COGNITE

Surface Your Data

A manifesto for data liberation
in subsurface & drilling

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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

Volatility and uncertainty are ever-present in the global oil and gas market. In this changing environment, it can be difficult for exploration and production (E&P) companies to focus on long-term gains in subsurface and drilling.

But volatility shouldn't preclude change. The time for fundamental change in the oil and gas industry is now. Because the industrial future will be shaped by those who digitalize first and best.

To drive and speed up change, improve and shorten decision-making processes, minimize risk, and create value, oil and gas companies should turn to a reliable, though perhaps underrecognized ally: liberated, contextualized data. This includes structured data, such as seismic, well, and geospatial data, but also unstructured data, information found in sources such as documents, images, reports, and spreadsheets.

However, the biggest challenge with subsurface data, whether structured or unstructured, has always been that it is typically stored in legacy applications, proprietary databases, and complex folder structures located on internal drives, making the search for critical information a time consuming – if not impossible – process.

Thanks to cloud-native technologies, the oil and gas industry now has the capability to retrieve unbiased information exposed by structured and unstructured data fused together. This combination can improve myriad processes, from exploring new areas to planning new wells to creating rig activity plans, among many others.

At Cognite, we believe data, algorithms, and software should power the industry, freeing human creativity to shape a profitable, safe, and sustainable future. Today, heavy-asset industries such as oil and gas have reached a digitalization tipping point. Increasing access to data has made data handling a key differentiator.

Competitiveness in the digital industrial future will equate to data deftness. Companies must put their data to work, powering solutions that solve traditional pain points and answer the needs of their workforce. The companies who seize the mantle as digital frontrunners will have the greatest influence over their respective fields.

Whether in exploration, field development, or drilling, digital technology powered by liberated, contextualized data can help the upstream industry make trustworthy decisions that save time and costs.

This paper explains how.

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The challenge: data accessibility in subsurface & drilling

The lack of access to liberated, usable, and shareable subsurface data is a major bottleneck within oil and gas companies. Any solution that aims to tackle that challenge needs to meet the different needs of the many stakeholders within organizations who hold decision-making power.

It is not news that subsurface experts spend most of their time looking for data. Already in 2009, an SPE Digital Energy Survey of 200 users representing 30 companies found that 90% of respondents said they spend more than 50% of their time and human resources on identifying and formatting the data needed for their analyses1. In data acquisition, storage, and preparation for analysis, the survey indicated that the greatest problems have to do with collecting data from multiple sources and preparing it for consumption by different software developed by multiple vendors.

A decade later, this bottleneck persists. The challenges don't stop there, however. Once the analysis is complete and decisions are made, the application files, analytical tools, and captured knowledge become additional silos of information, remembered or understood only by the people originally involved in the analysis and decision-making.

It is often difficult for users to remember where specific information is stored and how to navigate to that location. For experts who have recently been assigned to a new project or asset, it is downright impossible. The only way to surface the information is to find an experienced colleague who can point to where the source is located.

On the other hand, if this information was effortlessly accessible, subsurface and drilling experts could discover a wider range of unbiased information, run applications more efficiently, and make better decisions. They could invest more of their time in developing creative, cost-saving approaches to their decision-making processes, deploying and testing different analyses and tools to innovate the current subsurface and drilling workflows.

While subsurface and drilling experts wrestle with data, other stakeholders in oil and gas companies wrestle with the architectures that allow for full integration of data- and workflows themselves. The departments that are in charge of the digital transformation of their organizations are charged with exploring how technology can create new architectures and business value by changing existing business processes. But digital transformation can be difficult to achieve when those processes are still fragmented into silos and vendor-dependent systems.

Although in the last decade software providers have enabled companies to integrate different data and disciplines into a single platform, full vendor-to-vendor and data integration have yet to be achieved. Examples – of which there are many – include the incompatibility of geoscience and drilling platforms and the impossibility of extracting lessons learned from unstructured data, which makes collaborative sessions among subject-matter experts for infill well planning quite cumbersome.

