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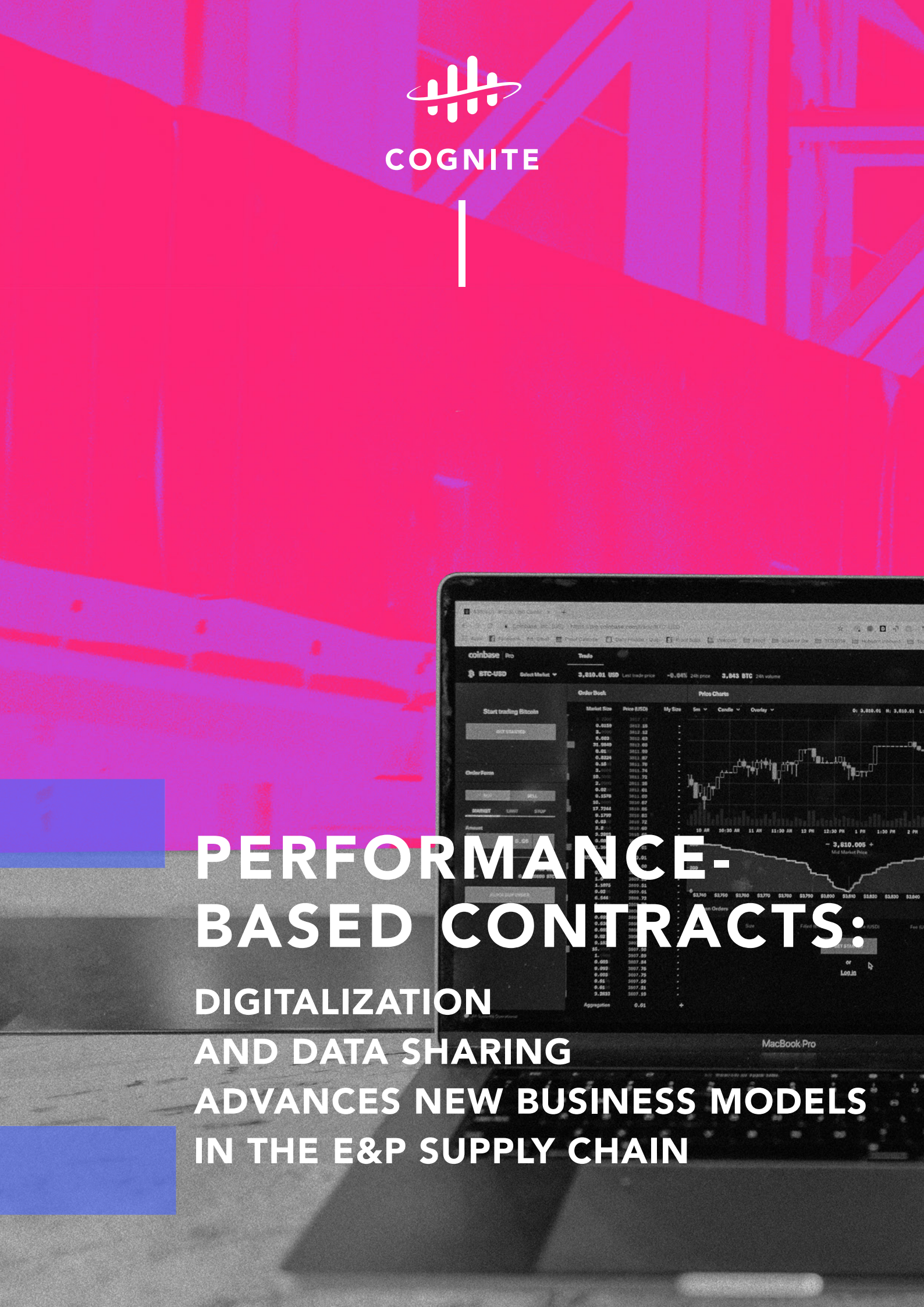

PERFORMANCE-BASED CONTRACTS:

