Finding Petroleum

The emerging role of the 'smart digital asset'

How to manage class libraries

Using analytics to support decision making

Understanding risks with live data

Using graph databases in operations

Transforming Offshore Operations - Working with Digital Technology, Stavanger, Nov 29 2017

Special report

Transforming Offshore Operations - Working with Digital Technology

November 29 2017, Stavanger

Transforming Offshore Operations with Digital Technology

This is a report from the Finding Petroleum conference "Transforming offshore Operations with Digital Technology", held in Stavanger in November 2017

Event website

Many of the videos and slides from the event can be downloaded from the event agenda page.
www.findingpetroleum.com/event/477a5.aspx

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Our Stavanger "Transforming Offshore Operations with Digital Technology" event looked at integrated operations, digital twins, getting digitalisation adopted, maintaining class libraries, using analytics to support decisions, getting dynamic risk data and using graph databases to understand production

Adolfo Henriquez, former specialist technology, Petoro and former project director integrated operations, Statoil, explained how to get integrated operations moving in an oil company. Hexagon explained how to build and use a 'digital twin' or digital representation of a real thing, and why it is a prerequisite to successful digital transformation.

Draga explained how independent consultants can play a crucial role in getting new digital technology properly used in a company. Datum360 explained how to build and maintain a 'class library' of all the engineering data you need during operations, keeping it up to date through all future modifications.

Teradata talked about how analytics can be used to fill gaps in human understanding, helping experts make better decisions from the available data. Presight Solutions talked about better ways to use data to understand your changing risk picture, using 'live' or dynamic data, rather than a static risk analysis.

Fablabs talked about how graph databases could be used in the oil and gas industry replacing the ubiquitous spreadsheets, with an example of how they can be used to help maximise production while not overloading your separation and processing equipment topsides.

Conference chairman Adolfo Henriquez, former specialist technology, Petoro and former project director, integrated operations, Statoil

Getting Integrated Operations moving

The challenge of getting "Integrated Operations" moving between different parts of a company, including onshore and offshore, is more about culture than technology, said Adolfo Henriquez, formerly with Petoro and Statoil

When implementing 'integrated operations', technology can be the easy part, compared to the challenges of changing organisational culture, said Adolfo Henriquez, former specialist technology, Petoro and former project director integrated operations, Statoil, who was chairing the forum.

You have to get support both from upper management and from the "base" – all employees in the company.

Ultimately, the Norwegian Integrated Operations projects helped achieve billions of dollars in saving and extra production for the Norwegian Continental Shelf, he said. In the Heidrun field alone, the estimated savings were $1.5bn. A description of the project results is given in SPE 111470.

It may be useful to set up a global competence network, which gathers know-how in how to remove boundaries between different parts of the company and people, he suggested.

It is important to establish a sense of urgency, to get the change happening now.

What we call "operations" is made up of disciplines (subject matter expertise) and assets, and these have to work together. "This is not something that is done at the top - it is done at the bottom," he said.

Statoil started its integrated operations projects in around 2005, after seeing a study of Norwegian oil companies showing that it was ranked 5 out of 6 companies in its development with Integrated Operations. After putting in considerable effort, it was ranked number 1.

The project was supported by the entire company, from the CEO and vice president of exploration through to the reservoirs and operations team.

Communications is important. For example, Statoil created an "Integrated Operations" poster, which was hung up in every operations centre. It also made movies, fact sheets and newsletters, including with success stories, showing the benefits of 'integrated operations'.

Having "short term wins" is very important – showing something that succeeds in the first couple of months, and using that to get support behind the project.

A lot of the core technology is more mature than it was 10 years ago. It no longer needs to be developed for purpose by oil companies internally, he said.

Hexagon – using a Smart Digital Asset to optimise offshore operations

Hexagon (formerly Intergraph) is helping oil companies put together 'digital twin' of offshore equipment (digital representations of the real thing) and leveraging this to provide business benefits. It can be used to help optimise offshore operations efficiency, safety and predictability

Having a 'digital twin', or a digital representation of a real thing, can be very useful as a master data repository, an enabler for digital transformation, and a way to keep other data systems, such as maintenance management, reliability, inspection and many others, up to date, said Adrian Park, Vice President, Information Management at Hexagon.

Adrian Park, Vice President, Information Management at Hexagon.

The term "digital twin" originally came from GE, defined as a 'digital replica' of the assets, processes and systems. It should describe the configuration of the asset, and how the components in it relate to each other, both within the system (for example processing a production flow) and geographically. Then there should be data about all of the components, he said.

Having a digital twin is essential when planning modifications to the platform, because you need have trustworthy data ready available to make sure any new equipment will fit in the space available, work, planning the modification work, including helping analyse hazards, ensuring jobs can be done safely, and issuing 'permits to work'.

The digital twin can also provide a common access point of master data to enable various other software packages to work together without the manual work of import / export of data.
For example it can allow maintenance management software such as SAP and Maximo to work with data from historians such as OSI Pi and asset performance management systems such as Meridium.

There can also be mobile applications and "extended reality" software connected to the digital twin. For example, someone onshore can support an offshore worker, being able to see everything the onshore worker can see (from a head mounted camera), and providing them with instructions, such as how to restart a pump which has tripped.

The digital twin can be accessed through a web browser (without the need to install any special software).

