Downstream Digitalization

Digital strategies
for refinery operators

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About Cognite

Cognite is a global industrial SaaS company that supports the full-scale digital transformation of asset-heavy industries around the world. Our core Industrial DataOps platform, **Cognite Data Fusion®**, enables data and domain users to collaborate to quickly and safely develop, operationalize, and scale industrial AI solutions and applications.

Cognite Data Fusion® codifies industrial domain knowledge into software that fits into your existing ecosystem and enables scale from proofs of concepts to truly data-driven operations to deliver both profitability and sustainability.

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� Introduction

Large-scale digitalization of the downstream sector will only be possible if companies make all the data they collect available in a way that's intuitive to human users and machines. However, for many downstream operators, data is trapped in complex, siloed systems. This makes it more complicated for workers to use the data in their day-to-day activities; data scientists must build point-to-point integrations every time they want to develop a new application, and maintenance workers have to access multiple systems to find the information they need.

Digital transformation presents a game-changing opportunity to improve yield, productivity, asset reliability, and workforce effectiveness. Refiners need to sharpen their digital capabilities in three critical areas: analytics in production, field force effectiveness, and asset management.

Unexpected refining outages have soared in recent years, surpassing 2,000 incidents in 2019, quadruple 2015 levels, according to Industrial Info Resources, a provider of industrial process and energy market intelligence. Cognite's solutions can help operators monitor asset integrity, anticipate unexpected shutdown, and boost plant uptime with a state-of-art root-cause analysis system powered by physics-guided machine learning.

Strategic investments in digital tools and systems

support cost reductions and production optimization, which can help refineries become more adaptable, responsive, and competitive in a shifting landscape. To stay competitive, companies need to embed digital capabilities in all aspects of their operations in order to improve efficiency, reduce costs, and protect revenues and margins.

Cognite helps liberate the data from siloed systems — such as historians, control systems, and various ERP systems — and contextualize it for easier creation and deployment of analytics models and business applications powered by artificial intelligence and machine learning. Cognite creates a digital representation of a company's operations by connecting all of the IT and OT data together. With contextualized data as a service, downstream operators no longer need to collect, clean, and contextualize data for every new data science project. This enables companies to scale beyond pilot projects and create solutions that generate real value, from more robust and reliable machine learning applications for optimization and automatization to human-facing applications such as advanced visualizations.

Liberating and contextualizing data expands the applications of advanced analytics, which can significantly improve our understanding of how plants work by revealing hidden bottlenecks and solving complex problems. Cognite's interdisci-

plinary team, which includes people with more than a decade of experience from operating refineries, as well as experts in process engineering, instrumentation, automation, and optimization, is perfectly positioned to help downstream operators identify and unlock unrealized value.

This paper explains how Cognite's products can help operators and plant owners accelerate field force effectiveness, optimize plant production efficiency to reduce the cost of operations while increasing refinery throughput, and plan and carry out effective maintenance and inspection activities while gaining much deeper insight into asset integrity.

⬊ Production optimization: maximize throughput by ensuring operational excellence

Investments in data operations (DataOps) platforms and digital tools can support cost reductions and production optimization, which can help refineries become more adaptable, responsive, and competitive in a shifting industrial landscape. To stay competitive, companies need to embrace digital capabilities in all aspects of their operations in order to reduce costs, improve efficiency, and bolster revenues and margins.

Current processes make assets run inefficiently, consuming significant resources

Digitalization requires universal access to understandable data — data that has not just been collected across siloed source systems, but connected for contextual significance, discovery, and meaning. It requires a central DataOps platform that allows subject-matter experts to unleash their creativity, resulting in operationalized digital use case execution for better decision-making and streamlined processes.

Cognite Data Fusion® gives operators that foundational layer, providing a holistic data model that represents the physical assets and serving as a robust structure to digital twin applications.

Common processes in refineries like crude oil allocation and scheduling require data from many different systems, such as historians, ERPs, laboratory data, specification sheets, and more. The process of feeding the data into software or a proprietary algorithm requires a lot of manual work by a skilled worker. Since the process isn't automated, it consumes significant resources and carries the risk of manual errors.

Further, downstream operators have highly coupled processes that require predictive control. Real-time optimization presents an opportunity to run plants optimally, stabilize plant processes, and help make them more agile.

Running a downstream asset continuously at maximum efficiency and effectiveness isn't an easy task. Operators have to apply their subject-matter expertise to manually ingest data, run experiments by tweaking variables and seeing the impact on asset performance, and make decisions based on the results. This is time-consuming work, and there is no guarantee that the asset will be operating at its maximum efficiency.