What's the alternative? A digital ecosystem that oil and gas companies themselves control. Such an ecosystem would allow IT and digitalization departments to integrate different IT systems via vendor-neutral, service-oriented architectures and exchange data based on industry standards, combine and automate work processes, leverage experts across disciplines, and enable real-time collaboration and operations monitoring, among other benefits.

A digital ecosystem can also help oil and gas companies take a mental step back from the repetitive tasks that make up day-to-day routines to understand what keeps assets from performing optimally. By liberating data from different source systems, companies can identify the assets' unmet requirements with cross-domain, cross-functional information. The asset becomes the center of the value creation; team members collaborate using the same digital representation of the subsurface,

contributing to the same goals, while suppliers provide solutions for the asset rather than closed data and application packages.

Once both humans and machines are enabled by data shared across an entire organization to fulfill the needs of an asset, business models will need to adapt. As the demand from operators changes, so will the market. This will push and incentivize suppliers to innovate faster, develop tools and services to continuously achieve better outcomes - moving the industry forward.

Five guiding values for data liberation in subsurface & drilling

Among many similar studies, a 2015 study of 97 wells drilled in the UK sector of the North Sea from 2003 to 2013 showed that more than 50% of the wells failed due to poor integration, improper application of domain science, lack of context, and absent or ineffective peer review 2. The right technology and software can address all of these shortcomings.

Liberated, contextualized structured and unstructured data takes out the guesswork – removing human biases, reducing processing time, enhancing collaboration, and empowering workers to become innovators. But to make subsurface and drilling more effective, efficient, and better for all, the data has to deliver the following five values:

Confidence. Though some software products claim to minimize uncertainty in subsurface and drilling decisionmaking processes, human interpretations will always introduce a degree of uncertainty. Digital products and software that run on liberated, contextualized data target this uncertainty by putting subsurface information to use across stakeholders, enabling cross-team collaboration and peer review, powering data-driven decisionmaking, and maximizing the wells' uptime and delivery.

Reliability. Data and information should always be auditable. If not, subsurface interpretations and models have a high risk of being incorrect, leading to decisions usually based on overestimated reserves calculations, which drives up investments and costs. Liberated data, by contrast, with enriched quality tags referencing source systems, users, and history can provide the foundation for best practices in modern, automated enterprise data governance. Users will always know which data sets are validated and able to run their digital workflows.

Fidelity. Data must be consistently packaged, contextualized, validated, and shared throughout a multifunctional organization's entire decisio making process. This process typically involves multiple teams of experts and organizational functions. To avoid confusion, they need a single source of truth. Information and data flows should be open and accessible to all stakeholders. This enables data re-utilization and enrichment without losing quality, resolution, or other important attributes. Only open data platforms and software that contextualizes data can make this possible.

Flexibility. Throughout the entire subsurface lifecycle, data should be evergreen, continuously adapting to new streams of data (new seismic imagery, production data, real-time drilling data, etc.), building resilience, and replacing static, inflexible processes that slow organizations down.

Speed. With information and data effortlessly available and ready to use with low latency, organizations will find that they can run company-specific automated or semi-automated standardized processes and best practices, accelerating time to value.

Cognite in subsurface & drilling

Cognite's products provide instant access to the data that subsurface and drilling experts need to apply their expertise and accelerate decisionmaking processes.

Cognite's main software product, Cognite Data Fusion (CDF), solves key challenges for oil and gas companies, allowing them to accelerate time to value in three steps:

1. Liberating structured and unstructured data from different data sources, from legacy master data systems to files stored in internal drives.

2. Contextualizing data; that is, automatically connecting critical information from different

data sources to become interrelated data via human-based relationships.

3. Empowering people via an open API architecture that exposes data to internal and external service-based domain applications.

CDF integrates seamlessly with existing IT and OT systems in the cloud, at the edge, and onpremise. By contextually enriching industrial data, CDF provides an open, unified industrial data model that humans and applications can access easily. This contextualization process enables an end-to-end digital twin of an asset, from subsurface to topside. The combination of Cognite Data Fusion and Cognite's suite of business applications enables full integration of planning and operations, empowering subsurface and drilling experts to make data-driven decisions that reduce the time to decision and create value.

