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INSIGHTS

JULY **2018**

How digital technology can best serve your oil and gas business

A guide to oil and gas leaders to how digital technology is actually adding value to oil and gas companies today

When senior management start to understand tech

Equinor's digital road map

Subsurface - seismic processing AI,satellite imagery, Kosmos Energy, reservoir data

Production - optimising, graph databases, well performance reviews

Facility operations - managing engineering data, predictive analytics

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How digital technology can best serve your oil and gas business

This issue of Petromall Insights presents the latest developments in oil and gas digital technology for people who run oil and gas companies – who want to know which technologies and approaches are working and which do not

We see a big change in the roll-out of digital technology – as senior managers of oil and gas companies start to take a deeper interest in how it works – and encourage the development of systems which are more supportive and helpful to their own employees – making their work more productive, and, even, more enjoyable.

For all the years of development of digital technology, until, roughly speaking, now, senior managers of companies which buy technology did not care about it too much. They recognised the need to sign a cheque for it, yes, but largely left the IT department alone to do their own thing. This meant that IT departments became very insular, rather than integrated with the rest of the company, and employees had to make do with whatever they were given.

But now, attitudes among senior management are starting to change.

At an executive conference session at the Copenhagen June 2018 meeting of EAGE (European Association for Geophysicists and Engineers), we saw senior managers, including the SVP E&P North Sea & Russia, Total, expressing informed views on how digital technology can best serve their businesses.

We heard how Total is evaluating where specifically analytics can add value to the business, in a program called "DAVE" (Data analytics Value Exercise, and also the name of one of Total's asset managers). The program found that the fastest payoff for analytics was in predicting production from wells.

We heard Repsol's director of geoscience and digitalisation saying he sees data adding value to subsurface analysts similar to how it adds value for oncologists interpreting cancer images, where in experiments typically computers get it right 30 per cent of the time, people get it right 70 per cent of the time, and people plus computer get it right 70 per cent of the time.

John Etgen, seismic imaging distinguished advisor to BP, recommended that oil companies do not necessarily just look for the large IT contractors to solve their problems. "If you only look at big companies you will miss stuff," he said. "There is a whole ecosystem [of small IT companies] out there."

We heard discussion about how working with software could be made more enjoyable – for example if people can come up with hypotheses and then the computer make it easier for them to test them out.

This changing attitude to digital technology is important – because getting the most value possible from digital technology probably requires high levels of integration between the computer systems and the individuals which work with them.

In the world of insular IT, we generally don't see that. The status quo has been software products which are hard to use, poorly integrated with other software, and designed purely around maintaining an income stream for software companies.

You can draw your own conclusions about why this is, but it seems reasonable assumption that it takes a senior manager, who both has oversight over the technology decision, and cares about the results of employees, to make it happen.

What good digital technology looks like

Good software is not necessarily the sort of digital technology big software companies want to sell. It does not need to be complex. It needs to provide people with information they need at the right time. It needs to support the way they want to work. It needs to avoid interrupting them with updates or bugs. It needs to

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This edition of Petromall Insights was written by:
Karl Jeffery, editor,
Digital Energy Journal / Finding Petroleum

Layout by:
Laura Jones, Very Vermilion Ltd

Published by:
Petromall Limited
CentralPoint
45 Beech Street
London EC2Y 8AD
United Kingdom

Email david.bamford@petromall.org
+44 (0)20 3286 2556
www.petromall.org

Senior managers at EAGE discussing digital technology. From left to right: John Etgen, Distinguished Advisor, Seismic Imaging, BP; Ashok Belani, EVP Technology, Schlumberger; Darryl Harris, Chief Geophysicist, Woodside; Francisco Ortigosa, Director of Geoscience & Digitalization, Repsol; Michael Borrell, SVP E&P North Sea & Russia, Total.

be modelled around people's needs.

