

FACTORY OF THE FUTURE: ACCELERATING JAPAN'S MANUFACTURING SECTOR WITH DATA

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INTRODUCTION

We believe data, algorithms, and software should power industry, freeing human creativity to shape a profitable, safe, and sustainable future. Today, heavy-asset industries like oil and gas, manufacturing, shipping, and power 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. Must adopt software solutions to solve traditional pain points and answer the needs of their workforce. Quickly, creatively, progressively. The companies who seize the mantle as digital frontrunners will have the greatest influence over their respective fields.

Cognite helps manufacturing companies reach that future and capture value along the way with technological solutions such as **Cognite Data Fusion (CDF)**, a software package that supplies contextualized data as a service (CDaaS); **services** that enable real-time data access, condition monitoring, and machine learning hosting; and **applications** such as Asset Data Insight and Operation Support, which make data available and accessible to users.

This paper explains how.

STATE OF THE INDUSTRY:

Digitalization in Japan's Manufacturing Sector

Japan is one of the world's largest economies. Its manufacturing sector is already a powerful engine for economic growth. As more industries digitalize their operations, adopt modern business models, and invest in new partnerships, that growth will only accelerate.

Japan is already recognized internationally for its best practices and leadership in major manufacturing verticals, including electronics, the automotive industry, and chemicals. As one of five countries in McKinsey's "Advanced Asia" economic category, Japan has already achieved high urbanization, high connectivity, and high per capita GDP compared to its neighbors.

The market for Japanese manufactured goods is opening up globally as well. For example, since the Economic Partnership Agreement between the EU and Japan came into effect in February 2019, Japan can take advantage of "the largest open trade zone in the world," and annual trade between the two entities could increase by nearly €36 billion, according to the European Commission. The agreement will help EU companies access procurement markets in 54 large Japanese cities, increasing the availability of mission-critical resources from Japan's manufacturers.



The Ministry of Economy, Trade and Industry (METI) has identified advanced manufacturing as one of Japan's key growing sectors, predicting that it will reach 30 trillion Japanese yen (\$270 billion) by 2020.

Accenture, "Asia Pacific: Shaping the Future of Industrial", 2019

At the same time, Japan is transitioning into more advanced manufacturing sectors through partnerships, acquisitions, and growth. Japan continues to pursue the economic growth strategy its government approved in 2010, known as the "Rebirth Strategy for Japan." The plan focuses on Japan's manufacturing and technology capabilities and targets the creation of 4.7 million jobs by 2020.

As we will find, new investments in education and job training driven by these changes will align with a more innovative, digitally transformed industry.

Creating a Culture of Talent and Innovation

As Japan's manufacturers face challenges to employee readiness and technology adoption, data has the potential to become these industries' most valuable asset.

The World Economic Forum has noted that the development of globally competitive "talents and innovators" is central to Japan's manufacturing future. Japanese manufacturing executives claim they are prioritizing empowering their entire employee populations to innovate highly advanced products, processes, working styles, and values. Indeed, both Japan's government and its private sector are investing heavily in manufacturing innovation, automation, and job training, with government funding specifically targeting improvements to the manufacturing process, according to Accenture.

Japan's chemical manufacturers are driving this cultural change, fueled in part by the Japan

Chemical Industrial Association's (JCIA) recent commitment to the support of more sustainable societies. As part of a broad set of initiatives, the group seeks to "encourage the development of outstanding and innovative science, technology, and products through the development of technologies" and to "take the initiative in innovation, as solution provider, for realization of [a] sustainable society through materials and substances in cooperation with the entire value chain."

Japan's manufacturing workforce therefore must include workers who are not only innovative and technologically capable per the requirements of their respective manufacturing sectors. A more diverse workforce must operate in the context of a global economy, with an awareness of the impacts their decisions have on broader populations and a firm grasp of the digital tools that will shape Japan's manufacturing future.

Improving Competitive Value in the Global Economy

Japanese manufacturers can use data to maximize their capabilities and sharpen their competitive edge.