DIGITALIZATION AND DATA SHARING ADVANCES NEW BUSINESS MODELS IN THE E&P SUPPLY CHAIN

CONTENT

INTRODUCTION

In August 2018, global pumping system provider Framo stepped forward with Aker BP, one of the largest Oil & Gas operators in Europe, to sign the first performance-based contract on the Norwegian Continental Shelf. The initial "SMART contract" initially ran for six months and was recently extended for six more. It includes diagnosis, troubleshooting, service, parts, and total maintenance for Framo's five seawater lift pumps on the Vallhall and Ivar Aasen platforms. The price is fixed, based on performance attached to a list of defined KPIs. These targets reflect a nuanced consideration of risk and reward for both parties. Aker BP and Framo have found a way to share responsibility on two key fronts: maximizing pump uptime and optimizing pump performance.

On the surface, operational data appears to be most immediately valuable to operators, but OEMs have a unique opportunity to access that data and use it to advance a digital vision of their own. For Framo, that vision is about taking control of the industrial future for their field. With instant, secure, real-time access to operational data, OEMs can redefine what it is they sell. In the near future, Framo expects to shift from selling seawater lift pumps and fire water pumps to selling cooling water and fire water.

In preparation for that future, OEMs and Operators need to address a number of important criteria including:

- **Digital Infrastructure and Digital Competence**
- **Definition of success (common KPIs)**
- **Compensation details**
- **Verification plan for the algorithms used to power the contract**

This paper will outline the SMART contract between Framo and Aker BP, providing a set of prerequisites for OEMs and Operators interested in developing something similar.

WHY REIMAGINE THE OPERATOR-OEM BUSINESS MODEL?

Digitalization is the transformation of business models and activities through the strategic use of digital technologies.

The most exciting part about digital transformation is that it begins with something we already have: industrial data.

For decades, OEMs have collected data about their products in the design phase, manufacturing phase, and testing phase. At the same time, Operators have increasingly used pervasive, low-cost sensors to collect operational data from those products once they've been purchased and deployed in the field. All this data has been collected and stored, albeit in siloed systems that restrict its usefulness. But it's there and ready to be accessed, analyzed, and wielded like the strongest, most flexible tool of the 21st century.

Up to now, the Operator-OEM relationship has worked something like this:

Aker BP might need a new pump system for one of their platforms. They purchase the system from Framo, who delivers and installs the system offshore. Once Framo leaves, they have little to no investment in the ongoing daily operation of that pump system. Instead, they take a reactive position, providing scheduled calendar-based maintenance or, if something unexpected happens, emergency on-call maintenance.

Even if the pump system runs smoothly, it must be retrieved (pulled from the ocean) after five years or 40,000 running hours, whichever comes first. This is written into the standard contract for the delivery of a pump system. During those five years, Framo does not receive any information about the pump system in operation unless there is a problem.

The drawbacks of this model are potentially very costly for a number of reasons.

On the most basic level, the majority of parts replaced at the predefined 5-year mark can be used longer safely, so scrapping them early means wasting money for the replacement parts and wasting materials for the discarded parts. Of course, parts are only a small fraction of the cost of a full retrieval and overhaul of the pump system. On a greater level, keeping operational data separate from design, manufacturing, and testing data cut both Operator and OEM off from potentially groundbreaking insights in terms of condition monitoring, predictive maintenance, and product improvements. Advancements in these areas would certainly reduce unforeseen breakdowns, avoid unplanned downtime, and increase the lifespan of equipment in the field, all with huge price tags attached.

It's time to put data to work for industry. To do that, OEMs and Operators alike need to recognize data as a valuable resource that can be traded between one another to extract value on both sides.

LEVELING-UP TO FACE DIGITAL CHALLENGES

In the old days, Framo had to wait for someone from Aker BP to call and tell them that something had gone wrong with the pump system in the field. This exchange would only happen once an anomaly had occurred. Framo then had to collect information on symptoms and responsive measures from Aker BP's offshore personnel. Diagnosis took extra time as Framo used their expertise to ask different people different questions and, where necessary, gather data from multiple sources. Valuable time was lost at each step in the manual process.

Now, it's possible for algorithms to tell human monitors, instantly, when and why something has gone wrong with a pump system. It's even conceivable for the algorithms to alert the right people before the anomaly actually happens.