If there are 3D models or laser scans available of assets, you can very simply view and navigate around them using digital twin software, integrated with any available data.

If you are looking at a component such as pump, you can pull up information and documentation about it from within the 3D model. You can see other information which is relevant to it.

About Hexagon

Hexagon PPM's oil and gas information management software business grew out of a company Intergraph. Hexagon, a Swedish conglomerate with about 18,000 employees, acquired Intergraph in 2010. Intergraph decided to change its name to Hexagon PPM in 2017.

In the broader group, Hexagon has products for safety infrastructure (including systems to manage emergency response services), manufacturing intelligence (including measuring components to make sure they all fit together), and automated machinery. It also owns Leica Geosystems, which produces products and systems for surveying and geographical measurement.

All of the Hexagon businesses have a common theme of merging the real world (measured using sensors) and the "planned" world. In other words, looking for the gaps between what was intended to happen and what is actually happening.

Some software from other parts of the group can be applied to oil and gas. For example, Hexagon owns a company in Oslo called HxGN Smart Visualization which develops and delivers a wide range of visualization technologies for mobile, desktop, AR, VR and Web, and one called Catavolt which provides a platform for mobile applications. "We're working with them to create a suite of mobile applications - to provide people with offline access to data and documents and capture data in the field," he said.

Hexagon also has security and government services, with capability to analyse CCTV footage and monitor intrusions.

It also has ground penetrating radar technology which can view through walls, and could be used together with augmented reality to help people drilling through a wall check they are not disrupting anything. Many of these visualization, analytics and advanced sensor technologies are complementary to managing the digital asset and can be adopted within the "Smart Digital Asset" initiative of Hexagon PPM.

Data integration

One of the hardest parts of making a digital twin work is making data integrations with other software work reliably.

Hexagon has developed "ODATA4 RESTful APIs" to provide interoperability with other software systems. REST is an acronym for Representational State Transfer and API is Application Programming Interface.

The RESTful APIs provide simple and fast access to data and enable Hexagon's software to more easily integrate with software systems like SAP, which typically run on premise rather than on the cloud. It also makes it easier to connect to cloud based systems, mobile applications to Hexagon's own software portfolio of design tools.

The digital twin software can act as the master data store for engineering information, feeding other software packages. So (for example) when new equipment is added, and tags are created for it, the company's SAP software can be automatically updated with the new tags.

The "digital twin" can be integrated seamlessly within the user interface of third party software, for example displaying a list of engineering documents within SAP, and a SAP user does not know it is coming from the Hexagon system. "People haven't had to log out of SAP and log into our world," he said. "This means that appropriate information and documentation from the digital twin can be shown in the context or the work process being undertaken in third party systems. This is an important capability to achieve digital transformation or work processes."

Brownfield facilities

Hexagon has tools for capturing information about brownfield assets and making it available via the digital twin.

It has document crawlers which can go through documents distributed on the company's network and capture useful information from them. It can spot duplicates, or where there appears to be two similar versions of the file (in which case it can help identify which is the most up to date one or the 'master').

If the files are structured, such as a 2D CAD file or 3D model, information can be extracted from it. If it is a bitmap file, the data can be scraped for example with OCR (Optical Character Recognition).

The software can then provide an 'infomap', demonstrating the object and the relationships with data discovered so far.

Many old pieces of equipment only have very rough technical drawings available, sometimes just the piping and instrumentation diagram (P+ID).

There are research activities ongoing to investigate the feasibility of using AI to automatically link tags on a P+ID with a laser scan image. "It's an incredibly complicated process to take a schematic drawing like a P+ID, and take a laser scan and interpret and find pieces of equipment. It's not going to be simple. But we're having a go to see how it works," he said.

Data handover

One challenge with building digital twins is managing the data handover, ensuring you get good quality (complete, consistent and correct) data from people who create it when building a new asset (contractors and vendors) to people who will need it in operations.

In a survey, Hexagon found that 1-5 per cent of the entire project costs can be spent on data handover, including a lot of work validating information from multiple sources.

As an example, Inpex, a Japanese oil and gas company developing the Ichthys LNG Project offshore Australia, estimated its information handover costs would be between 2 and 4 per cent of the total installed costs of $34bn.

In a survey, only 23 per cent of people said they are totally confident the handover specification reflects what is needed.

There is a project to develop an industry standard for data handover, called the Capital Facilities Information Hand Over Specification (CFIHOS). It is being developed jointly by USPI, a Dutch non-profit standards organisation of process industry companies, and ENEA, the Engineering Advancement Association of Japan. CFIHOS aims to eliminate many of the inefficiencies in the handover process through the project value chain.

The CFIHOS standard "has a lot of momentum behind it," he said. It is basically a "class library delivered as Excel spreadsheets," or in other words a directory of what information is needed for different pieces of equipment. It includes a standard dictionary so equipment and documents can be named in a consistent way, and you can work out what data you need for a given piece of equipment.

Draga – independent consultants can help implementation

Independent consultants can be a big help in a software implementation, if they are trusted to act in the customer's best interests, said Kent Andersen of Draga

When implementing new digital technology in an oil company, it can be very helpful to have independent consultants assisting with the implementation, rather than relying on the software companies to do it, said Kent Andersen, technical advisor with Draga. A consultant can be trusted to act in the customer's best interests, while people will always be sceptical that the software company is mainly interested in selling more software.