Japan's industrial future will therefore be shaped by those who digitalize their organizations first and best. Companies that liberate a wide variety of industrial data from separate, siloed sources can use these assets to optimize and automate processes, improve human-facing applications, and meet the ambitious goals set by internal and external stakeholders. According to Accenture, manufacturers who are leading this digital transformation in Japan have the following commonalities:

- A strong commitment to new business and operating models as part of the digitalized enterprise
- A desire to deliver greater innovation and agility, and achieve faster time to market
- A willingness to invest in smart connected products and experiences as a means to fuel growth
- A determination to scale intelligently, especially through partnerships and "outside-in" innovation

Industry trailblazers are focusing on their shared desire to innovate with other public, private, and academic stakeholders in the country. JCIA prioritizes "[w]orking more closely with stakeholders [who are] leading innovation, such as government or universities, [and] aim[ing] at creating yet-to-be-realized breakthrough innovation as well that leads to [the] evolution of [the] entire society," according to its 2018 annual report.

In fact, partnerships will be paramount in shaping Japan's manufacturing future, as manufacturers increasingly branch into related industries, such as healthcare. Partnering is already becoming a core capability among leading companies, creating new opportunities for Japanese manufacturers' market reach and digital futures.



ACCESSIBLE DATA:

The Key to Efficient Digitalization

Today many manufacturing companies are still in the early stages of the data science journey, where they are exploring the troves of data at their disposal and identifying business problems that could become data science use cases.

This is also the stage where the potential of digitalization enters a technical bottleneck. Companies might find that the time to deployment is lengthy and costly. That scalability across assets or equipment is low. And that connecting different sources of data together to create meaningful insight requires many areas of expertise. These and other challenges are why 80-90% of the time it takes to complete a data science project today isn't actually spent on creating models, but on gathering, cleaning, and contextualizing data.

The lack of access to liberated, usable, and shareable industrial data is a major source of inefficiencies within manufacturing companies, requiring workers to complete time-consuming manual processes to find the information they need to do their jobs. Examples include:

• Business analysts: "I want to have all customer data in one place, so that I can avoid wasting time running around to collect it. I also want to be able to export reports, which would free up time that I can spend other tasks, and get upto-update critical equipment data so that I can review developments shortly after they are reported."

- Data scientists: "I need access to all our data in one place. That way I won't have to gather, clean, and collect data for every new analysis."
- Quality control specialists: "I want critical equipment data reported in a dashboard, so that I can avoid wasting time manually filling out a spreadsheet. I also want critical machine values flagged and the ones that are not reviewed yet presented on top, so that I do not have to search for it."
- Equipment engineers: "I need to be notified when the data flow has stopped, so that I can investigate if a sensor has failed."
- Maintenance experts: "I want to be able to review alarms from all our machines on the factory floor in one place, instead of having to manually pull a local log from each machine."

COGNITE DATA FUSION (CDF):

Cognite Data Fusion (CDF) was developed specifically to tackle the technical challenges that chemical producers, engineering, procurement, and construction (EPC) services providers, and other manufacturing companies face.

CDF integrates seamlessly with existing IT and OT infrastructures to liberate a wide variety of industrial data from separate, siloed source systems, collecting it all as a comprehensive set in the cloud, securely and without space limitations. It then automatically structures the sensor data in relation to other relevant data (e.g., process diagrams, 3D models, event data, and more). This contextualization process effectively creates an operational digital twin of an asset or system. With contextualized data as a service (CDaaS), manufacturing companies 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 and apps for the digital factory worker.

By maximizing their own capabilities with data, manufacturing companies can sharpen their competitive edge.

Features

The Cognite Data Fusion Software-as-a-Service product accelerates digitalization in the manufacturing sector. We offer easy access to tools for the whole use case life cycle. There is no lock-in, only options for those solving the use case.

Our goal is to accelerate your existing digitalization or AI team with rapid and easy access to the operational data they need, and connect you with the best tools in the market. This includes offerings from our expanding ecosystem of specialist partners.

CDF and our accompanying suite of applications and services enable your team to work in an iterative manner toward operationalized value. We put you in immediate contact with live data and get MVPs into operation fast.



