Shell's Enterprise Journey to

DIGITAL
TRANSFORMATION

OSIsoft®

1 SHELL
at a glance

Dropping oil prices, expanding supply and growing regulations are bringing significant changes to the oil and gas industry. To stay competitive, the petroleum sector is undertaking a digital transformation and turning to Big Data, industrial IoT and advanced analytics to unlock business value.

For over two decades, Royal Dutch Shell has harnessed the power of digital transformation to optimize its operations and drive enterprise-wide performance. What began with a single digital oilfield has spread to the whole globe. Today, Shell gathers operational data from over 7.5 million devices across its enterprise, from the Gulf of Mexico to Australia's Browse Basin. Every piece of industrial equipment, from Shell's drill bits miles beneath the ocean floor to the flares of its refineries, is monitored by OSIsoft's PI System™. Shell's PI System, one of the largest in the world, is helping to digitize the enterprise and monitor all of Shell's production and manufacturing across the world.

This is a story about how one of the largest energy companies went from reactive to predictive operations, empowered its engineers with data-driven insights, and recognized early on that data is vital to achieve its enterprise-wide objectives. Reporting critical business value from real-time technology, Shell extended its existing Enterprise Agreement (EA) with OSIsoft to encompass even more areas within its operations. Today, the Enterprise Agreement helps Shell to expand its data-driven culture and accelerate its digital transformation.

7.5 M
data streams from industrial sensors

100,000
real-time calculations every minute

40,000
operational data displays

30,000
reports powered by the PI System

15,000+
users and counting

2007
signed an Enterprise Agreement (EA) with OSIsoft

2 FROM REACTIVE TO PROACTIVE OPERATIONS

For Shell, the digital journey began with a single refinery. Aiming to improve performance of its downstream equipment through data monitoring, Shell chose the PI System in 1998 to optimize operational efficiency and increase asset reliability, while seeking to solve the millennium (Y2K) issues of its data environment.

Once Shell deployed the PI System downstream, the company began to gather operational data at an oilfield in the Gulf of Mexico to improve performance of its wells, rigs, and drill floor equipment. The PI System was managed on a local level at each site, with engineers building data tool kits unique to their project.

But with rapid growth comes complexity. After a decade of gathering sensor-based data, Shell obtained hundreds of data servers, databases and equipment definitions, and their number was rapidly rising. While the Anglo-Dutch supermajor saw the need for managing data on a global scale, its site-by-site approach was leading to deepening silos of data. Facing an exploding number of data streams, Shell was looking for a new, comprehensive strategy for centralizing its distributed systems across the world and unleashing the value of its real-time and historical data.

The company signed an Enterprise Agreement (EA) with OSIsoft in 2007. The EA offered Shell a strategic partnership with favorable licensing terms, support, and key advisory services in a single framework. Shell no longer needed to count licenses for each installation and was now driving its digital transformation without barriers to growth. "The value of information is when it is used," said Paul Paterson, Shell's Product Manager for SMART Products and Platforms. "Moving to an Enterprise Agreement helps to unlock that value. It turns questions about whether to use data and technology from a 'why?' into a 'why not?'"

Working in collaboration with OSIsoft's EA advisory services, Shell aligned its vision with a strategic approach. The result was a high-performance data platform—a one-stop shop for delivering operational insights and predictive maintenance solutions on a global scale linked to Shell's internal and third-party applications.

"This Enterprise Agreement really brought Shell and OSIsoft much closer. We are now developing together…"

—Peter van den Heuvel, Manager of Shell's PI Center of Excellence (CoE)

3 ENTERPRISE-WIDE INTELLIGENCE WITH SMART SOLUTIONS

To lead the transformation, Shell formed the PI Center of Excellence (CoE), a team of knowledgeable and talented engineers who worked closely with OSIsoft to architect the company's global data infrastructure. The first step for PI CoE was to gather a decade of operational data from thousands of PI System servers across the world into a few Super Collectives located on different continents. With the Super Collectives centralizing millions of data streams across entire lines of business, Shell's operational data was ready to go global.

