON ENGINEERING

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COVER FEATURE

# PREPARING FOR THE IIoT EVOLUTION

**Bart Winters and Francois Leclerc, Honeywell Process Solutions,**
present a real-world approach to the Industrial Internet of Things (IIoT) for process reliability.

In the process industries, plants must operate not only at desired capacity, but also at optimal efficiency. This means predicting undesirable process conditions and equipment failures before they occur, and then systematically addressing them as part of a continuous improvement process. The current approach at many facilities is to 'run-to-fail' since abnormal conditions and malfunctions are not identified until alarms provide a warning or something breaks.

A growing number of industrial facilities are exploring the power of the Industrial Internet of Things (IIoT) to optimise their business performance. The IIoT enables plant operators to improve process reliability by capturing and analysing data, and then identifying the warning signs of potential issues – predicting when process adjustment and equipment maintenance are needed, and preemptively servicing installed assets before problems arise.

This article examines the latest techniques, including Big Data analytics, to enable smart, connected plant operations. In particular, it describes how the IIoT can support continuous improvement and address previously unsolved problems to increase plant availability, safety and reliability. By taking advantage of streaming data from sensors and devices to quickly assess current conditions, recognise warning signs, deliver alerts and automatically trigger actions, IIoT-based analytics solutions fundamentally transform production and maintenance strategies.

## Digital intelligence

In a highly competitive global marketplace, industrial organisations seek 'digital intelligence' to manage and operate hundreds or thousands of assets from a single site or across an enterprise to address critical operating demands. They need effective tools to transform process data into real-time information regarding process performance, equipment health, energy consumption and emissions monitoring.

Plant operators, process and equipment engineers, and managers require continuous monitoring and surveillance, notifications, and collaboration with experts so that appropriate proactive actions can be taken. This will minimise degradation, poor performance and secondary damage to equipment to reduce costs, as well as increase throughput and profits.

In an effort to ensure uptime, companies have historically sent field technicians out to perform routine

**Figure 1.** Equipment failures have a significant impact on industrial operations, making it imperative to optimise predictive maintenance strategies.

diagnostic inspections and preventive maintenance according to fixed schedules. This is a costly, labour-intensive process with little assurance that failure will not occur between inspections.

To improve efficiency, companies have implemented advanced process control (APC), defined operating boundaries with their alarm system, created key performance indicators (KPIs), and called upon local experts to help solve operating problems. The effectiveness of these measures has been difficult to sustain as they rely on dedicated and knowledgeable on-site personnel.

In addition, industrial firms are looking for ways to make sense of vast quantities of data that can have a significant impact on their performance. For instance, reporting and interpreting of alarms and alerts is central to safe operations. It is also important to act upon abnormal situations quickly and effectively.

To support the variety of monitoring and decision support applications necessary within a manufacturing facility, data needs to be turned into information and delivered with context so it can be understood and used in a myriad of ways by various people.

## Operational objectives

For manufacturers and other operating companies, asset failure and almost imperceptible reductions in process and equipment efficiency are constant threats to the operating plan and overall equipment effectiveness (OEE). As a result, they are shifting their spending to increased equipment maintenance, and thus losing potential revenue. Factors such as availability of skilled workers and increasingly complex production processes are impacting the ability to predict and detect deteriorating asset health and process performance.

To maximise their overall performance, modern plants are looking for ways to transform their operating and maintenance philosophy from 'break-fix' to keeping operations running as efficiently and steadily as possible while decreasing unplanned downtime.

Key operational objectives include the following:

- Deploy online, continuous monitoring and exception-based alerts for process performance, equipment, and controls.
- Capitalise on increased data availability across the enterprise.
- Put data into context so as to compare assets to determine similar conditions or behaviour.
- Implement tools for process and reliability engineers, enabling visual data exploration to decrease reliance on complex machine learning algorithms to solve problems.
- Establish collaboration with both internal and external subject matter experts (SMEs).

Integrated, operational and maintenance strategies open up new possibilities for companies. Data from sensors monitoring both process and machine conditions are combined to identify any patterns that indicate a possible fault or process limitation. This allows the onset of a stoppage to be recognised early, and corrective measures to be planned and introduced in the most effective way.

Combining both process and equipment data leads to truly understanding asset capability, and enables the definition of accurate, consistent operating and integrity envelopes that can be used in APC strategies. The result is greater process stability within control and monitoring systems for situational awareness at all levels of operations, as well as improved decision support systems to ensure assets are operated in an optimal manner. With this approach, unplanned downtime can be avoided, and both staff and resources can be employed more effectively.