EMPOWER PEOPLE

Make it securely accessible to developers based on their use cases



CONTEXTUALIZE DATA

Connect OT data with IT data in a way that mirrors the physical world



LIBERATE DATA Break OT data free from siloed source systems

Selected capabilities of CDF include:

Machine Learning Hosting: Machine learning is most effective when the models can run constantly, alerting the right people when necessary and advising on what steps need to be taken. Cognite's Model Hosting service makes it easy to deploy, schedule, and maintain analytics models. Our specialization is models for time series, which are very complex when you want to build robust, reliable, scheduled data pipelines. You can use another hosting environment, if you have one you are comfortable with, but Cognite is proud to offer our own as an option.

Integration with Analytics and Visualization

Tools: CDF 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 CDF, the path and time to solution is significantly reduced. **Digital Twins:** Manufacturing companies can enhance their understanding of their own operations by putting all OT and IT data through our contextualization pipeline to create an operational digital twin. Combining that data with a 3D model, for example one created using photogrammetry technology, creates a foundation for authorized users, whether internal or external, to streamline the creation of models for individual components, equipment, and processes.

The operational digital twin allows for data consumption based on the use case. Any model created can live off the streaming live data that exists there, enriching the space by feeding its own insights or derived information (e.g., synthetic temperature or vibration information created by a simulator for equipment where no real sensor exists) back into the twin. Combined with live and historical data, these insights on equipment behavior shore up the operational digital twin, making it even more complete and useful for the future. Interactive P&IDs: Paper documents can be unwieldy on the factory floor, and by themselves, they don't tell the full story about plant operations. Asset Data Insight, Cognite's flagship application for smart maintenance, lets users easily build infographics by combining different data sources contained in CDF. For example, users can assign labels to individual components in a Process & Instrumentation Diagram (P&ID), and by clicking on one of the labels, the user is taken to an asset explorer page. The user can then view asset metadata, and search and filter time series, events, and other documents such as instruction manuals.

Asset Data Insight is developed for handheld devices and computers. This means factory workers – no matter where they are located – can look at the same P&IDs to make data-driven decisions that improve operations.

COGNITE IN ACTION

Contextualized data from Cognite Data Fusion (CDF) can heighten your analysts' and engineers' understanding of their own operations and empower your teams to maximize daily production.

With real-time access to the right data in context, your teams can remove unnecessary production constraints and take actions to release more production, increase production capacity by process debottlenecking, mitigate production deferral, and take actions to close the gap between production capacity and actual production.

How Cognite Data Fusion (CDF) reduces unplanned failures and maintenance costs

Challenge: Many manufacturing companies run their maintenance operations on a schedule, tasking workers to conduct routine inspections of equipment at set intervals. In addition to scheduled maintenance, workers also conduct reactive maintenance, such as when a sensor alerts them to a potential issue involving equipment.

This approach to maintenance means that workers may spend several hours of their day inspecting equipment that is in good working condition – hours that could instead be spent performing other tasks that generate value for the company.

Solution: Yokogawa and Cognite used the liberated, contextualized industrial data stored in Cognite Data Fusion (CDF) to build maintenance solutions in Asset Data Insight, Cognite's flagship application for smart maintenance.

One such solution is an alarm overview that reduces unnecessary inspection of equipment. The overview shows a bird's-eye view of the manufacturing plant and live sensor data from the pumps on-site. If a pump's vibration exceeds a predetermined threshold, one of Yokogawa's systems will send a signal to CDF, which will visualize it as an alert. When a user clicks an overlaid label associated with a pump on the infographic, the user is taken to an asset explorer page. The user can then view asset metadata, search and filter time series, events, and documents such as the instruction manual.



This enables workers responsible for the plant operation to diagnose the issue and decide whether it needs to be corrected immediately.

Another solution combines the process diagram of the plant's energy center with live sensor data. By clicking on the individual components that together form the energy center, workers can easily view all the information about the equipment available in Yokogawa's maintenance system. The information can also be displayed in convenient charts that reveal how different factors may be connected, for example pump flow rate, temperature, and vibration.

Impact: Instant access to data allows companies to conduct maintenance on equipment based on its actual condition, as opposed to running its maintenance program on a set schedule.





How Cognite Data Fusion (CDF) improves the efficiency of manufacturing plant maintenance workers

Challenge: Large-scale digitalization of the manufacturing industry 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 manufacturing companies, 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.