People are not being overloaded with superfluous information, or more information than they can mentally process. They can get maximum value from available data and algorithms to support decision making. People do minimal superfluous work, or minimal work which would be relatively easy to program a computer to do. People have control over their work, can constantly improve their understanding about how the real world situation works.

Organisational IT is more like plumbing. Getting the right data to the right place reliably, getting everything to integrate, getting the job done, managing customer expectations, using the right standards and suppliers. Like in plumbing, nearly every job is different, so you need to learn (and be motivated to learn) from an experienced expert. You can't learn it on YouTube. The same with IT. Plumbing has recognised apprenticeships and experts.

A company doing IT well has found the right balance between commercial off the shelf products (COTS) and building its own products, and the products it uses integrate well.

In a good IT implementation, the software is probably both "plug and play" and platform agnostic, with a combination of open source (offering avenues for innovation and interpretation), and solid enterprise platforms.

Analytics can be done at the 'edge' (running on existing data systems), rather than requiring large data movements to do analytics.

The software is likely to be more visual and data-driven. There are immersive visualization tools allow drag n' drop to formulate instant graphs, bubble plots, correlation matrices.

The data is well looked after and trustable and ready where it is needed. There is a trackable data lineage (you know where data has come from).

The right data models are used to put different sorts of data together, so it can be analysed if necessary, and someone can make a decision made from different pieces of data at once.

Software systems are developed with "reuse" in mind, with the idea of making components which can be applied again and again in different areas.

Artificial intelligence is used where it adds value, for example spotting patterns in large amounts of data. People also understand how the algorithms work.

What bad digital technology looks like

Bad digital technology implementations have some common themes. No-one knows where data has come from. Tools have been chosen without a full understanding of the problem they are fixing. There is no overlap in skills between people who work in the domain, and people who work in data. You get the IT people telling the business what to do, rather than being subservient to the business.

Companies do a bunch of isolated projects, rather than having an overall plan. People are still working the way they always have, and won't change. Projects are lengthy, rather than short. The learnings from one project are not re-used in another. Data is stuck in silos. (Thanks to Teradata for this definition).

The challenge of implementation

Oil companies are starting to recognise that their biggest challenge is no longer developing technology – it is implementation or 'operationalising' technology which already exists.

Dr Duncan Irving from Teradata

Duncan Irving of Teradata quoted one oil major head of research, who believes that the oil and gas industry already has all of the algorithms it will ever need (such as for processing seismic, simulating a reservoir or making predictions about maintenance). What the industry does need, is to get better at putting them into day to day use, or 'operationalising them'.

There is a big gap between what data scientists can do in one-off projects and what companies do every day as their 'strategic capability', he said.

Cloud makes it easier

The cloud can potentially make it much easier to move faster with advanced technology, because it makes it easier for different companies to offer services on the same platform, working with the same data, he said.

For example if a geophysical company offers software on Microsoft Azure or Amazon, and this is where the oil company already stores its data, it is much easier for the software company to provide its service.

It gets to a point where software companies should ask themselves, if their software isn't available on the cloud, why not? Dr Irving said.

Data and integration

Ultimately many of the potential benefits require good integration of high quality data. For example if a company drilling a

well wants to be able to bring up reports and data of when the company drilled a similar geology before. They can also use their personal experience and memory together with useful information from the archives served up by computer.

Too often, oil and as people find themselves working with lots of different applications which don't integrate together, and they have to figure out how to make it work – similar to trying to drive a car made from lots of old components from different manufacturers, Dr Irving said.

Technology doesn't just have one gear

As a manager, you don't need to be excited about every technology you see. The idea that a technology could actually be the wrong choice for an organisation might seem weird to a technology enthusiast. But the technology enthusiast will usually only be excited about what the technology can do, not the results it can lead to.

As an example of technology which could well be wrong – consider autonomous ships. Many technology and automation companies imagine that autonomous ships will be just as appealing as autonomous cars, and automatically come into operation once the technology is good enough and cheap enough.