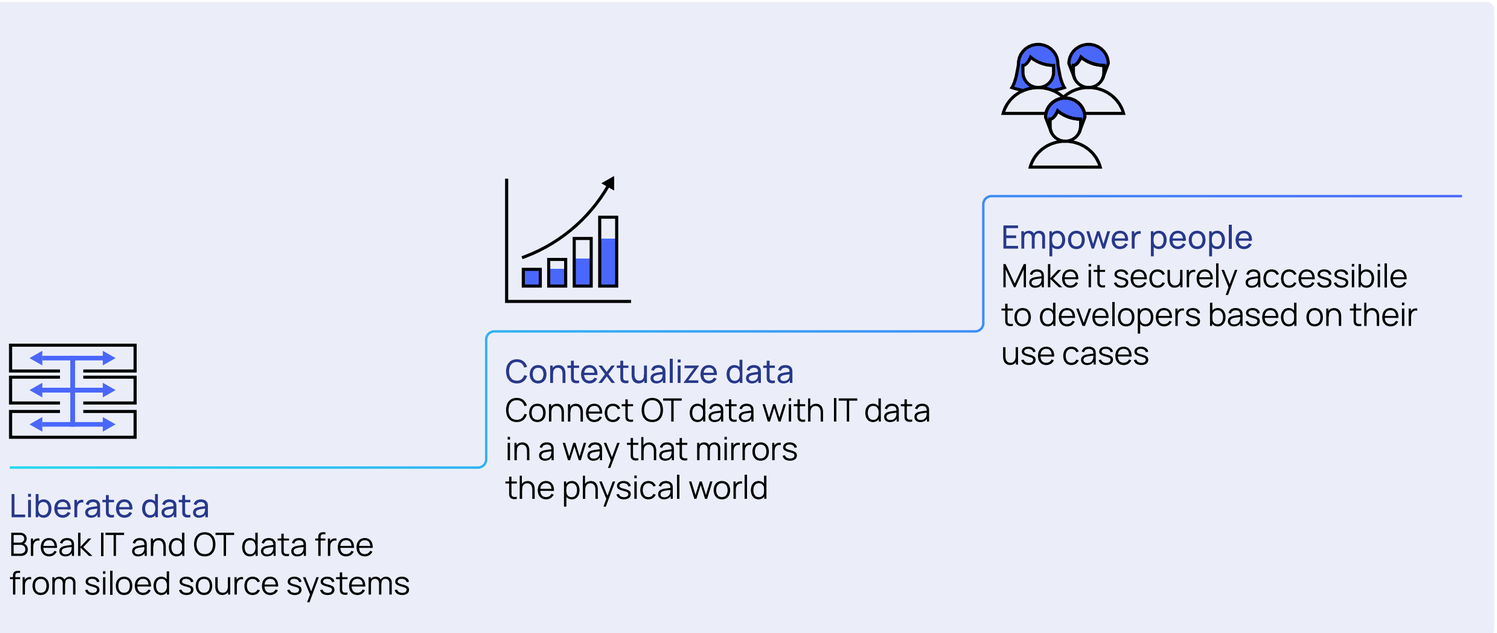
Features

Liberating data. Cognite Data Fusion supports a range of flexible data extraction and integration patterns, emphasizing security and governance at every step of the process. This helps companies extract subsurface and drilling data directly from source systems and contextually integrate it with data from data warehouses and data lakes. This data fusion layer creates the foundation for accessing unlimited, fully open sources of information, shared across the entire organization, to solve the most complex challenges within subsurface and drilling.

Once the data is available, users don't need to think about data loading. Instead, they can focus on identifying, profiling, and resolving data quality issues at every step of the data lifecycle, ensuring that all data consumers can rely on highquality data in safety-critical environments. Users can define their own data quality requirements, receive alerts when there are issues with dataflows, and display data quality status in other applications and dashboards.

Contextualizing data. Cognite Data Fusion delivers contextualized data as a service through a combination of machine learning, natural language processing, rules engines, and subject-matter expert enablement, making data discoverable, understandable, and comparable independently of its origins. Users can convert data to knowledge by setting up contextualization pipelines to retrieve businesscritical information; leverage pretrained machine learning and natural language processing models, state-of-the-art rules engines, and domain expertise to develop solutions quickly and at scale; and convert unstructured data into structured knowledge by liberating information trapped in documents, diagrams, images, video, and more.