Solution: In less than two days, Cognite liberated data from Yokogawa's source systems, including time series, equipment information, historical

events, and instruction manuals, collecting it all as a comprehensive set in Cognite Data Fusion (CDF).

Yokogawa and Cognite then identified two specific ways of getting the liberated, contextualized data into the hands of maintenance workers.

The first is Operation Support, Cognite's flagship application for digital field workers. Available on computers and handheld devices, Operation Support streams data from CDF. By scanning a tag on any piece of equipment in the manufacturing plant, Yokogawa's maintenance workers can now pull up all real-time and historical data, documentation, maintenance records, pictures, and more information relevant to that equipment.

The second is a digital twin that combines the liberated, contextualized data with a 3D model.

After taking about 400 pictures of the Kofu plant, Cognite used photogrammetry to make a 3D model of it in about 30 minutes. Cognite then overlaid the 3D model with real-time and historical sensor data, giving users a powerful visualization tool to explore the plant.

Contextualized data can also enable easier creation and deployment of analytics models powered by artificial intelligence and machine learning. Historically fault finding, analysis, and diagnosis is done based on data from standalone systems. This means that it is not possible to correlate various signals and systems across a plant. With large amounts of historical data about pump flow, vibration, and events, however, companies can detect anomalies and fault conditions that were previously not possible to diagnose.

Impact: Operation Support enables field workers to collaborate with remote experts looking at the same data. Working together, they can more quickly diagnose errors and conduct maintenance work more efficiently. The 3D model with contextualized data enables field workers to more efficiently search for and locate equipment and plan remote operations, and also improves off-site planning and support.

How Aarbakke and Cognite are extending the lifetime of CNC machines

Challenge: Aarbakke has dozens of computer numerical control (CNC) machines at its factory in Bryne, Norway. The machines complete complex operations on sometimes rare materials to achieve highly precise product requirements that its customers in the oil and gas industry demands.

nore efficiently. **Machine Service Overview** ALARMS Machine Type Subtype nativeSeventy nativeCode Decription Start T





Historically, the CNC machines have sometimes been unknowingly operated in a suboptimal way, and there have been no alerts or warnings prior to them breaking down. Issues include high temperatures in coolants or oils, which leads to wear and tear; wrong pH and salinity in the coolant, which can cause corrosion or bacterial or fungal growth; incorrect lube oil consumption; and missed maintenance on the machines.

Aarbakke lacked a master log of these machine alarms, as well as a system to filter out less critical ones. Service managers previously depended on operators to send them a note every time a critical issue occurred. Otherwise the service managers needed to physically go to each individual machine and manually pull a local log to view the alarms.

Solution: Aarbakke and Cognite first liberated the data about machine alarms from its source system, ingesting it into Cognite Data Fusion (CDF). With all the data streaming from one place, the developers then created a dashboard that shows an overview of all alarms but also groups alarms by machine and issue. This helps service engineers pinpoint specific issues and machines and take targeted maintenance actions to address them.

Aarbakke and Cognite plan to add more functionality to the dashboard in the future, including a feature that lets service managers assign levels of criticality to alarms, ensuring that the alarms they deem most important will always be featured at the top of the list. **Impact:** Improved monitoring of operational parameters and the ability to look at records of alarms and warnings centrally will reduce the number of breakdowns and extend the lifetime of the machines. Beyond that, collecting cleaned, contextualized data about alarms will help drive Aarbakke toward a future in which the company can predict potential failures before they happen.

Aarbakke estimates that the dashboard will reduce service costs by 20-30%, reduce downtime, and avoid unplanned stops due to mechanical reasons.

How Aarbakke and Cognite are optimizing the use of cutting tools

Challenge: Aarbakke's computer numerical control (CNC) machines use more than 22,000 unique cutting tools to complete complex operations on sometimes rare materials. However, due to old numerical control programs, lack of operator experience, and other reasons, these tools are sometimes used in an inefficient way, and operators and production managers are only aware of a suboptimal cutting process once the part is finished.

It is also difficult to get an overview of tool usage and performance. Some tools may be in use for hundreds of minutes in a single day, while others may hardly be used at all.