## Leveraging IIoT

There is no doubt the IIoT carries major implications for industry, especially at a time when infrastructure is ageing and veteran operators and engineers are retiring. There is a shortage of experienced workers to take the place of seasoned personnel, resulting in a loss of knowledge. The IIoT can be leveraged to institutionalise knowledge capture while requiring fewer internal experts. This can be carried out with the help of external experts, such as process licensors, who have expertise and visibility beyond the company's assets. Moreover, the IIoT can have a significant impact on competitiveness as manufacturers struggle to pull their weight in the global economic recovery.

The IIoT allows companies to do more with their current systems and extend their business processes to enhance monitoring and reduce the time to action. For example, a cloud-based control loop and APC monitoring system can be set up to monitor controls across the enterprise by an internal or external domain expert. With visibility and knowledge across sites, experts can alert and collaborate with site SMEs and recommend actions when control benefit degradations are detected. Each site can benefit from earlier detection and faster resolution of problems afforded by a higher level of expertise focused on control performance. For the enterprise, these capabilities can be deployed using fewer resources than having an expert at each site.

**Figure 2.** Real-time process performance monitoring provides an expanded view of operations to help plant personnel maintain the health of critical assets.

In order to make better business decisions, the IIoT offers companies the ability to:

- Aggregate data from existing sources.
- Create additional data sources in a cost effective way.
- Gain visibility into new data.
- Identify patterns.
- Derive insight through analytics.

Through this approach, previously unsolved problems, as well as new ones, can be solved with assets communicating and providing real-time usage data to allow plants to carry out predictive maintenance and process optimisation.

Industry-leading companies are transforming their operations by utilising proven solutions in the areas of process and event data collection, combined process and asset-centric analytics, and visualisation technology to continuously and automatically collect, organise and analyse data. Indeed, advanced analytics is one of the pillars of the IIoT, connecting people, processes and assets to optimise business results. It can transform work processes from manual and reactive to automatic and proactive, helping users avoid unplanned downtime, and improve performance and safety.

An IIoT-enabled plant uses a combination of advanced sensors, automation systems, and cloud technologies integrated with current systems and data analytics to become smarter. This provides the ability to locate data in a cloud environment where it can be accessed and analysed with analytical tools. For example, an equipment vibration reading would be sent to the plant's distributed control system (DCS) as a single value, whereas rich dynamic data stored in the cloud would allow engineers to study the harmonic signature of a bearing or shaft to determine the root cause of a pending asset failure. Currently, in most cases, dynamic data is only employed by specialists in custom applications – limiting its accessibility by other users in the plant.

In terms of predictive maintenance and process performance, IIoT-based solutions enable industrial enterprises to proactively manage their assets and make more informed decisions through analytics at the edge. Production and maintenance strategies can be combined for optimal overall performance and executed based on how assets are expected to function tomorrow – not solely according to a specific periodicity or on particular present conditions.

Another key driver of the IIoT is a reduction in the level of information technology (IT) skills and expertise required to support standalone applications, so that companies can focus on their core competency of running and managing operations.

## Making the most of plant data

Major automation suppliers have developed innovative technologies that deliver real-time process and asset-centric analytics, performance calculations, event detection and collaboration for plant management, engineering, maintenance, center of excellence (COE) experts, and operations. These solutions are designed for online continuous monitoring of equipment and process health, enabling industrial facilities to predict and prevent asset failures and poor operational performance.

Today's tools for real-time process performance monitoring provide statistical calculations and embedded performance models which, when paired with near real-time surveillance of instruments, processes and equipment, allow users to accurately assess asset performance. They offer a clear window into plant processes – continuously monitoring operating conditions, and enabling decisions and actions to prevent production loss, minimise downtime, and reduce maintenance expenses.

The latest developments in the field of plant equipment and process health monitoring leverage secure, managed, and hardened edge-to-cloud platforms, while focusing on data science and analytics, and applying 'digital twin' patterns to drive their analytic models. With the help of external experts, these solutions enable industrial firms to extract meaningful insights from their data. This leads to improved decision-making and addresses such issues as safety improvement, asset management and optimisation of operations. As a result, process plants are becoming more agile, driving increased revenue and keeping the focus on what matters most – production.