What is Industrial DataOps?

"DataOps is a collaborative data management practice focused on improving the communication, integration, and automation of data flows between data managers and data consumers across an organization."

Gartner.

"DataOps is the ability to enable solutions, develop data products, and activate data for business value across all technology tiers from infrastructure to experience."

FORRESTER®

Optimize production processes to maximize plant yield

Reduce time to value. Cognite's products drastically reduce the time skilled workers need to access data from multiple data sources, making the data available via a unified API, feature-rich SDKs, various connectors, and through dedicated applications. This helps free up time, which experts can then reinvest in activities that generate value. Automating data collection and cleaning also eliminates the risk of manual errors, increasing data quality.

Cognite Data Fusion® was built to tackle data quality monitoring challenges and make data readily available for computation. Liberating and contextualizing the data from different sources makes it easy to perform real-time optimization. Cognite's digital twin technology can be leveraged to combine the liberated, contextualized data residing in Cognite Data Fusion® with visualizations, simulators, and optimizers to guide a suboptimally running plant toward the optimal operating point.

Cognite provides an open, unified asset model supported by a holistic DataOps framework. With the help of Cognite Data Fusion® and advanced analytics it facilitates, assets can consistently operate at maximum effectiveness and efficiency. All the data from different systems is easily accessible, making it easy to perform production programming.

Data in Cognite Data Fusion® can power machine learning models that can predict yield, energy consumption, and product specifications within the error ranges defined by experts. These machine learning models can then be incorporated into dashboards to ensure assets continuously work at maximum efficiency, maximizing yield while reducing energy use and waste, and keeping assets within their specification limits. Even small improvements in asset performance can translate into significant revenue gains.

Together with some of the largest players in oil and gas, Cognite has developed best-in-class intraday performance logic to reach the full value potential of production optimization by adopting a continuous, data-driven approach to production performance management. Using insights from historical and real-time production performance tracking to provide guided recommendation and access to performance enhancing advisors, refineries can detect, assess, and act on opportunities for reaching and expanding maximum throughput.

Ready for Hybrid AI. Capturing data and performing advanced analytics on normalized and contextualized data can help refineries, but reaching the maximum value potential in production optimization requires a hybrid approach. Often the phenomena operators are trying to predict in refineries are extremely complicated processes, and it is not given that the available sensors are able to represent the underlying physics. Consequently the predictions are questionable, and the ability to predict outside the range of the training data will be even worse.

The solution is hybrid AI, a combination of data science and physics-based modeling. By introducing physics into machine learning models, operators can more accurately predict these complicated phenomena. Cognite's products are built to support the confluence of data-driven machine learning, physics-based modeling, and virtual simulation to arrive at robust and highly accurate predictions and recommendations for refinery processes.

LEARN MORE ABOUT COGNITE'S INDUSTRY SOLUTIONS FOR PRODUCTION OPTIMIZATION →

⬊ Smart maintenance: get a closer, smarter look at your maintenance activities

With easy access to data that flows freely across the organization, operators can make informed decisions about where to prioritize maintenance investments, maximizing plant performance and extending equipment life. Cognite's products can help operators and plant owners plan and carry out effective maintenance and inspection activities while gaining much deeper insight into asset integrity.

Operators lose money and degrade equipment life with outdated maintenance activities

Despite the rise of tools and techniques to enable predictive maintenance, most downstream operators waste time and money on calendar-based maintenance that doesn't increase the lifetime of assets. Calendar-based maintenance of equipment leads to inefficiencies, as the condition of the equipment can't be accounted for in real time, occasionally resulting in unexpected and costly reactive maintenance and, more importantly, downtime.

Maintenance systems and software rarely integrate with other databases and data sources (such as physics simulations) to intelligently schedule maintenance work. Without this contextualized data from different sources, the systems are unable to suggest when maintenance is required.

Yet downstream operators already collect massive amounts of data about their equipment, including vibration and temperature measurements for the equipment body, shaft power consumption, and fluid measurements such as flow rate, pressure, and temperature. However, refineries often lack an enablement layer that integrates data from disparate sources and correlates it to failure events. Even if the refinery tries to manually get these insights, the process of integrating and standardizing data from different sources typically involves a considerable amount of time and effort from skilled workers — time which could have been invested in carrying out the actual analysis.