Shipping companies, and their clients, such as oil companies, are unlikely to take this view, indeed there is barely any example of a shipping company actually welcoming autonomous ships. From a safety point of view, there's a big benefit to sticking to what is reasonably well understood (people in charge) rather than experimenting with that is not, and the savings, in terms of the cost of a few seafarers, is not so great to justify what is basically a safety risk.

Shipping company people are largely problem solvers, in that the routine business of shipping is handled automatically anyway -and problem solving, where it involves assessment and integration of many different types of data, is the hardest task for a computer to do.

The bottom up model

Some oil companies adopt what could be called a bottom up model, where they focus on putting the IT infrastructure in place – including sensors and software systems, and then standardising and integrating it.

This approach can obviously work, but is perhaps less useful for executive decision makers – because it implies an almost infinite potential spending (you could spend forever polishing your IT infrastructure) and not necessarily any business value (if you end up with something impossible for people to work with).

Dr. John Markus Lervik, founder and CEO of Oslo technology company Cognite AS, working with Aker BP, emphasised that it is very important for the industry leaders to set the vision. "Digitalisation will never happen bottom up," he said. "It will happen because you [senior managers] set ambitious goals and follow up on those with bottom up. It is as simple as that and as hard as that."

Making sure technology works for people

Making technology which works well for people is a lot harder than making technology which just works for technology's sake, or technology which can require that people work the way the technology wants.

For technology to work for people, the software design would need to take into consideration what the operator actually needs to be thinking about while they use it, and what they need to understand, and the range of options they might be considering.

Too often software seems to assume that thoughts related to the decision (the customer / user is making) are unimportant and the only important thing is that the software has the information it needs to bring a result.

Attracting staff

Attracting data professionals into the oil and gas industry might actually be getting easier this year, helped by the recent bad publicity around many consumer IT companies like Facebook, and the fact that data people want the most exciting projects to work on, and know they can choose.

Cognite's Dr Lervik said that many top IT people are tiring of working with Silicon Valley consumer technologies, and want to move into more exciting things," he said. "What is more exciting than having digital technologies representing and modelling and optimising the physical world?"

When Cognite was founded, the company found that 4 of 10 people in discussions about joining the company said they didn't join "because it was oil and gas".

"But after that we have been much better at explaining," he said. The industry has "very exciting computer science and machine learning problems. Plus it is also about improving the industry and how we operate as a nation."

As a former IT person, "I see we can solve a lot of interesting problems," he said.

Getting from probabilities to absolutes

One theme which emerges across upstream oil and gas digital technology is moving from 'probability models' to working with absolutes. Wouldn't it be good to know exactly how much oil you have or how much your production will be?

For example in the subsurface realm, until now work has been largely around probabilities. For example, the probability of finding a reservoir can be calculated around the probability of there being the elements which create a reservoir – source, charge, trap and seal. But, with so much subsurface reservoir data available to us, we want to move to a world where we can say for sure there is oil there.

Similarly in drilling – companies want to get away from having to mitigate against various risks, to knowing exactly what pressures they will need to drill through, and so not needing to drill with a mud fluid heavier than they need.

There could be more certainty on offer in the safety realm. With more data available, it ought to be possible to know for sure that a component is not going to break, if an explosion happens it will only take place so fast, that gases will be able to escape before causing damage, and so on.

Equinor's digital road map

Equinor (formerly Statoil) is setting up a "digital centre of excellence" and putting together a company wide digital "road map," explained Torbjørn F. Folgerø, senior vice president and chief digital officer, speaking at the Oslo "Subsea Valley" conference in March 2018.

There are 6 "programs" for the digital centre of excellence - safety / security / sustainability, subsurface analytics, next generation well delivery (including automated drilling), field of the future, data driven operations, and process digitalisation and insights.

The company has ambitious targets to in-

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crease production, reduce drilling costs and reduce capex, with digital technologies such as automated drilling, standardised developments, remote operation and other automation.