Cognite Data Fusion lets users themselves add those crucial links between unstructured and structured data, further deepening their organization's knowledge base. In one example, a subsurface expert may be consulting a publicly available document that mentions casing defor-



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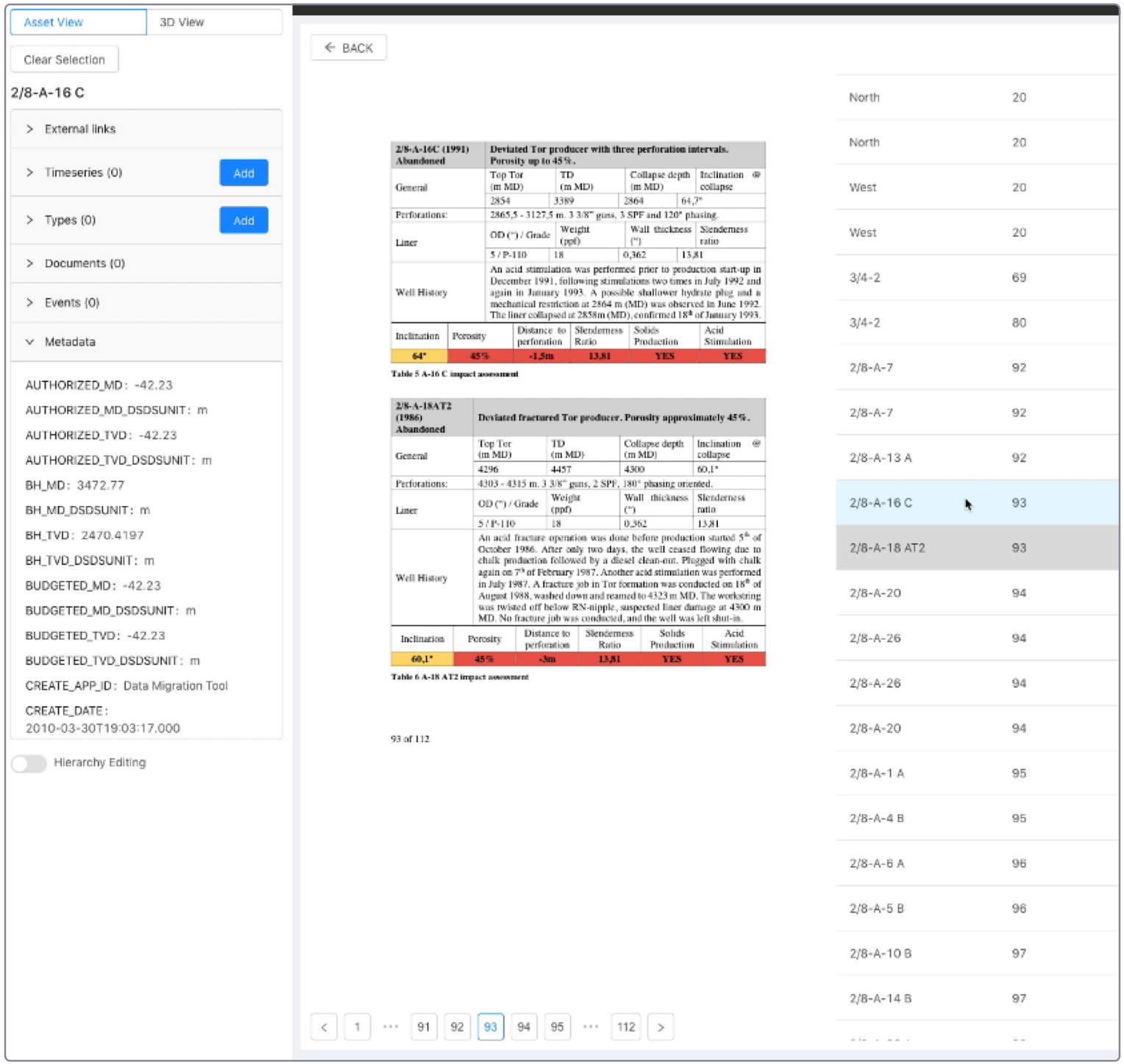
mation events that occurred in wells at one of the assets operated by their organization. The expert is then able to link the contents of the document to the relevant wells, which makes the information consumable by analytical tools.