Companies across the Oil & Gas value chain want to take advantage of these advanced technologies, but must first address two major challenges:

- **Digital Infrastructure:** Upgraded software and hardware are required to support the necessary handling and sharing of data in an efficient and secure way.
- **Digital Competence & Mindset:** Building, training, deploying, and maintaining algorithms to do condition monitoring/predictive maintenance requires a set of skills new to the industry. Depending on algorithms requires trust, and trust requires understanding. The Operator (in this case) must trust the algorithms that alert on equipment condition and/or trigger maintenance; by extension, this means trusting the OEM to develop and maintain the algorithms.

Digital Infrastructure

Before an OEM can agree to sell equipment performance, they must be able to retain a new level of control over that equipment in the field. This requires that both Operator and OEM have a powerful, flexible data foundation in place, one populated with contextualized data that is accessible and meaningful for both humans and machines.

With the advent of cloud-based technology, industrial companies have begun to invest in aggregating their data and making it available to their personnel, usually by utilizing a cloud data warehousing set-up. This has enabled them to achieve new levels of data access and control within their organizations. But this digital infrastructure needs to be taken one step further.

Collecting OT and IT data in one static data lake is not enough. It must be put through a contextualization step, a process that is both automatic and manual, to create an operational

digital twin that reflects a comprehensive, living view of the industrial reality. Constructed correctly, this operational digital twin may include all types of data, stored and structured in multiple ways (allowing users to access data intuitively based on their own unique needs), and enables strategic data sharing with authorized external third parties.

In this case, Framo and Aker BP both deployed Cognite Data Fusion, which offered the capability to liberate a wide variety of industrial data from separate, siloed source systems and collect it in one place, automatically and without space limitations, and structures it in a readable, meaningful context, including:

- **Equipment context:** all data related to the designated piece of equipment, including sensor data, maintenance logs, control system data, etc.
- **System context:** if the designated equipment is part of a larger system, a problem or breakdown elsewhere in the system could impact that equipment, so the OEM should have access to the related system data, as well.
- **Boundary conditions:** depending on the type of equipment designated in the contract, other data about conditions external to the equipment and/or system may be relevant. This could be the measure of hydrocarbons flowing through the system, or information regarding water temperature and currents, for example.

These layers of context are crucial to building accurate, dependable algorithms. In this case, CDF structures Aker BP's sensor data in relation to process diagrams, production information, 3D-models, and event data (maintenance, incidents), as well as other kinds of reports and documentation. Cognite calls this functionality contextualization. By organizing industrial data this way, connecting relevant data to one another, Cognite presents a digital representation of the industrial reality, both historical and real-time.

Aker BP and Framo each have their own "tenant" in CDF, a sovereign space where they securely store their own data. Cognite makes it straightforward to choose what gets shared between them. The appropriate operational data from Ivar Aasen and Valhall--which Aker BP continues to own--is duplicated in Framo's tenant and further contextualized with Framo's own additional data sets. This aggregation of live, contextualized data sets becomes a living digital twin of the pump systems designated in the SMART contract, allowing Framo to build, train, and run the algorithms that power the contract.

Digital Competence & Mindset: Bringing Data Science In-House

Data science is an interdisciplinary field that extracts knowledge and insights from data using scientific methods and algorithms.

The demand for data science competence in Oil & Gas is growing fast. When faced with this need previously, most companies opted to engage external consultants to perform data science tasks on a project basis. This strategy makes sense when the need is temporary, finite, or cyclical. However, the overwhelming trend of digitalization across the industry has caused some companies to rethink the choice.

Framo's leadership could see that digitalization really equates to digital transformation, a comprehensive change. The need to understand and utilize operational data, especially with increased access to real-time data from the field, will only grow. Framo has established a small, dedicated data science team and already has plans to expand its numbers. They believe having this team in-house will develop the necessary focused competence faster and will enhance continuity and increase familiarity with data and digital strategy across the organization.

Understanding which kinds of data are necessary to power the right data models is a learning curve. Sensor data isn't always enough. The OEM may also need service reports and/or technical reports. In building the best possible algorithms, access to contextualized data is crucial.