As an added wrinkle, maintenance teams are often tasked with monitoring and maintaining many machines simultaneously. It can be challenging to aggregate and monitor data across many different machine brands, models, etc. Even with machine data, "alarm fatigue" often overwhelms the teams, leading to reactive decision-making. Furthermore, there are examples of equipment specific to refineries that simply can't be fully monitored through live and historical data alone. For instance, suboptimal reboiler operations caused by rapid fouling can lead to large performance losses for refineries and require augmented data to facilitate data analytics and predictive maintenance.

Increase equipment efficiency and life with a pre-emptive approach to maintenance

Cognite's products liberate data from different source systems and create a holistic data model with contextualized data that helps plant operators optimize how they conduct maintenance of their critical equipment. This results in increased throughout, less unplanned downtime, improved maintenance planning, and reduced costs. By moving to a more data-driven approach to maintenance, Cognite's customers are also able to reduce their energy consumption, as healthy equipment requires less fuel.

Here are some examples of how Cognite's solutions can improve maintenance activities:

Scalable pump performance overview. In one specific use case, Cognite created a pump performance dashboard with all the relevant data that a company's first-line support engineers require to do their jobs, including pump performance (both real-time and historical), events related to the pump (e.g. work orders), and estimated time until oil changes based on runtime. This solution enabled the company to extend the lifespan of its centrifugal pumps by 20%, improving planning and reducing waste by taking a more proactive approach to main-

tenance. With Cognite Data Fusion®, the company was also able to scale these dashboards across multiple pumps with minimal effort and make the data readily available for internal or external use.

Hybrid ML-powered reboiler monitoring. Cognite products help monitor reboiler health by identifying operational conditions that influence the heat transfer coefficient degradation rate of reboilers and predicting when maintenance is recommended or required. Using hybrid ML — a combination of data science and physics — to predict when to clean the reboiler, and machine learning to estimate reboiler heat transfer coefficient degradation over time, Cognite greatly simplifies the integration of data from physics simulators to enrich the analysis in confluence with live and historical data from different sources. In one example where this solution was implemented, engineers found they had enough lead time to plan maintenance activities in advance, helping the company avoid downtime. The solution can also be applied to many other types of equipment to give a holistic picture of when the equipment might need maintenance. This can increase production, optimize refinery operations, and boost uptime.

Oil separation quality monitoring. In another instance, Cognite, using the contextualized data in Cognite Data Fusion®, set up an automated root cause analysis system that improves oil separation quality monitoring. The system, built by Cognite's

and a customer's subject-matter experts, uses a live hybrid ML model to identify bad actors of poor oil separation and provide recommendations for how to improve the separation process. By comparing the suggested bad actor with relevant data, end users can validate whether a component is a true bad actor and perform mitigating actions accordingly. This enables engineers to better plan production, as they can change settings to reduce the chance of quality-related problems before they arise. The oil-water separator analysis system helped boost the uptime of the plant, and increased the equipment's efficiency and throughput, saving the customer an estimated $9 million a year. This is a scalable solution that can be deployed using Cognite Data Fusion® to gas-oil separation plants (GOSPs) struggling with crude oil quality.

Maintenance prioritization. To streamline maintenance and inspection activities for an operator, Cognite built an application that aggregates alarms across all machines and applies custom rules so that the operator's maintenance team could easily identify hot spots and prioritize actions based on severity, duration, interruption, and more in a 3D interface. With better marking and collection of data, the application further refines decision-making, providing more reliable estimates on the time needed to fix issues and which machines have reoccurring issues, which helps maintenance teams optimize maintenance campaigns. Visual contextualization of SAP maintenance data drastically reduces time spent planning maintenance

work orders, increases efficiency, and democratizes access to data that experts can use to increase equipment performance.

LEARN MORE ABOUT COGNITE'S INDUSTRY SOLUTIONS FOR SMART MAINTENANCE →

⬊ Digital worker: boost field workers' health, safety, and productivity

The key driver to workforce enablement is equipping operators with updated, contextualized data that reveals insights into operations and empowers them to make data-driven decisions. Workers can collaborate across installations and coordinate more transparently with other colleagues, and refineries can optimize the planning and execution of day-to-day operations and maintenance activities by using real-time data to quickly identify equipment in its digital and physical contexts.

Limited access to data limits field workers' productivity while exposing them to greater risks

Refineries tend to have a huge backlog of maintenance orders, and operations and maintenance teams usually perform a risk assessment of the complete set of tasks planned for the following day to ensure work can be executed safely and efficiently. Data about work permits, operational risk assessments, and temporary deviations are stored in separate systems, meaning members of the team spend much of their time before and during meetings on accessing and compiling information that is not readily available.