Empowering people. Cognite Data Fusion empowers oil and gas organizations through a rich suite of open APIs and SDKs for a variety of data consumption cases. Ingestion and query APIs enable a powerful search tool – based on relevance or on geographic coordinates -- that supports both human- and machine-generated queries.

Cognite Data Fusion also interacts seamlessly with modern software (e.g., Python, Scala, Spark, Spotfire, Grafana, Databricks, Tableau, and Power BI, among others). This provides the ideal environment for users and domain experts to efficiently organize, explore, and accelerate the development of models – and visualize the results in real time. With Cognite Data Fusion, the path and time to solution is significantly reduced.

Cognite Data Fusion provides a vendor-neutral environment. Users can access data without delving into proprietary databases, and easily launch domain applications via APIs as services on top of the data. Cognite's other applications, including Asset Data Insight and Operation Support, are only a few clicks away – as are popular productivity software such as G Suite and Microsoft Office and Sharepoint, as well as specialized tools such as Power BI and Grafana. There is no lock-in, only options.



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Cognite Data Fusion® in action

Improving seismic data discovery, quality assessment, and retrieval with a cloud-based seismic data store and API

Challenge: Seismic data discovery, quality assessment, and retrieval are often time-consuming and iterative processes between geoscientists and data managers. Typically, only the metadata is organized in a proper database, making seismic datasets retrievable only as flat files. Querying for a subset of seismic data is practically impossible, as is getting the actual data coverage within a survey. Normally the full seismic dataset must be loaded into interpretation software before any kind of qualitative or quantitative assessment of the data can be made. Individual vendors and seismic software providers often implement their own proprietary data stores. The result is duplication of data, cumbersome cross-tool collaboration and workflows, limited access to and from third-party applications, and difficult automation of processing, interpretation, and analytics. This situation leads to significant loss of time, costly vendor lock-in, and a structural inability to access the full potential of the data.

Solution: Aker BP, one of Europe's largest independent oil and gas companies, is implementing a seismic data store based on Cognite Data Fusion in its cloud environment as part of the company's larger digitalization program. This will enable:

1. fast, tool-independent access to Aker BP's seismic data through an API that allows queries of the whole survey, but also of subsets of the seismic data;
2. overviews of the actual data coverage within each survey;
3. seismic previews;
4. and third-party applications running as services on top of the seismic data.

Impact: The cloud-based seismic data store and API will help Aker BP overcome the previously mentioned data bottlenecks. Data managers can focus on data quality rather than spending their time loading data into different applications. An API with proper access control streamlines sharing data, making it easier for Aker BP to share seismic data with third-party companies.

Prediction and prevention of anomalous chalk influx events using physics-driven models and data analytics

Challenge: The Valhall field in the North Sea produces oil from a fine-grained chalk reservoir. Production started in 1982 by pressure depletion and compaction drive (re-pressurization). In 2004, after water injection was introduced, the reservoir started to experience compaction, leading to seabed subsidence. One of the consequences of this process is enhanced production of chalk, leading to well instabilities and, in many cases, well plugging. Chalk influx events are infrequent but costly; Aker BP, which operates the field, experiences about five chalk influx incidents a year, and these events cost the company millions of dollars a year due to large production losses, oil deferrals, and the cost of coiled tubing clean-out.

Solution: To avoid future chalk influx events, Aker BP and Cognite designed a chalk influx advisory system that combines subsurface and topside data analytics, physics-driven models, live data monitoring, and an end-user notification system. The development team identified patterns that are highly correlated with chalk influx events, and the information was used to develop a series of models that detect these patterns in multiple parameters.

The models run continuously on a model hosting environment in Cognite Data Fusion, monitoring live sensor data and writing results back into CDF. These models rely on signal conditioning and data analytics methods that detect patterns associated

with the initial stages of a chalk influx event.