If the OEM is building a data model to predict maintenance on a seawater lift pump, they obviously need the live sensor data (i.e., sensor data on temperature and pressure). They also need to know how the Operator is running the given pump (e.g., event data). Beyond that, the OEM can add conditional data to the model from part manufacturers. For example, a bearing manufacturer does calculations at their own factory and supplies approximations to the OEM in the form of tables that show pressure conditions that may reduce bearing life. The OEM then does its own calculations that incorporate the information because they know best how the bearings should be used in the pumps. Both levels of information can improve the algorithms used in the contract with the Operator.

The more layers of relevant data available to the data scientist in charge of building and training the models, the more accurate and useful the resulting models are likely to be.

KEY CONSIDERATIONS OF A PERFORMANCE-BASED CONTRACT

Fast, secure data sharing enabled Framo and Aker BP to use their performance-based contract to align their interests in a way that had previously been impossible. Both parties are now invested in keeping the designated pump systems up and operating as long and as efficiently as possible. This includes avoiding overall pump breakdown, which is an extremely expensive scenario. But the SMART contract specifies more than basic condition monitoring and maintenance.

Measuring success: Common KPIs

KPIs for the performance of the pump. Typically, this is about pump availability (uptime) measured by prolonged service intervals and reduced unnecessary/calendar maintenance. The number of trips offshore can also be the foundation for a good KPI.

Aker BP agrees to operate each pump within an agreed upon operating range and perform a basic maintenance routine, including the replacement of filters and monitoring of oil levels, etc. Framo will use the conditional data on their equipment plus the operational data supplied by Aker BP to reinforce their machine learning models and strengthen their algorithms for predictive maintenance. A possible bonus is built into the pricing of the contract that hinges on the increased accuracy of Framo's algorithms, an additional incentive for Framo to be proactive and creative in their use of the live pump data.

Based on their knowledge and expertise, Framo will also advise Aker BP on how to improve equipment performance by changing the way they operate the pumps. This is meant to lengthen the time period between maintenance overhauls, which results in cost savings.

KPIs for increased sustainability. Built into the KPIs is a shared responsibility for sustainability, minimizing environmental impact and energy consumption for the pump system. The initial six-month period of this pilot contract will be used to establish a baseline for energy consumption, which will provide a foundation for future targets to improve on that score. Aker BP also agrees to take a series of oil samples and share that data so that Framo can monitor trends and supply valuable feedback.

Getting paid: Compensation format

As of May 2019, Aker BP and Framo have agreed upon a fixed annual fee per pump. The fee is all-inclusive (all maintenance, all spare parts). Establishing the amount of the fee is one of the most complex parts of the process because it's based on the uptime of the pump systems. It's possible to calculate what the uptime should be using the past five years of operational data as a benchmark for existing pumps or using test data for a new pump system. Understanding the value of uptime is harder.

For Operators, uptime value boils down to steady production (i.e., steady income). They want to avoid downtime, both due to planned maintenance and unexpected breakdowns. Any maintenance on the pump systems requires that the equipment is down and people have been mobilized to service and repair it. Unexpected breakdowns are even more worrisome, as they add a sense of urgency. And urgency is always expensive.

Calculating the expected uptime of a new system is more challenging. Each party needs to consider the scenario from the other's point of view.

The Operator will likely want a warranty, for example. But then, the OEM designates the service interval as five years. If the OEM takes on the whole cost of maintenance in that period, they need to bring in some amount of money upfront to offset costs before they perform an intervention, because an intervention costs much more than the annual fee they will charge. This cost will even out over the course of the five year term. The important thing to remember here is the OEM's newly aligned interests. A fixed fee means they want equipment to run as long and as well as possible. Maintenance of any kind will eat into their flat fee.

Algorithms & Verification: The Question of Intellectual Property

The whole performance-based contract hinges on algorithms.