By modelling first principle compressor performance and baseline performance, for example, current performance can be continuously compared to detect both sudden changes and long-term degradation. These events have successfully been demonstrated to trigger maintenance activity, such as chemical injection to clear fouling or a compressor wash, or to initiate further action if required.

Unlike condition monitoring solutions focused solely on the equipment's physical condition, the latest data analytics and asset monitoring solutions use performance degradation as a leading indicator of potential problems. With the IIoT, identification of performance degradation and course of action are continuously improved since both process and equipment data are used, not only for a specific compressor but also for all compressors of similar design and service. Some tools employ pre-defined best practice templates for a wide range of equipment types, including

pumps, compressors, exchangers, valves, and turbines. Combined with an interface to process design simulation software, this solution helps users rapidly deploy equipment or process monitoring on any plant asset – eliminating the need for complex model development.

It is important to remember that the IIoT is not just about capturing sensor data. Information needs to be put into the asset context structure; merely operating on tag-based data will not ensure a repeatable and scalable solution. Processes are instrumented for control rather than reliability or optimisation. As a result, much of the 'derived data' important for prediction and decision-making is locked in spreadsheets and other standalone tools. It is essential to continuously calculate this data and bring it into the IIoT environment, where continuous runtime analytics can examine historical performance for use in machine learning algorithms.

Furthermore, IIoT solutions should not solely rely on a statistical model to detect deviations from the norm. Having a fundamental, physics-based model creates a digital twin, with a virtual representation of the process or asset located in the cloud. This allows users to model and compare expected process performance against actual results, and then apply these deviations as early indicators of health degradation.

Digital twins exist at the intersection of physical engineering and data science, and their value translates directly to measurable business outcomes: reduced asset downtime, lower maintenance costs, improved plant and factory efficiency, reduced cycle times, and increased productivity.

## Benefits to industrial organisations

Rapid adoption of the IIoT has created economies of scale for smart sensors, connectivity, analytics, and robust software platforms. This change is driving the adoption of enterprise-level performance management, process monitoring, predictive maintenance programmes, and business transformation with the goal of eliminating unplanned downtime and reducing operating costs while maintaining product quality and compliance.

A real world approach to the IIoT enables the integration of current systems and the addition of new data sources and analytics to support complementary, continuous improvement processes, focused on performance monitoring and decision support. The specific benefits of this approach include the following:

- Increase process reliability and asset utilisation up to 10%: plants can reduce unplanned downtime by defining and operating within operating and integrity envelopes, predicting failures and providing proactive responses, as well as minimising rate and efficiency losses.
- Increase operating efficiency up to 10%: industrial organisations can manage performance, including yields, energy and raw material usage, to achieve up to 10% reduction in costs. This results from enhanced engineering and production effectiveness with continuous monitoring, remote collaboration and ready access to required information, as well as improved decision support.


**Figure 3.** There are measurable benefits from the integration of current systems with new data sources and analytics that complement processes focused on performance monitoring and decision support.


**Figure 4.** Many industrial organisations view the IIoT as key to reduced downtime, lower operating costs, improved regulatory compliance, and better overall product quality.

- Sustain advanced control and preventable degradation with benefits up to 25%: control teams can proactively maintain the effectiveness of control loops, controllers and models; adjust controls to new operating conditions and process changes; and quickly address critical instrument issues.
- Increase safety: production facilities can minimise risks by ensuring normal and stable operations, and also eliminate production stops for safety system verification.
- Reduce maintenance costs up to 10%: operations teams can take proactive measures to minimise equipment damage and emergencies while optimising maintenance based on real asset conditions, thus improving reliability and extending equipment life.

## Conclusion

Organisations across the process industries are seeking to improve their return on large asset investments. Effectively managing assets, however, requires a wealth of information and analysis. Industrial facilities need combined production and maintenance strategies to minimise unscheduled shutdowns and optimise product quality while cost effectively using the operations, maintenance and engineering resources on hand.

The true value of the IIoT can only be fully realised with a holistic view of asset management. Powerful virtual cloud networks will continually collect, aggregate and model data for accurate prediction of degradation and failures, and put contingencies in place to limit their impact on system availability. This approach is becoming fundamental to improving process reliability and driving cost takeout by delivering real-time, intelligent and actionable data to connected systems and the end user. Although it may take time for some companies to become an IIoT data-driven organisation, this evolution is coming and they should begin preparing for it.