Additionally, the team developed a digital twin of Valhall's subsurface and a multiphase virtual flow meter (VFM). The VFM feeds on live sensor data from CDF (e.g., pressure and temperature) and environmental parameters (ambient and sea temperature) from a weather station. The VFM results are coupled with an enhanced sand detector model to identify early signs of chalk influx events and other abnormal events.

Finally, a chalk influx notification system continuously monitors the model outputs and alerts reservoir engineers if a chalk influx event is predicted. The alerts are sent as messages to the engineers' phones and computers. Each alert is enriched with information such as type of anomaly detected and proposed mitigating actions, links to dashboards and documentation, and functionality to acknowledge the alert and communicate with other engineers.

Impact: After the chalk influx advisory system was implemented on a test well, the solution was immediately scaled to 11 additional wells prone to chalk influx events. Since the system was installed at Valhall during the first half of 2019, no chalk influx events have stopped production from the monitored wells.

Redefining drilling activity planning and execution via a digital drilling ecosystem

Challenge: Today each step of the drilling activity planning is performed in separate spreadsheets and documents, and legacy applications that require point-to-point connections, frequent data importing and exporting, and manual typing and retyping. These inefficiencies make it difficult to standardize ways of working, accurately communicate the drilling activity plans to all stakeholders and partners involved in the value chain, and reuse data to improve the planning process.

Solution: Aker BP is developing an open, standardized, and structured digital drilling ecosystem that orchestrates the exchange of plans between systems while enforcing standardized plan structures from well construction, time estimation, and the time planner to the rig action plan and its connection to a rig control system.

Central to this ecosystem is a "smart hub" that receives and centrally masters updated plans, checks each plan's conformance to the schema on which it is based, and distributes each committed plan to registered consumers. The smart hub provides a loose coupling between itself and connected plan consumers and publishers, which enables the easy connection of new systems or the replacement of one system with another.

Impact: By leveraging the connection of automated drilling to the digital drilling ecosystem, Aker BP believes it can reduce drilling time by 15- 25%. This will create substantial cost savings and thus allow smaller reservoirs to be more profitable. Other benefits include more accurate time estimates and resource planning, more efficient logistical services, and better data-driven decision-making.

Conclusion

Open data technology is laying the foundation for the oil and gas companies to reclaim their power and minimize the risk of relying on a single technology stack or vendor within subsurface and drilling. Oil and gas companies can establish their own vendor-neutral data architectures, where they decide on the best technology to implement based on their own business priorities and competitive landscape.

Liberating data and information from legacy applications and making them accessible via open, standard formats is the first crucial step. Accessing open libraries of technology for subsurface interpretation, modeling, reporting, and visualization, as well as deploying proprietary or third-party vendors' microservices via APIs, enable organizations to build an operational ecosystem that best fits their business objectives.

The oil and gas industry has every opportunity to improve, optimize, and succeed in the years to come. Whether the industry is able to do so will depend heavily on decision-making processes driven by democratized access to data and technology, enabling subsurface and drilling workers to innovate and do their jobs more confidently, resiliently, rapidly, and with a competitive edge.

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Want to know more about our product?

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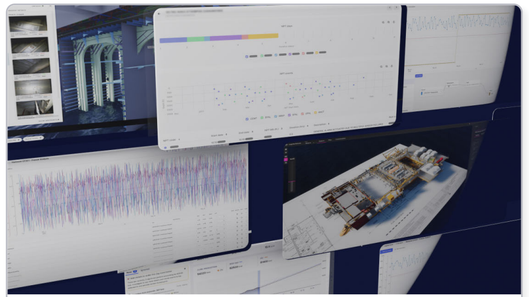
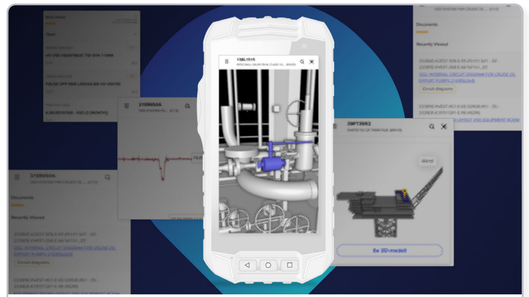


PRODUCT TOUR

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

WATCH NOW →



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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