Some companies have had an experience of being persuaded to use many different products from the same software vendor, when not all of them are the most suitable products available, he said.

Vendors will often focus on helping customers to use their own system, rather than emphasising how it will solve the customer's pain points, he said.

There can be multiple problems bringing software to an organisation, such as integrating the software with existing applications, developing work processes which work with it, and helping people use the existing software with training programs which address their specific needs.

An independent consultant can help companies define their existing work processes and show which work could be automated.

They can also help manage data integration work, providing the interface management between the integrating software vendor companies.

The independent consultant can help make decisions about vendors. These can be tricky when every vendor believes they have the best solution for every problem.

The consultant can help create software training programs geared around how the customer plans to use the software, and perhaps using the customer's own data and processes, rather than a generic training solution.

If training is needed, it is easier if the training is broken down into bite sized chunks, so there is time for learners to reflect, experiment and apply the new principles. "Just don't buy into the 5-day training – it does not work," he said.

The consultant can also help ensure everybody in the company is alongside with a new project. In Norwegian business, "consensus is king," so a few objectors can kill a project.

Kent Andersen, CEO, Draga

One tactic is to use short duration comparative pilots with different software packages, and let the company employees choose which one they like the most. Or if that is not feasible, you can choose the most intuitive system, even if another one has more functionality.

Critically consultants can use their experience to help determine mechanisms to aid user adoption. They can also highlight typical 'pain' points and solution methods and priorities.

Some people may see that adoption of the new software could lead to them having a reduced status in the company, for example if their status is tied to them being the main authority on a certain software package, which the company is no longer planning to use.

"Implementation of new systems will always create strong protest from people who will either lose their job or clout because of this. Create a redressal mechanism for it. Wherever possible, consider bridging courses to help them retain their position," he said. "Those people are key people in the organisation, you have to convince them to be part of this new digital journey."

Some people will never be interested in new software – their perspective is that they have worked out how to do their day to day work with their special method and want to stick with that. So in that case they would need some incentive or threat to be part of the new roll-out.

You can create 'gamification' of system adoption, to make it more fun.

"Remember technology alone cannot deliver any benefits. It is always technology with people," he said.

It helps if companies should see digitalisation as something much more than an IT project – because it affects the entire business, he said.

They should make sure digitalisation projects include improving engineering information and making it available, not just creating data lakes and better management of well data.

About Draga

Mr Andersen formed Draga in 2015 with a colleague, and the company has since grown to 10 employees and recently completed an ISO9001 quality audit. His background is as a maintenance modification engineer, working with engineering information systems.

The company's focus is on "helping operators choose the right tool for the job," and configuring the solution in the right way, so it adds the most value possible.

The company limits its scope to the engineering domain, digitalising information and helping companies do more with it. It does not get involved in analytics, data lakes or similar technologies.

Draga works with systems from suppliers such as Hexagon and AVEVA. Draga is not aligned with any vendor, however, it has a long history with Hexagon products.

To manage engineering information, manage class libraries

Managing the 'class library', or list of your classes of equipment and what data you need for all of them, is probably the most useful thing you can do if you want to manage your engineering data, said Datum360

Getting the definition of the class library right is the most useful thing you can do if you want to have well managed engineering data for an offshore asset, said Lin Whitworth, director client services for Datum360, speaking at the Stavanger Finding Petroleum forum in November 2017, "Transforming Offshore Operations".

Having accurate and complete engineering data for an asset will support accurate maintenance planning and engineered modifications to the asset over its lifecycle which in turn will help to create safe working environment, he said.

At its simplest, the 'class library', sometimes known as a Reference Data Library (RDL), is a list of all of the different classes of functional equipment and their documentation and engineering attributes, said Lin Whitworth.

So the 'class library' is a description of what engineering data your company needs.

It also defines the information that you need when the asset is being modified or handed over from a project development team, as your Engineering Data requirements specification.

By comparing the delivered data to the class library requirements you will be able to report where you have data missing, and what data you need to complete the modification.

During the lifetime of the asset, the "class library" also needs to be managed in order that it can stay aligned with your organisation's business requirements.

What class libraries are

Equipment and assets are now complex items, and as staff move jobs more frequently, it has become much more important to have a reliable central record of engineering information. But many brownfield oil and gas assets still rely on the organic 'people's heads' method, he said.

The core unit of the class library is "functional tags", which provide data describing the function each item must fulfil, for example a pump, heat exchanger or transmitter. For example, what fluids must it pump and at what rate, what operational pressures and temperatures it must be able to work under.

Lin Whitworth, Director of Client Services, Datum360

Each item might have non-functional information, which is critical to having a complete class library, for example you can require that each pump must have a relationship with a location in a P+ID diagram.

The pump itself also has physical parameters which are not directly related to its function, but which you probably want to store, such as the pump's weight, certification, dimensions, number of cylinders. These are stored separately. "We don't confuse the design information with the physical information associated with a particular pump."

Building a class library

If you are building a class library for a new (greenfield) asset, the work is about creating a specification for the data you want to receive from the contractor who is building the asset, before the asset comes into operations.

There is an industry association developing a "Capital Facilities Information HandOver Specification(CFIHOS)", a standard way for an operator to describe to itself, and any contractors, exactly what information will be needed. It covers all equipment usually used in oil and gas facilities.