Tooling Intelligence





Timestamp	WinTool Id	Tool Description	Material Description	Material Group	Material Number	Tool Class	Machine	Workorder	Duration [min]
10/3/2019 8:59:40 AM	102029	Turning Head SL60 CNMG 16 L Sandvik	ST52 PR OD495*L300	ST52	61708	279	F65	572037-30	25.46
10/3/2019 7:19:27 AM	100999	Turning C6 Left SNMG 15 Sandvik	ST52 PR OD495*L300	ST52	61708	42	F65	572037-30	27.05
10/3/2019 7:17:12 AM	100383	Endmill 6x10mm Z4 Walter	WELDOX 700E PR OD370*L20	WELDOX	602383	24	G32	587419-30	15.54
10/3/2019 7:06:35 AM	100383	Endmill 6x10mm Z4 Walter	WELDOX 700E PR OD370*L20	WELDOX	602383	24	G32	587419-30	9.91
10/3/2019 6:22:18 AM	103599	Spot Drill 20mm 120" Wedevåg	AISI 420M B OD241 MM	AISI 420M BAR+BORED	601375	1	H63	584052-30	2.28
10/3/2019 6:16:58 AM	103607	Mill 390 66x15,4mm Z5 C6 Sandvik	AISI 420M B OD241 MM	AISI 420M BAR+BORED	601375	29	H63	584052-30	5.32
10/3/2019 6:13:46 AM	103599	Spot Drill 20mm 120* Wedeväg	AISI 420M B OD241 MM	AISI 420M BAR+BORED	601375	1	H63	584052-30	3.21
10/3/2019 6:02:43 AM	103607	Mill 390 66x15,4mm Z5 C6 Sandvik	AISI 420M B OD241 MM	AISI 420M BAR+BORED	601375	29	H63	584052-30	11.05
10/3/2019 6:00:29 AM	103599	Spot Drill 20mm 120" Wedevåg	AISI 420M B OD241 MM	AISI 420M BAR+BORED	601375	1	H63	584052-30	2.23
10/3/2019 5:56:19 AM	118753	Thread 16NR 20mm Aarbakke	INC 718 B OD044,45	INC 718	INC718Ø44,45	300	VD80	571707-30	11.80
10/3/2019 5:51:49 AM	106791	Turning Head SL16 DCMT 07 L Sandvik	INC 718 B OD044,45	INC 718	INC718Ø44,45	279	VD80	571707-30	4.50
10/3/2019 5:48:07 AM	113055	Turning Head SL16 DCMT 07 R Sandvik	INC 718 B OD044,45	INC 718	INC718Ø44,45	284	VD80	571707-30	3.70

Solution: Aarbakke already had in place separate systems that tracked machine operation data and work orders – the systems just didn't communicate with each other. Cognite and Aarbakke therefore liberated the data from the systems and collected it all in Cognite Data Fusion (CDF), and then visualized it in a dashboard.

The dashboard gives production managers, team leaders, and operators an overview of which tools are most frequently in use and color-codes the usage based on the material that the tool is cutting into. Aarbakke can use this information to optimize tool usage during cutting and reduce cutting time. **Impact:** By analyzing historical use of tool assemblies and their performance, Aarbakke aims to reduce tool assemblies by up to 60% and boost the efficiency of the remaining tools by 10%.



ALL ABOUT COGNITE

Our Vision



An industrial world powered by data and algorithms, freeing human creativity to shape a productive and sustainable future

Our Team



Cognite is a global software company supporting the full-scale digital transformation of heavyasset industries around the world, from the U.S. to Japan to Austria to New Zealand. Our impressive interdisciplinary team includes more than 250 of the best software developers, data scientists, designers, 3D specialists, and industry professionals. Together, we have built Cognite Data Fusion (CDF), a software package that empowers companies in industries like Oil & Gas, Energy, Shipping, and Manufacturing to extract value from their wealth of existing data by transforming it into useful information. CDF supplies data contextualization as a service, delivering reliable, meaningful data to industrial applications that increase safety and efficiency and drive revenue.

Curious about Cognite? Call on us!



These are just a few of our 250+ industry andctech specialists, all proud to be shaping the future of Oil & Gas.





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