To bring a consistent structure to operational data, the PI CoE team deployed OSIsoft's Asset Framework (AF) and created an enterprise-wide data model that added context and structure to the time-series data. With AF, Shell was able to start constructing digital twins of each asset. Data is presented in terms of pieces of equipment and recognizable assets rather than tags. AF allowed calculations and visual displays of data to be templated and replicated quickly to different assets.

Today, millions of pieces of Shell's industrial equipment are modeled using AF into a global hierarchy across every continent, region, oil field and downstream facility. Once real-time data is combined in the Super Collectives, it enters the Smart Solutions platform where it is structured with AF. To maximize actionable insights, Smart Solutions blends operational data with business enterprise data such as SAP and laboratory and maintenance data. The combined data is then fed to Advanced Analytics tools for complex calculations and then deployed back into the platform with new Machine Learning algorithms that help thousands of users leverage data for operational intelligence and decision support.

Enterprise Agreement: How it Works

The Enterprise Agreement (EA) accelerates the digital transformation and maximizes success with access to:

- OSIsoft Enterprise experts focused on strategic deployment

- Architectural guidance, best practices, 24/7 support

- OSIsoft EA software licenses when you need it for rapid expansion

- Training for faster adoption and compliance

4 ADVANCING OPERATIONS WITH ANALYTICS

For Shell the journey to industrial analytics began a few years ago when the company decided to maximize the value of its data through predictive analysis. Today, Shell relies on a global team of data scientists who are focused on solving complex operational problems using advanced technologies like MATLAB, Alteryx, R and Python for algorithm development. Leveraging advanced mathematics, statistics and machine learning, the team collects real-time data from Smart Solutions and converts it into algorithm-based insights that are deployed back into global operations.

Shell's data scientists work very closely with the company's PI CoE team throughout the process. "Magic happens in the blends of discipline," said Peter van den Heuvel, Manager of Shell's PI CoE. Advanced technology is now moving into the hands of everyone—managers, engineers and operators—while data is becoming business intelligence.

Today, a large group of Shell employees gather two or three times a month to discuss the commercial potential of advanced analytics and share new technologies. Gaining commercial advantage from advanced analytics and new technologies is a cooperative effort which Shell relies on to gain continuous insights. The company's Data Science Workbench makes it easy for engineers new to analytics to experience these solutions. By democratizing sensor-based data across the enterprise, Shell is empowering its employees with smart analytical applications as it advances towards the future of prescriptive analytics and industrial AI.
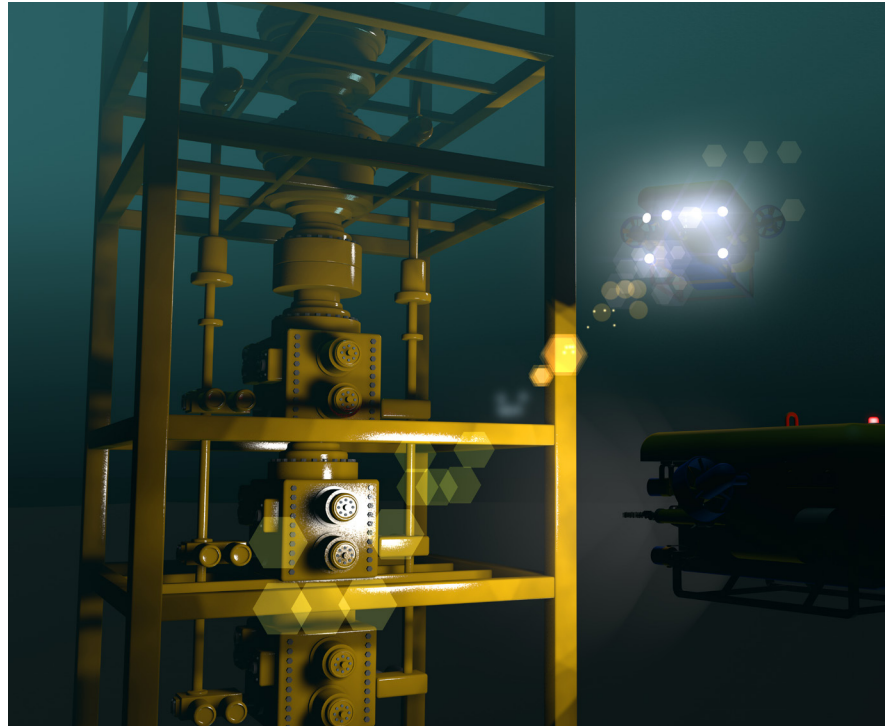
"This is all about empowerment. It's about changing an organization. It's about digitalization."