Historically, condition monitoring has meant engineers watching computer screens and waiting for alarms to sound. The OEM--responsible for maintenance--has been kept at a distance. Now, Operator and OEM are agreeing to put an algorithm in charge of monitoring. The model can run continuously, at any selected interval, and without fatigue. When the algorithm alerts the engineers at Framo that their pumps are operating outside of the appropriate range, Framo uses all available operational data to determine what caused the alert and make a recommendation to Aker BP. Sometimes that means ordering new parts and organizing a complex maintenance procedure; sometimes it's as simple as Aker BP's offshore technicians making an adjustment to their operations based on Framo's expert advice.

The algorithms behind this business model are incredibly and increasingly valuable; they are also the intellectual property of the OEM.

As explained above, the OEM uses as much data as possible--as many types and layers as are relevant to the model--to build and tune their algorithms. This makes sense both because they best understand their own pump systems and because the new business model puts them fully in charge of maintenance. At the same time, the business model only works if the Operator trusts the algorithm to be accurate and trusts the OEM to take the appropriate actions in case of an alert. This can be a tough sell because the Operator is still on the front lines and reasonably wants to understand why they are directed to take action.

The Operator's concern is that the algorithm won't be accurate enough to predict a breakdown. If cooling water fails, production must stop. That value greatly exceeds the cost of repairing the pump. But the OEM can't simply hand over the algorithms for inspection because this would expose their intellectual property, allowing operators to apply the algorithms themselves. At the same time, Operators need to be reassured that these are the strongest possible calculations. They need a form of insight or we need to demonstrate a data set to run through and test it.

The Operator's trust in the algorithms can be ensured by some kind of verification. For the SMART contract in question, Aker BP is able to verify the algorithm against historical data (i.e., what they know about their own pumps today). Verification will become an increasingly important part of the process in these new business models.

What does each party need to bring to the table?

When the parties arrive at the negotiating table, each must bring something essential, dictated by their responsibilities in the contract and their desire for good faith in the agreement.

The OEM needs to monitor the pumps. They will obviously bring their equipment expertise and their own carefully developed data models to analyze equipment condition and behavior. But none of this works without the Operator's willingness and ability to supply live operational data (both time series sensor data and event data, i.e., reports) streaming at low latency.

Success must be predefined and agreed upon beforehand. Not only in the form of negotiated and approved KPIs but in terms of alignment regarding costs to be saved. Particularly, the Operator needs to demonstrate a comprehensive understanding of the cost of mobilizing the supplier. This total cost includes an amount to retrieve the pump, transport it to the workshop, transport it back offshore and reinstall it. But there are many other miscellaneous costs to consider, for example, manhours and housekeeping, including the cost of food for those offshore.

Both parties need to employ data scientists to understand, utilize/leverage the shared data and insights. They should also align on how much each party wants (or is willing to) depend on subcontractors. In the digitalized industrial future, particularly where companies are prepared to share whatever data they can for mutual benefit, companies will be free to focus on core domain expertise and subcontract for other services, competencies, etc. More collaboration will be required, but it will maximize competitiveness all around.

CONCLUSION

The SMART contract between Aker BP and Framo is only the beginning. It won't work for all cases. Most older installations lack the necessary technical infrastructure and the remaining lifespan of these installations dampens the cost-effectiveness of a digital overhaul. At the same time, the fully unmanned platforms of the future will need a system that can be monitored remotely over a longer period of time; this will require enormous dependence on condition monitoring algorithms and digital collaboration between Operators and multiple OEMs. The internal costs of these unmanned platforms will also be different enough that we can't predict what the associated contracts will look like.

But business models are evolving. Oil platforms don't need pumps; they need cooling water and water to fight fires. Measuring the value of this as a service is difficult, but the answer will come in the data. OEMs like Framo can seize the opportunity posed by access to live operational data to increase digital competence and overall competitiveness. With a better understanding of their pumps in operation, a more deeply established relationship as a trusted advisor to the operator, Framo can help optimize the use of cooling water and evaluate the service(s) that will underlie their future contracts.

The Oil & Gas ecosystem is changing, becoming more nimble and data-driven, more willing to collaborate to the benefit of all. Those companies that have a clear vision of the digital industrial future are taking steps to leverage their data as completely as possible as soon as they can, influencing their own performance and contributing to the overall health and competitiveness of their field.

OUR LOCATIONS

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