Due to the sheer size of refineries, uncertainty about where specific equipment is located, and

inaccessible data, maintenance workers spend unnecessary time traveling back and forth between different locations and have a skewed representation of the actual risk related to maintenance activities.

A single maintenance task may require an onsite operator to access several separate systems to get the required data. Sometimes they must request additional permissions to get access. Too much time is wasted hunting for information across many different systems and printing it out for use in the field.

In addition to technological obstacles, there is the human element. Factors affecting risk exposure and planning such as a deviation that was observed during the day — a spill or a piece of equipment emitting a strange noise, for example – has to be entered manually in today's system, meaning that someone has to remember to include it, or to bring it up during meetings. Given the amount of work, complexity, and sometimes limited system support, it is possible that safety concerns could slip through the cracks.

Without a unified enablement and integration layer, the relevant contextualized data can't be accessed from one place. Integrating data from different sources requires personnel with specialized skill sets along with a major investment

in building custom extractors for each data source.

These challenges are born out of rigid data architectures that were not designed with an open, holistic view of enabling data utilization for models and applications. The good news? Rigid data structures can be fixed with Cognite Data Fusion®, which creates holistic data models that can be accessed through APIs, high-quality SDKs, connectors, and plugins to help operators use the applications they find the best suited to their needs.

Empower field workers by giving them access to data

Cognite's products help liberate data from siloed IT and OT systems, and contextualize it for easier creation and deployment of analytics models and business applications. With contextualized data as a service, downstream operators and workers no longer need to collect, clean, and contextualize data for every new data science project or new business application.

For Aker BP, one of the largest independent oil companies in Europe, Cognite's products have helped increase plant workers' safety while increasing their productivity.

InField. In one example, Cognite fed data from work permits, leaks, barrier impairments, well integrity status, noise levels, and more into Cognite Data Fusion®. Cognite's developers then made this data, as well as 3D models and equipment tags, available to field workers in InField, Cognite's flagship Digital Worker application, in order to help the company speed up visual inspection and testing of various equipment.

InField runs on top of Cognite Data Fusion® and is accessible on computers and mobile devices. The application enables engineers and technicians to instantly access all live sensor data and historic equipment performance data with less than one second delay, find essential documentation (e.g., procedures, work orders, drawings, P&IDs and maintenance logs), interact with 3D models of installation and equipment, share pictures and notes with their crew, and use computer vision to locate equipment tags and automatically provide related information.

Aker BP used InField to boost worker safety by giving its offshore management team a clear overview of factors that affect safe execution of upcoming maintenance tasks. The application boosted awareness of risk factors and reduced time spent preparing for meetings by combining data about work permits, barrier impairments, leaks, noise levels and asset integrity status. The solution also helped the company fulfill its regulatory responsibilities and expedited risk assessment during meetings.

In another example, Aker BP used data in Cognite Data Fusion® to improve its maintenance routines for process shutdown (PSD) valves. By giving field workers the ability to see equipment tags in context with other information — specifically, 3D models of the equipment — Aker BP was able to reduce annual maintenance checks by 66% and cut the time of an average maintenance session by 50%.

LEARN MORE ABOUT COGNITE'S INDUSTRY SOLUTIONS FOR DIGITAL WORKER →

↘ Conclusion

Cognite's solutions help downstream operators run their refineries optimally, maximizing yield, minimizing waste, and automating simulation data usage for accurate operations and forecasting. With Cognite Data Fusion®, operators can make their data do more, unlocking new opportunities and new ways of working to make their production faster, safer, and more sustainable.