If you are building a class library for a brownfield asset, part of the work normally starts by persuading all the relevant engineers to provide data about the process plant, which may well be sitting on their computer hard drives.

Engineers keep information on their personal hard drives not for selfish reasons, just because they cannot find the information they need on corporate systems, so it is the only way they can do their job. You need to gain their trust to persuade them to keep their data in a 'single source of truth" database such as PIM360 which is configured by the corporate class library, Mr Whitworth said.

It will usually take 4-6 weeks to gather data from people's personal data silos and integrate it into PIM360, with badly named equipment and documents all renamed to a common 'language' in order to comply with the class library rules, he said.

The process of adding new data into PIM360 is carefully managed via the granular management of change functionality in PIM360. for example data can be tagged adding metadata to the change, saying "this is Joe's ATEX register which he used to keep on his C drive but is now putting into the central data store."

As new data is added, it can be checked for consistency with existing data, and any anomaly can be resolved, for example if one tag source says a pressure is 20barg and another tag source says 30barg.

An audit trail is kept of everything, including who agreed to a change.

Eventually, you achieve 'critical mass', when people realise it is better to use data from corporate data store (PIM360) managed according to the class library, than from their personal data stores. They start providing more data directly into the central data storage.

The PIM360 data also interfaces with systems such as Maximo and SAP, using file transfer and APIs. "Other people can pull data from us and we can pull data from them," he said.

About Datum360

Datum360 considers itself an expert in engineering data, and has a mantra "technical information as it should be."

It works with oil and gas, mining, process and manufacturing companies to help them specify their engineering data requirements (class library) and manage their engineering data. The company makes two SaaS cloud hosted software tools for compiling a class library and hosting engineering data in the cloud (including the management of change process)

It produces the PIM360 software which companies can use as their single source of truth for capturing, reviewing, reporting and managing change in engineering information.

It produces the CLS360 software for companies to manage their class library or engineering data requirements in CLS360, which is used to configure PIM360.

Duncan Irving – analytics fill gaps in decision making

Digitalisation could be described as using digital tools to try to fill in gaps of human understanding, so that people can make better decisions, says Dr Duncan Irving of Teradata

One definition of digitalisation in the E&P space could be trying to fill gaps in people's information and understanding of a situation, so that they can make better decisions, said Dr Duncan Irving, Oil and Gas Practice Partner with Teradata.

The basic idea is that the organisation can make better decisions, through better responding to operational, tactical, strategic issues and opportunities, by assimilating and contextualising data.

It can be described as a "very tight coupling between what your organisation captures in terms of data, how it can process it, and decision support around that," he said.

It can be seen as a continuation from other methods to improve decision making and reduce problems for a few decades, such as with the methods from W Edwards Deming, who helped the Japanese automotive industry improve during the 1960s and became something of a hero in the mid-1990s in the US.

It will ultimately enable the CEO of an upstream oil and gas company to respond to challenges with the best decision in the best time frame.

Teradata is a US company with around 12,000 employees, working in banking, retail and telecom industries as well as oil and gas, helping companies to get more value from their data.

In the oil and gas industry, Mr Irving's work can be about explaining what digitalisation can do, what the data science capabilities are, where the failures are, and where expectations from digitalisation need to change, from both clients and technology providers.

Data silos

One obstruction to the use of analytics in the oil and gas industry is data silos, where data is kept in buckets unconnected with other buckets. Another term for this is "data islands".

Part of the blame for this can be placed on the "point" software packages which oil and gas companies use for specific petrotechnical tasks, such as model the subsurface or simulate reservoirs.

It can be very hard to integrate data from these point software packages with anything else, he said.

The problem is not so bad in other parts of the industry. Oil and gas companies have been integrating sensor data with inventory, asset location and financial systems for a while now, partly under their "digital oilfield" initiatives. Perhaps the growth of "point" software for petrotechnical work was due to limited understanding of the petrotechnical domain by IT staff.

The data silos can work well individually, but the silo-isation means that the overall company is sub-optimal, and there wasn't much standardisation and consistency between departments, he said.

IT departments in other industries have been fixing these sorts of problems for 10-20 years, "but we never got around to that in operational centres of the oil and gas industry," he said.

"Other industries that from a distance look a bit like the oil industry have been doing this quite well for a few years," he said.

For example Siemens is using analytics to monitor performance of its locomotives, and by doing this, achieves very high levels of uptime.

The analytics is used to predict components about to fail, and then use that understanding to improve equipment uptime, and maintenance schedules. There are add-on benefits, for example rail companies work out that they can manage with less locomotives because there are less failures and less need for spares.

Duncan Irving, Practice Partner, Oil & Gas, Teradata

Another example is pipeline companies which use analytics to predict hydrogen sulphide build-up, and then use this understanding to better manage pipeline integrity and improve asset management, and getting better flow assurance.

Why it is hard in oil and gas

Dr Irving listed a number of obstacles which make analytics difficult in the oil and gas industry.

One obstacle is the "project" mentality – staff are used to embarking on short term projects, but less enthusiastic about changing how they work.

Another obstacle is that many people have a siloed view of the industry, seeing mainly their own part of it rather than the overall picture.