—Dan Jeavons,
Shell's General Manager of Advanced Analytics

5 CASE STUDIES

A Digital Blowout Preventer Saves Millions

In 2016, Shell wanted to improve the reliability of the subsea blowout preventers (BOPs) across its drilling operations. Sitting on top of wellheads on the ocean floor, BOPs are the first line of defense against uncontrolled surge of crude backing up the drill string and causing disaster. Critical to safe drilling operations, these complex systems of valves, which can be up to six stories high, are also the leading cause of non-productive downtime. Unplanned maintenance for a BOP can cost over a $1 million a day in lost revenue. Failure requires pulling the entire drill string—miles of it—from the ocean floor to the platform, costing millions in idle rig time.

Before Shell's BOP Reliability Team began to deploy the PI System to monitor its assets, crews gathered performance indicators through manual daily reports that provided a piecemeal view of equipment health and usage. To detect failure, engineers had to wait for its early symptoms—a costly, reactive approach.

Today, the BOP Reliability Team uses the PI System to collect real-time data from all BOPs in the field. The digital BOP initiative uses available data—valve positions, wellbore pressure and temperature, alarm data, and much more—to improve BOP performance and reliability. Shell relies on custom dashboards and PI Vision to visualize the data and maximize insights. A month after deploying the new system, the team found an issue in the hydraulic system of one of BOPs, which was being pressured too frequently. The detection meant preventing an unplanned stack pull and saving over $5-7 million.

Capturing Greenhouse Gases with Advanced Analytics

To help reduce the carbon footprint from processing oil sands into light crudes, Shell operates a carbon capture facility in Canada. The company liquefies and injects CO2 into storage wells, where the gas is locked more than a mile deep underground. To monitor the CO2 levels near the surface of the wells, engineers deploy a laser sensor that gathers real-time data on gas concentrations and sends it to the PI System. The sensor data is structured in Asset Framework and presented to Shell's Advanced Analytics tools that calculate CO2 levels based on constantly changing factors, such as live weather conditions. Despite the complexity of the calculations the users of the system have a simple dashboard interface. The approach shows the results of the collaboration between the PI Center of Excellence (CoE) team and Shell's data scientists. The end result is that Shell can demonstrate its regulatory compliance to the Canadian government and maintain its license to operate.

Real-Time Data on the Largest Vessel on Earth

Shell's Prelude FLNG is the largest floating vessel in the world. At a length of 1,601 feet and weighting as much as six aircraft carriers, the Prelude is longer than the Empire State Building is high. The new offshore facility, now anchored a few hundred miles off the coast of Western Australia, can produce natural gas and then liquefy it at sea, without the need for long pipelines to deliver it to gas processing plants onshore. Once production begins, the PI System will monitor all equipment onboard the vessel, which combines upstream and downstream operations, for the next 25 years. Pushing the boundaries of innovation, Shell's Prelude has the PI System deployed in two layers: in the process control system and in the business domain. OSIsoft's data infrastructure will monitor everything from the giant chain winches in the hull to the gas wells under the sea as well as the 50 million liters of cold ocean water needed to cool the natural gas. Shell's SmartConnect solution will use the PI System to monitor all rotating equipment remotely. Engineers will offer asset health support from a centralized location in Perth and advise operators onboard the ship in real-time from thousands of miles away, saving the company millions in transportation costs alone.

"PI Vision is helping us create powerful views of our data and rapidly share them with our users in a controlled way."