Torbjørn F. Folgerø, chief digital officer and SVP, Equinor

Equinor has already put all data from its onshore production onto cloud systems, including safety and subsurface data. This means that the data can be much more easily found by others, and shared with supplies in new ways, he said.

Equinor is creating a portfolio of digital training courses, driven by the needs of current employees. "We want to refocus them," he said.

For its US onshore operations, Equinor has built a new operations centre to manage data. It can monitor problems with wells and despatch engineers to fix problems. It can also optimise production and try to predict where maintenance will be needed. It plans to create a similar operations centre for offshore wells in Bergen.

Equinor is looking at where it can do more advanced analytics on its subsurface data, and perhaps build a "subsurface data lake".

Equinor is moving to a "minimum viable product" approach, with people working in "sprints" of 2-3 weeks and trying to develop a solution at the end of it, said Mr Folgerø. In the past, the company might have spent 9 months making design documents for a system, then giving it to the IT department to build, and then keeping it in place for years.

Equinor is also changing to allow more flexibility and fluidity, with people having access to more data than before, which should lead to people being able to do new things. The management just set the direction rather than specifying how everything should be done, he said.

Equinor and Robotic Process Automation

Equinor is experimenting with 'robotic process automation' (RPA), using software to automate repeatedly done software tasks, so that people no longer have to do them.

Equinor's chief digital officer, Torbjørn F. Folgerø, said that the company has identified 60 work processes which could be automated, including in subsea, maintenance and procurement.

Equinor started looking at RPA around March 2017, aiming to identify work processes which could be automated in this way. So far most of the value is in back office processes, including supply chain management and logistics, said Stein Petter Aannerud, head of RPA in Equinor.

People in oil and gas companies do a "huge amount of activities manually", he said. For example, when one person copies a certain section of data on a spreadsheet and then e-mails it to someone else every day. Perhaps it is fairly easy to automate that.

The RPA software sits on top of the usual software, perhaps having its own log-in, so it appears to the host software as another person. "This technology is fairly easy to put into any part of your process," Mr Aannerud said.

Every step the software makes needs to be carefully mapped out – the software cannot be expected to do much 'thinking' itself.

The company set up a robotic employee "Rob Robot" as an external consultant in Equinor's identity management system, so it could get access to computer systems in the same way as a human employee would.

There has been some reticence from company employees to support the effort to roll it out, since they have read newspaper articles about "robots taking over your jobs" and think this is what it is, he said. But it is maybe more correctly described as "taking robots out of humans, removing tasks humans are not fit to do," he said.

Subsurface

How digital technology adds value – including seismic AI, dynamic reservoir data, and helping professionals make better decisions

The subsurface ream includes subsurface surveys (mainly seismic), integrating and modelling the data to understand the subsurface, modelling reservoirs (fluids), gathering and interpreting well log data, keeping everything for future use. It includes advising drillers where to drill and what they might find when drilling, advising production engineers about production, advising field development people how best to develop the field.

A few decades ago, oil and gas subsurface teams had the most powerful computers in the world, or near enough.

The big trend is for more and more data, and high performance computing, to be done on the cloud, rather than on in – house computers. This is usually much cheaper (unless special computing facilities are needed), and makes it easier for the company to access a wide range of data processing and analysis tools, made by many different specialist companies.

Data management is also an area of focus, although it is hard to detect if it is more of a focus now than in previous years. With good data management, companies can retrieve older data much more easily, for example if they want to find out about the company's experience with a well similar to the one they are drilling today. Data management has always been a focus, but today perhaps more so, if it becomes easier, with data stored on cloud servers.

Good data management is simple to describe but very hard to do – there is only one version of any particular well log or model so people do not have the confusion of deciding which of multiple versions to use. All data in the archive is quality controlled, so it can be trusted by future users.

Many data experts still despair at the lack of focus given to good data management at oil companies, seeing it as work which is comparatively inexpensive but very value adding to the company.

Seismic processing and AI

The seismic processing world, converting raw seismic data into subsurface models through a series of complex steps, is a prime target for many artificial intelligence companies.

is a prime target for many artificial intelligence companies.