Another problem is communications difficulties. IT and data managers are often not very good at understanding business requirements, and business people are not very good at communicating to technology providers what the business does. There is a gulf in vocabulary between technology providers and clients. Concepts like data lake, data governance, meta data and master data are used to mean different things in the oil industry to how they are used in other industries.

Also, the upstream space often does not have data well managed and open enough to be used for analytics.

Sometimes inter-company communications are poor. Dr Irving often finds an oil company can have multiple IT teams doing similar projects and no alignment or integration between them, leading to duplicated effort.

Another obstacle is lack of strategic planning. Sometimes oil companies decide they will make big investments in analytics with millions of dollars over multiple years, but it just ends up with people dabbling in a point project and then moving onto another one, rather than the company improving the way it works.

Individual projects can run over years, which means that when people finally get an analytics tool, it meets their requirements of 3 years ago and might be no longer relevant to their needs.

Data quality

The oil and gas industry should make data quality a central focus if digitalisation is going to work, he said.

Organisations need to have consistent standardisation of their data, and quality and governance applied around it, consistently through the company.

If you want to try using machine learning and pattern recognition algorithms on your data, it won't give good results if your data is bad to begin with, he said. This will also mean that any machine learning engineers your company has hired won't be able to do anything, and will probably get bored.

The oil and gas industry could start working with data engineers. Other industries with large amounts of data, such as banking and retail, do this. The data engineers know how to make sure that data is in a format appropriate for the business, and know how to provision data from the point at which it is acquired to the point where it can be used.

It is also helpful to have domain experts (such as petrotechnical professionals) working with data, because they understand factors like how the sea state will affect the data recorded in a seismic survey.

How other companies do it

Outside the oil and gas industry, a typical set up for improving data could be to have a team working on day in two week bursts. They would aim to come up with something useful during this time, or something which opens the door to another stage of the project.

There might be two tiers of data people. On the bottom tier you have people who are managing a data platform, presenting a data interface. On the top tier you have "technical design" specialists who build analytics tools running on the data platform, which might generate something useful to the business, ensuring that the data quality is good enough for it to work.

Their analysed data can then be presented to the industry professionals (such as geophysicists). The whole infrastructure can be part of the permanent corporate data systems.

Maturity scale

You can describe a maturity scale for digitalisation, so companies can see how well developed they are, Dr Irving said.

The end goal is to reach a maturity level where companies have systems which can answer questions like, "last time the well targets were like this, the drilling options were like this, and I had this sort of engineering capability, what well plan proved to deliver the best outcomes?"

It means having a "feeling of data quality" baked into the organisation's culture, processes and tools.

But too often the oil and gas industry is at a very early stage of digitalisation maturity, with companies struggling to answer a question like "can you give me a list of all the wells in our organisation without duplicates".

Having a list of wells with no duplicates is an essential starting point for integrating data from multiple sources, for example combining the well logs from one data store with the borehole data from another data store.

As a general point, having high quality data means that you can put one type of data in the context of another piece of data, without having to spend a week checking. People can take data they need out of the corporate system as they need it, without questioning whether they can trust it.

"Our key recommendation to our clients at the moment is, you need someone as a director of quality across all of your upstream data."

Good enough data

What quality of data is "good enough" depends on the application. For example, you need different levels of numerical and spatial precision depending on whether you are working at a well, basin or overall portfolio scale.

An exploration geologist does not need super-accurate data. The understanding comes from reading a few papers, looking at maps, looking at some wells data, and looking at some 3D seismic, and forming a mental model of what is going on.

But if a company wants to benchmark reservoir performance against each other, spotting underperformers, it will need a great deal of information about the reservoirs in a format the computer can read.

For example, lithology, reservoir properties, production dates, perhaps even political situation of the country. Typically companies do not have their reservoir data anywhere near good enough for this sort of work, he said.

But when working at a more tactical level, defining well targets and planning wells, working with say 30 different wells and sidetracks, with models from reservoir engineers, and well needs to reach a certain formation, you need an understanding of what is going on "in a few tens of metres". You need to be comfortable that you can trust the data, including data provided from one of the partners in the asset.

When drilling is going on, with efforts being made to keep the drill bit above the oil water contact and below the caprock, every couple of hours you want to check the data from the drill string, in the context of the petrophysical data you already have of the formation, the formation may be only 10m thick.

An example scenario could be to be drilling through rock at an angle, and you have logging sensors on the drilling tool recording data, and you have recorded the distance between the sensors and the drilling rig as a proxy for the depth of the sensor. But because the drilling is at an angle, you need to do some trigonometry to find out the actual vertical depth of the sensor. Otherwise, you might have errors in matching the lithography to the sensor log data.

A further problem could be that you don't record whether or not you have made the correction to convert the position of the sensor on the drillstring to vertical depth – and so someone makes this correction twice.

This illustrates that good data quality is not just about numerical quality, but understanding the metadata around it – how the data was actually recorded and any corrections which have been made.

Integrating all company data

Some companies have tried to integrate all of their company data into a single system, perhaps misunderstanding the 'data lake' concept, and it hasn't gone well, he said.

"If you take a technology into an organisation and it's not ready for it, and you don't understand what you are doing with the technology, you will make a mess," he said.

You have to start with small projects, perhaps with a well understood problem like predictive maintenance, and gradually change culture.

For example Siemens tried to improve reliability of some of its locomotives, rather than try to improve analytics for the whole organisation. Then someone realises that the analysed data can work together with something else.