WHY COGNITE DATA FUSION® →   BENEFITS FOR YOUR TEAMS →   CONTACT SALES →
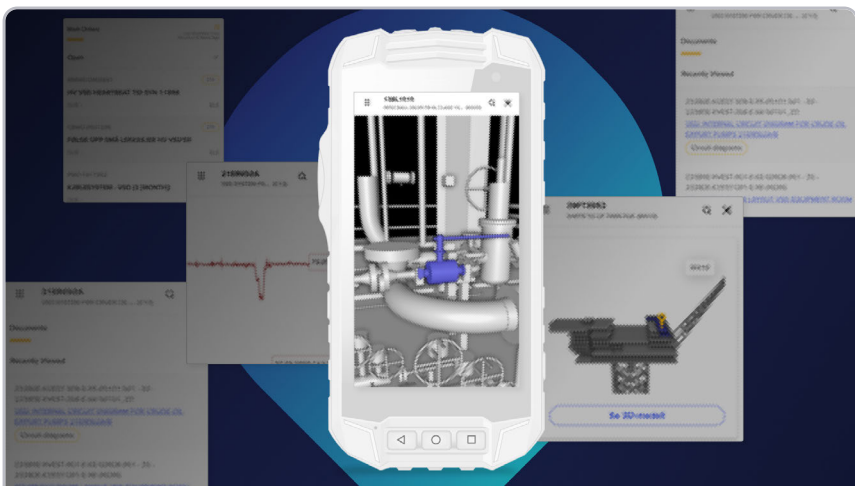
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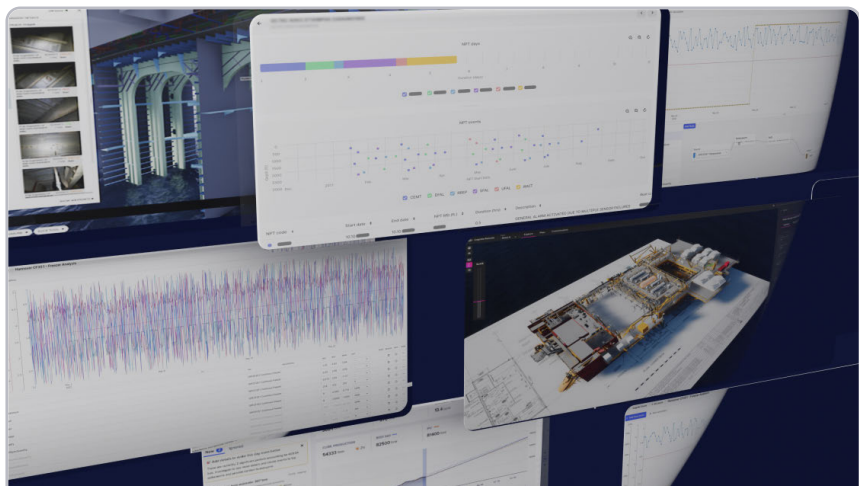
PRODUCT TOUR

Learn from Cognite customers and product managers how Cognite Data Fusion® simplifies and streamlines the data experience of a subject matter expert.

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CUSTOMER STORIES

Discover how Cognite Data Fusion® makes data more accessible and meaningful, driving insights that unlock opportunities in real-time, reduce costs, and improve the integrity and sustainability of your operations.
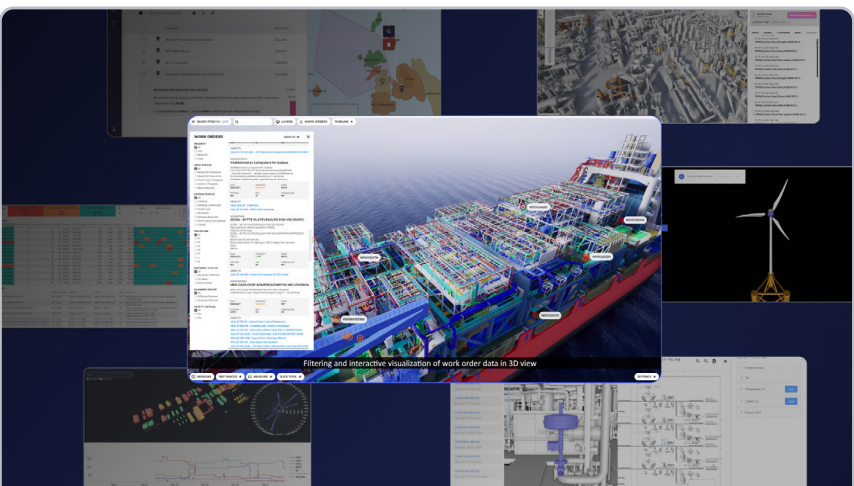
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ANALYST REPORT

Customer interviews and financial analysis reveal an ROI of 400% and total benefits of $21.56M over three years for the Cognite Data Fusion® platform.
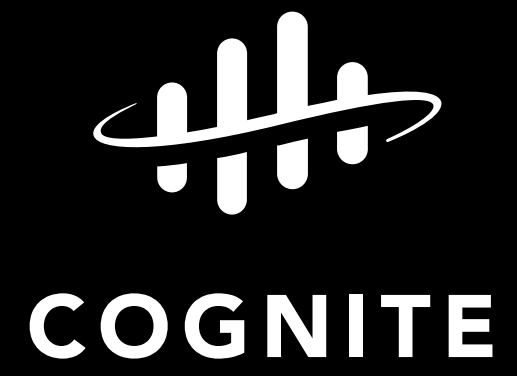
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