One of the dreams is that a computer might be able to automatically identify a reservoir on a seismic image, the same way as computers can automatically process radiology images, or pictures of cancer cells, or navigate an autonomous car.

The reality, as of 2018, is nowhere near that, but computers are being used in advanced ways. One approach is for the computer to copy the way a person has interpreted part of a subsurface image, so the person only needs to interpret a tenth of an image, and the computer does the rest.

Another approach is to analyse seismic "attributes" – a large number of different factors computed from seismic. You don't need to understand what the attributes mean or show, but you can use computers to pick out patterns between them in a seismic image, perhaps showing that there is an anomaly in one place, because some factors which correlate in other parts of the image don't correlate in this part. Such an anomaly could of course indicate oil.

Keith Holdaway, advisory industry consultant, SAS

Keith Holdaway, advisory industry consultant, SAS, and author of a book on the subject, says that too many oil companies still only do this kind of data science in a silo, rather than doing it across the whole company. And many of the models developed by data scientists are not trusted by geoscientists, who prefer to fall back on personal experience. Data scientists and geoscientists should be working together.

If all of the available subsurface data was analysed in different ways, putting together knowledge from the analytics together with people's experience, it should ultimately be possible to get a much better subsurface understanding, he says.

"Geoscience must take faith in what the data is saying through its patterns."

Subsurface data integration

Another dream is that it might be possible to integrate all of the various subsurface data – including gravity, electromagnetics, production and well data – together in the same model (usually derived from seismic).

As of 2018, there is no easy way to do this. The problem is that each of the data sets has different characteristics and tells something different, you can't just overlay them on top of each other.

But there are many processes being developed to make it easier to work with multiple data types. We will see more of this in the future.

Improving land seismic recording

Bob Heath, a former vice chairman of SEG's Technical Standard Committee, believes that there is scope to achieve better data quality in land seismic surveys – or get equivalent data quality at much lower cost.

He sees the current approach as rather 'dumb' – based around the most number of channels (simultaneous recording) and the loudest seismic noise. It could be done instead using far more 'intelligence' – for example monitoring the seismic waves being created and using that data, and monitoring the quality of seismic recording as it is happening – so you can do more of the survey where it is working, and less surveying where it is not working.

Growth of satellite imagery

Satellite imagery is increasingly used in exploration, making use of the large number of powerful satellites, large and small, which have been launched in recent years.

One example is analysing images to spot hydrocarbons, on the basis that oil deep in the subsurface can lead to small changes in the colour of plants above them, due to the slow seeps the oil makes to the surface. The changes probably can't be seen by the human eye, but could be detected with a computer.

Bob Heath, former vice chairman of SEG's Technical Standard Committee

Explorers also use satellite images to search for oil seeps – oil which rises through the subsurface through water above – which can be an indicator of oil reservoir (or they could be an indication of a dirty ship). Analysing multiple images over time can tell you which it is.

In the operations realm, satellite images are being used to keep track on what competitors are doing, comparing images to look for well heads or road construction. They are even being used to assess the contents of storage terminals.

Infrared satellite images are being used to assess methane leaks from entire oil and gas facilities.

Exploration data case study – Kosmos Energy

Kosmos Energy, based in Dallas, is one of the world's biggest oil and gas exploration success stories, involved in 2 out of 3 of the major deeper cretaceous basin discoveries over the past 10 years – Jubilee in Ghana, Tortue in Mauritania, and offshore Guyana.

The company spends plenty of money on digital technology, including high resolution 3D seismic surveys.

Paul Dailly, senior vice president, Kosmos Energy

But when SVP Paul Dailly explained

how the company works at a Finding Petroleum forum in September 2017, his main emphasis was on how the people aspects of the company works.

Most of the original Kosmos management team have been working on the part of the world for decades, meeting at a company called Triton Energy which was acquired by Hess back in 2001.