Presight Solutions – using live data to understand risks

Presight Solutions of Stavanger helps companies use 'live' or dynamic data to get a better understanding of their current risk situation – which can be much more effective than 'static' systems such as bow tie analysis, the company believes

Presight Solutions of Stavanger helps oil and gas companies work with live data to get a better sense of their current risk levels and safety performance.

Working with live data can tell you about your current risks and enable you to drill down and investigate problems.

Most safety studies are made on the basis of static information, such as the 'bow tie' analysis. But that is not necessarily relevant for someone who is actually working offshore and wants to know about their current risks, said Karl Erik Dahl of Presight Solutions.

Another common safety approach is the 'balanced scorecard' which aims to give you a score for your safety. But that does not necessarily tell you what you need to know, he said.

For example, the balanced score card might tell you that you have done 90 of the 100 inspections you are required to do over the next 6 months, one month into the period. But a safety manager is more interested to know about the 10 outstanding inspections and how critical they are. If the inspection is really important, then it should be done today, not in 5 months' time.

Karl Erik Dahl of Presight Solutions

Another common problem Mr Erik Dahl sees is that companies spend too much time on checking and less time on doing. To put in the context of the famous 'plan, do, check act' Deming cycle, they are spending their time on 'check' and not 'do', he said. So there is no continuous improvement.

Keep it dynamic

An offshore rig is not a static environment. There are always objects being moved around and used in new combinations, and new work being done, all introducing new potential risks. This is why it can be much better to have a dynamic picture of your changing risk patterns, rather than work with a static analysis, Mr Erik Dahl said.

If something is flagged up on a dynamic risk management system, staff can look into it in more detail and then make a decision. For example, data from the crewing system might flag up that the crew is currently undercertified. A closer analysis might show that it is because someone with 30 years' experience has not renewed their certificates. This is not much of a risk because people do not actually lose skills overnight.

On the other hand, the closer analysis might reveal that there is someone on the rig in his first week on the job, which is a high risk scenario. In that case it would make sense to find someone to work with them for a while. "That is how you make decisions," he said.

"We go straight into the siloes, we get this overview, we adapt it in terms of the criticality, and organise it - in terms of getting the views that people want," he said.

The system could potentially replace the various performance standards and risk analysis done in the company, if it could tell you about your risks right now.

Many companies have multiple performance standards and risk analysis in use, sometimes multiple risk analysis for the same thing, all put together when someone thought it was a good idea, and then never withdrawn.

Part of the design work includes defining alarm situations. These can be defined on the basis of what offshore people say they need to be warned immediately about, not what a remote risk analysis person believes they should be warned about.

Sometimes onshore staff design an alarm, and find that offshore people say "that is not critical. We don't want to light up red and someone gets stressed about it, remove the alarm. I don't care if it is in whatever the analysis says," Mr Erik Dahl said.

Offshore staff often ask to reduce lists of items considered "critical", otherwise there are alarms going off all the time.

Different people want to see different information. In one example, the crane operator wanted to see wave heights and maximum permitted wave heights, – because sometimes he moves to another rig which has a different window of operation in terms of the wave heights it is able to operate in. Nobody else needed to see wave heights.

Presight's work always includes workshops with offshore staff, to try to establish "does this look right for you in terms of your role and the information you need, without having to waste time looking for it." People just want to see the safety status and then get on with their jobs.

Presight Solutions was borne out of a contract with Norwegian operator Norsk Hydro, which wanted to use its current data as a basis to make safety decisions, not relying on historic data.

They wanted to apply their resources to the biggest problem, such as equipment which would take production if it failed, or equipment which would cause a safety hazard if it failed.

Working with Songa

One client, drilling contractor Songa, wanted to do a thorough risk analysis after the Macondo disaster of 2010. There were very few risk analysis professionals available, so the company decided to do the work in house, but just focus on the essentials – processes which had an inherent risk, and what they were doing to minimise the risk. It brought in Presight to do this work.

Presight started by looking into all of the various digital systems which might be able to indicate risk, for example maintenance, procedures, documentation, and finding ways to bring the data together.

Then it conducted reviews with Songa personnel, looking at what was most safety critical for people on the rig and for people in the back office.

The system gives staff a detailed level of awareness of what is currently going on via a dashboard, such as whether certain jobs have actually been done. The information is available immediately, rather than issued every month in a report.

Songa was also using two different maintenance management software packages, and it was a challenge trying to get the output from both together onto a single dashboard.

Songa wanted to be able to see and interrogate data to try to identify weaknesses and where problems are being caused, and be able to check records directly.

Awareness can avoid problems

Mr Erik Dahl cited one investigation into an accident in Norway, where the investigations showed that nobody did anything explicitly wrong, but there were several areas where more awareness of the increased risks could have led to the disaster being avoided.

It is common for offshore projects to have very complex planning, with data stored in silos, so nobody is up to date with everything.

The company had KPIs and dashboards showing that it had fulfilled all its competence requirements and its certificates were in order, and equipment had been inspected. There was high confidence in the company that it could deal with problems with the staff on the rig.

But the problem was that the information in the maintenance system was not mapped with other documentation, he said.