—Paul Paterson,
Shell's Product Manager
for SMART Products
and Platforms

Shell's Journey to Operational Mobility

Recently, Shell's leadership gave its global IT team a mandate to go "fully mobile," with the goal of unlocking new efficiency gains through smart devices. The company knew that out in the field mobile technology can drive improved productivity. Smart devices let crews get out from behind their desk to tackle problems hands on. With mobility, issues can be "found small and fixed small"—as Shell engineers like to say—before growing into a big, costly failure. It's one thing to get a call to look at a compressor sounding an alarm. It's quite another when you get an automatic notification and head to the asset to pull up its predictive information on your phone before the problem occurs.

But industrial mobile technology is not without its challenges, and the global IT team faced several questions. To understand the best way to integrate smart devices with the company's data landscape, the team ran a pilot at a gas field in the Netherlands. For two months, 15 crew members used OSIsoft's PI Manual Logger on secure iPads to collect data directly from the equipment during inspections. Previously, operators relied on paper and spreadsheets to gather data from assets as they made their rounds—an error-prone process that offered no feedback to the crew on equipment performance limits and failures. Using PI Manual Logger, operators easily filled in information from equipment into the device, which fed the data to the

PI System, making it immediately available company wide. When equipment limits were violated, PI Manual Logger sent notifications to instruct the crew on how to handle the issue. To help visualize and trend real-time data, crews relied on PI Vision, a web-based visualization tool for PI System data, which put the power of operational data at their fingertips. "PI Vision and PI Manual Logger go hand in hand," said Prabhat Mishra, the Product Owner at Shell's PI CoE team. "Operators make use of PI Vision to visualize the data which goes into PI Manual Logger."

The results of the pilot were dramatic: field data gaps disappeared, data accuracy increased, and front-line teams become better informed about reliability of their equipment. It was easy to know who made the tour and know what was done.

Today, the mobile solution is being rolled out globally. Field crews in the UK, Norway and Canada are starting to use the PI System

on handheld devices to take pre-emptive action to reduce downtime, transform decision making and obtain dramatic savings. Shell's mobile vision is becoming a reality, and the PI System is driving the transformation.

"PI Manual Logger is giving us the feedback that we really want. The operator works in the field and fills in all the values that he needs to report and when he does this he gets feedback on previous failures."

—Thomas de Vries, Shell's Production Supervisor, 2018

6 THE ENTERPRISE AGREEMENT (EA) PROGRAM

When customers adopt the PI System, they immediately see value and start spreading data collection point-by-point from one installation to the next. While each site gains value, there is often a missed opportunity to deploy the PI System strategically across the entire organization. The deluge of IoT data from the rapidly growing number of sensors, tag pricing for each new installation, and the need for consistent data modeling often become logistical challenges, posing barriers to expansion and strategic growth.

While many organizations unroll the PI System incrementally, more and more of our customers are choosing to deploy enterprise-wide, with OSIsoft's Enterprise Agreement (EA) Program. With an EA, your company can collect and visualize all operational data and strategically integrate IT and business data for optimal vision and value realization. The result is an accelerated and more efficient path to success.

The EA removes the burden of counting licenses, minimizes complicated deployments and ad-hoc practices, and delivers advisory services for a successful enterprise deployment of the PI System.

Today over 175 OSIsoft customers have taken advantage of the EA program to accelerate their vision and deliver business transformations. Through an EA partnership, our customers mitigate technical and business risk while "future proofing" their company to take advantage of change.

Get more information about the EA program in this FAQ.

The EA delivers a program that is designed to:

- Accelerate the value and business impact of the PI System
- Encourage people to capture more data
- Minimize the cost of deployment and total cost of ownership
- Deliver improved scalability and reliability for the future
- Reduce and eliminate pricing penalties and licensing headaches

ABOUT OSISOFT

For 40 years, OSIsoft has been dedicated to helping people transform their world through data. Our software turns the vast data streams from sensors and other devices into rich, real-time insights. You'll find the PI System in oil refineries, mining sites, wind farms, national labs, pharmaceutical manufacturing facilities, distilleries, data centers and even stadiums helping people save energy, increase productivity or develop new services. Worldwide, the PI System handles more than 2 billion sensor-based data streams. Founded in 1980, OSIsoft has over 1,200 employees and is headquartered in San Leandro, California. To learn more, please visit **www.osisoft.com**.

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