The company is only focussed on exploration and early development, or the "front end" of E&P, bringing in partners for the further development and production stage. And the explorers are mainly focussed on a certain type of exploration – that part of the world, and a limited set of geologies – mainly basin floor fans.

It limits the number of "positions" the company takes around the world to 4 or 5, because otherwise it gets harder to mentally absorb all the information from them. It also does not drill more than 2-4 exploration wells a year, to make sure it can fully 'digest' the results from them.

From a digital point of view, this story illustrates that success usually comes from people, not technology. The technology's role should be to serve the people and what keeps them motivated – a feeling of success, or developing an in-depth understanding of something.

Reservoir modelling

The next step after developing subsurface models is to make a simulation of the reservoir, how fluids are flowing through the subsurface.

Reservoir simulators have been available for over 10 years, making very compute-intense calculations about how fluids are flowing through the subsurface, by dividing it up into tiny "cells" and calculating flow of different fluids into and out of each one.

The problem with these simulators is that they are often only accessible by a small group of staff, and there is sometimes not much trust in the models they create, because they are impossible to verify. Sometimes there is a feeling that the models are not incorporating all of the available data.

The simulator is only as good as its ability (and its operators' ability) to 'ingest' different types of data and understand what this data means –

Companies such as Emerson (formerly Paradigm) are developing lighter reservoir simulators, which model a simulator without requiring so much compute power.

Case study – reservoir software from Dassault

Dassault Systèmes, France's second largest software company, is developing software which gathers together all available data about a reservoir.

The software is based on the digital business platforms it provides for many of the world's aircraft and automotive manufacturers, as a single "platform" providing all of the relevant data, which all employees can access and work with, hosted on the cloud.

For reservoirs, the reservoir model can include a much broader range of information than most simulators, including rock stress data, subsidence, and well data.

The amount of data about reservoirs is always increasing – with new survey data (such as gravity and electromagnetics), new ways to monitor wells in production (such as fibre optics), and advanced reservoir modelling techniques.

What it doesn't do is simulate reservoir flow – but it integrates with existing reservoir simulation packages. The company sees it as providing a "business foundation" to reservoir simulation.

Understanding geological data quality

Nearly always, the subsurface data in a corporate archive is of a range of quality levels, which means that a large part of the work of making a decision using the data involves judging how good the data actually is.

The National Data Repository workgroup on data metrics, part of oil and gas standards body Energistics, is developing standard ways to assess how good data actually is. This metric can then be used to assess whether data is good enough to be used to make a decision, or (upstream) whether data is good enough to be kept in the corporate archive.

A big challenge in the work was deciding how good data actually needs to be, and what the common problems are, said Philip Lesslar, the lead participating in the group, speaking at Digital Energy Journal's forum in Malaysia in October 2017.

Philip Lesslar, data management consultant and former principal consultant, Technical Assurance, Compliance & Technical Assurance, Group Technical Data, Project Delivery and Technology, with PETRONAS E&P – currently leading the National Data Repository workgroup on data quality metrics

A common problem is when different versions of the same data are stored, for example if someone has made multiple efforts at picking out geological features in a seismic image. There can be several interpreters each leaving several versions each, very confusing to anyone who wants to see how the seismic interpretation was generated later.

Another issue is that extensive data clean-up work is often done as part of analytics projects, but there is no process for replacing the old data with the cleaned up data, so next time the cleaning needs to be re-done.

Geophysicists assisting other sectors

With better digital systems, there is scope for subsurface data experts, such as geophysicists, to provide much better support for drillers, particularly providing better advice into what they are about to drill into, and helping them avoid potential high pressure areas, said Dr Duncan Irving from Teradata.

They can also advise on the best way to construct a well, which factors might affect production.

They could also apply their expertise to the companies' existing data stores, particularly well logs, helping sort out the good data from the bad, correct bad data, and enabling the company to do more with it.

Field development planning, drilling and construction

How digital technology helps keep costs down for field development, drilling and construction projects

A critical decision affecting the profitability of an oil company is how its field is developed. The wells and facilities take a large amount of the costs for the entire project, so there are many decisions to get right.