Joe Chesak of FabLabs – using graph databases in operations

There are many places in the oil and gas industry where graph databases could be better than current technology, including managing production, linking production with reservoirs, or putting any engineer's model into a computer system with much more fluidity than on a spreadsheet, said Joe Chesak of FabLabs

Graph databases are quickly gaining traction in the enterprise, edging out relational databases where data is highly inter-dependent, said Joe Chesak of FabLabs.

The graph database management system, 'holds' the same data as a relational database, but with completely flexible data structures and gives you tools to model and monitor your data. You may ask: "Can I build a table in a graph database?" Answer: "Yes, and all reports can be in tabular format too."

In the oil business graph databases have a lot to offer because of their ease of use, and ability to directly represent the real world. They should be used in upstream oil and gas much more, Mr Chesak said.

His use of the graph database Neo4j varies from quick throw-away resource allocation simulations, to massive all-topside optimization projects.

He added that there's a pleasant surprise in store for the engineer who dares to tinker with Neo4j. "It allows you to think differently, without constraints purely about your domain. In the end it helps you go directly to what is important, understand what is going on with your wells and topside, and ultimately make better decisions".

Engineers are given large amounts of different types of data, and expected to synthesise it all in their minds. "There is a professional pride in that," he said. But the systems are not designed with much consideration about how much detail a person is even capable of parsing and synthesizing.

Databases aside, Excel is really the engineer's go-to tool for working with data. But that means putting data into rigid boxes again, and making a system which does not naturally map to the real world, he said. The graph database can store data in a way much closer to the real world, with a collection of nodes, or things, and relationships between those things.

There's one more oil industry favourite, and that's the time-series database. It's where raw data meets the engineer. It's as close to the real thing as we know, but it comes in isolated streams of data, indexed by time.

In Mr Chesak's mind, even though he feels the time-series database is a necessity, it is essentially a "dumb bucket of data". It would make more sense to structure the data according to the real-world connections between these data streams.

Engineers must respond to changes, big and small. Oil and gas platforms are like "ongoing construction sites where your world is being changed and constrained in different ways daily," he said.

As the engineer's monitored environment changes he/she needs to be able to know or identify what is impacted by each change. The graph model is ideal for such impact analyses. Small scripts can be run over the database to monitor for changes and power alerts that act in real-time. That beats having to build a new spreadsheet to assess an anomaly after it has already occurred.

Engineers do their own modelling

Consider several engineers having a discussion, and drawing something -anything -on a whiteboard. Typically you are going to see labelled boxes, circles, flows and connections, to show how something works.

"This is really how you model something in a graph database," he said. If you can draw something on a whiteboard with your team and you feel you have everything of importance represented, "if you can do that you are 90 per cent of the way to having a working model in a database that you can populate with real data and query endlessly."

"Engineers, in my experience, model what they can, using the industry grade fit-for-purpose software that is sold to the company. They make decisions based on that, plus a lot of other stuff in their heads that they cannot shoehorn into the tools," he said.

"If the engineers could extend the fit for purpose tools in the same way they extend their own spreadsheet they'd be in a much better place. They would be in control of what questions they can ask."

It is necessary to have a model in which the entire team can accept as 'close enough' to how their real world works. If everyone builds their own models--we all know where this is going. It is important for engineers to get involved in doing the modelling, rather than expect the system to do it all for them. They know the personality of their wells, they are closer to the problem than big industry suppliers can ever be.

Tuning production

Mr Chesak's Norwegian company, Fablabs AS, has built a software solution for production engineers, called Production Tuner, which can be used to build flow models about how wells and topsides are operating. The aim is to remove bottlenecks.

This way it can help companies make sure they are making the most of the available production capacity, at minimum operational cost, while staying within safety limits. The model accounts for all wells and all constraints to flow, such as limited capacity of a separator.

To imagine it, consider that if you had 2 or 3 wells, it might be easy to work out in your head how to maximise production while not needing more separator capacity than you have available. But if you had hundreds of wells, all with different proportions of oil, water, gas, CO2 and H2S in their flows, it quickly gets too hard to do work it out in your head or in a spreadsheet.

With flows changing by the hour or minute, it is practically infeasible.

Reaction times have improved in recent years, due to management processes such as Integrated Operations. But but one fundamental 'old' management practice remains entrenched. Production teams across the globe group their wells in some logical way, and assign each group to a different engineer. Perhaps this makes for healthy peer competition—every man for himself—but it literally puts them on different teams. They compete for the same resources on topside and elsewhere, without the knowledge or intent to maximise the flow from the export pipe. "We should view each engineer as a silo here." say Mr Chesak. The wells connected to one topside belong in one logical group, whether there are 20 or 200, and whether they come from one reservoir or three. They are one system and one system actually can be optimised.

The ProductionTuner software monitors what is happening in real time system-wide, and calculates forward looking scenarios. So if something changes in the production system, you immediately have a viable solution at hand, including when you are in an 'edge case' that you didn't know might happen until it does.

This is very different to the usual production engineering set-up, where most decisions are made by an engineer periodically checking different screens displaying data from a production historian.

Linking production with reservoirs

One idea, never yet developed to Joe's knowledge, would be to try to build a graph database of how a reservoir works, which a production engineer can use.

Reservoir engineers usually model reservoirs with enormous complex reservoir simulators – but it may also be useful to build simpler computer models, similar to the ones people hold in their heads, showing what is connected to what in the subsurface, where additional pressure in an injection well will lead to more production or more water breakthrough in a production well.

Typically production engineers do not focus on the reservoir in a structural sense, but base their decisions on what they see flowing through the wells. "It's reasonable, but we have to acknowledge that it's black-box." he said. Of course, the topside world is much easier to map out and instrument and measure than the reservoir is. But it seems plausible that the reservoir models should comfortably fit in a graph.

Though reservoirs are densely connected models, the graph database doesn't care how many dimensions the problem has, and does not penalize the model or modeller for fully describing a rich multi-dimensional dataset.

Working in an oil company

Mr Chesak's research is based on his experience as 'embedded tech' in a production engineering department of a major oil and gas company, doing this kind of work, for about 5 years.

The original role was to streamline data reporting. In the process of assessing engineers' challenges he found that he could make a bigger impact by moving up-stream data-wise, to work with data flows starting from the raw data arriving from offshore. Developing a single source of truth available make it that much easier for people to use tools like Neo4J "and identify patterns nobody knew existed".

What's different about graph databases?

Picture an old fashioned crime investigation map, where you have different documents pinned to a board--photos, news articles, police reports--and strings showing how they connect together. "I look at this and think, that belongs in a graph database," he said.

A graph database is really the right place to build the foundation for an alarm management system. And while we are making it possible to find 'where' the problem originates, rather than sounding an alarm if a single sensor fails or has a reading out of range, the system could compare the data from one sensor with the sensors around it, and see if it might be a fault with the sensor. Beyond that, it can suggest what is your best option forward if there is say a blockage.

Mr Chesak presented several tangible examples of modelling. One was a wired light switch system for a building stairwell – there is a toggle switch on each floor, any of which can turn the light on and off. When modelled in a graph database it essentially becomes a teaching aid, and it can be queried to determine whether the light is currently on or off.

Another was an old fashioned wooden blocks calendar. There are two blocks which can show any day of the month from 01 to 31. "Each block has a resource constraint, it has only 6 sides. The question is which digits should be placed on each block? It is a small enough problem to fit in your head and intuitively work your way through it," he said. But he also modelled it in a graph database.

The final example was a mathematics puzzle called the 'magic triangle' where you have to strategically distribute a set of consecutive digits on the corners and sides of a triangle such that they always sum up equally per side. This one is inherently dynamic because corner values impact two sides at a time. Mr Chesak figured out one solution working it out on paper, but employing the graph database, and it was solved in a few milliseconds and produced 3 more possible solutions.

There is an accepted concept--engineering judgement--which is essentially saying the engineer's experience allows for intuition to lead the way when time is short and data is scarce. "Intuition is real, and involves most of our brains. We solve so many problems without necessarily understanding how we do it, But intuition is very individual. It does not promote organisational learning because it's nearly impossible to pass on." he said.

The process of modelling really is an effort to develop the simplest mechanical representation of how something work. "You put the data in the structure in the shape that you want," he said. If you have the technical competence to write an Excel script, you can probably make a script for a graph database – although you might need someone to introduce you to the technology first. "From the time I started using this I never used Excel again," he said.

When asked, "Why do you believe the oil and gas industry still only using relational databases," he answered, "I have no explanation for that beyond culture."

Finding Petroleum: Transforming Offshore Operations - Working with Digital Technology

Norwegian Petroleum Museum, Stavanger, November 29, 2017

Knut Henrik Jakobsson, Senior Advisor in petroleum geology and foreign aid projects management, Norwegian Petroleum Directorate

Terje Amundsen

Arild Østbø, chairman of the board, Adsign Ideutvikling

Trond Ramslie, General manager, Adsign Ideutvikling

Ilya Sizov, Reliability Specialist, Aker Solutions

Lise Jemblie, Project Engineer, Aker Solutions

Jan Dybdal, Maintenance Supervisor, Aker Solutions

Sina Zahirian, Discipline Leader- Maintenance, Aker Solutions

Sverre Fjermestad, IT, Aker Solutions

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Børre Heggernes, CTO, Amitec AS

Tore Gelllein, Stokkamyrveien 13, Antenor AS

Kahraman Veysel Dogan, Maintenance Engineer, Apply Sørco AS

Arve Gruehagen, Senior Maintenance Engineer, Assetjet

Tetyana Kholodna, Capgemini

Paul Mathias Fiskaaen, VP O&G, CGI Norway AS

Mike Herbert, Integrated Operations Advisor, ConocoPhillips Stavanger

Adolfo Henriquez, Specialist Technology, Consultant

Lin Whitworth, Director of Client Services, Datum360

Kent Andersen, CEO, Draga

Sagvan Bamerni, Engineering System Specialist, Draga

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Øivind Hansen, COO, Draga AS

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Miguel Rocha Arteaga, Data Coordinator - Methods & Tools, Total

Saira Haroon, Total

Jerome Gras, Engineering Manager, T otal Norge

Borge Richard Kolstad, Partner, Wellwork Innovation AS

Arnaud Barre, Integrity Operation Manager, Wood

What did you enjoy most about the event?

The presentation from Hexagon PPM

Some good presentations plus networking.

Mike Herbert (ConocoPhillips Stavanger

Discussions in breaks/at lunch, but I also enjoyed presentations.

HEXAGON presentation.

New Insight in Big Data.