For example, how do you choose which license blocks to bid for, where to place your wells, and how to build them? Offshore, should you tie-back to existing facilities or build new ones, and what size should they be?

How should you plan the drilling activities and well design, how should you construct the wells? When you are drilling, how will you handle and avoid problems? How will you record the results of the drilling, so the data is made available for future use? How will you use the data to reduce the non-productive time of the wells in future?

Companies are finding ways to use data to improve all of these processes, including assessing different field development options, understanding both reservoir and safety risks, working out which rig crew to assign to this job, steering rotary drill bits, fixing drilling problems faster, and understanding and reducing problems which cause expensive delays.

Meanwhile, drillers have been getting steadily more advanced over the past 10 years at involving remote experts in drilling, enabling them to see drilling data and provide input into problems, perhaps because it is a geology they have a lot of experience with.

Drilling reporting systems are also getting more advanced. Companies have moved from providing daily drilling data on a spreadsheet (or just a fax) to putting it in databases, with different types of data integrated together. They are exploring ways to run analytics on the drilling reporting data, enabling predictions to be made about time and cost of future drilling projects.

In the world of construction, companies are using IT systems which make it much easier to change the overall plan as the project is underway. For example, if a key supplier goes out of business, companies will need to immediately check which parts of the plant this supplier was providing, if there are alternative suppliers available, and how the design might need to be adjusted to take this into account, for example needing a pipeline with a smaller diameter going into a pump provided by the new supplier.

Software systems are being more widely used to manage contracts, helping shield the company from unexpected large bills, and keeping track of what everybody has agreed.

Working with indexes and graphs in drilling

A number of companies are developing better ways to index or connect documents together, mapping them against a standard model of how the oil and gas industry operates.

For example, drillers generate thousands of different documents. But you can make them easier to organise and retrieve by recognising that there are a limited number of reasons why someone might make a report about a problem, because there are a limited number of different problems drillers have. One of those is drill pipe getting stuck, and that is caused by a limited number of reasons.

This creases a basis for "contextualising" your documents, says Øystein Drivflaadt, chief technology officer of Intop in Norway. For example, you can contextualise a group of documents against the theme "mechanical problems causing a stuck pipe." Then next time you have a stuck pipe problem, you can quickly retrieve documents about previous similar stuck pipe problems, which may help you work out a solution.

This means that the large corporate archive of oil and gas companies can be made to make a lot more sense, because you the documents are grouped around common problem.

Øystein Drivflaadt, chief technology officer of Intop in Norway

Case study: MAANA – helping drillers understand problems

Silicon Valley company Maana is working with a range of oil majors (its investors include Chevron, Maersk, Shell, and Saudi Aramco Energy Ventures), to work out better ways to organise drilling data so it can be used by hanging it together in a 'graph'. It likens is to the way that Google can hang together various data about a celebrity to bring you an overall picture – for example if you search for a celebrity you might see their birth data and place, education, books they wrote, family members, movies.

In drilling, a similar system could bring up a range of information about a problem you might have – such as other problems the company has seen at a similar depth or geological feature. In maintenance operations, it could tell you a range of data you need about your work today – what equipment, what spare parts you need, what common problems are.

The company says that the toughest part of the work is building the graph – because it isn't obvious what information someone will need to do a task, unless you are actually doing the task yourself. Perhaps the best way forward is to enable people who actually do work to build their own graphs.

Production

How analytics and other software can improve decision making around how oil is produced

Production is seen by some commentators as the area of oil and gas most ripe for improvement by digital technology and analytics.

Production engineers make day to day decisions about how to adjust the production of the well – to maximise production, or maximise use of the available facilities, or avoid damaging the reservoir by producing too fast, or how to adjust other elements such as neighbouring wells, or gas lift, to get the production they want.

The realm of production touches, and connects together, all areas of the upstream – subsurface, drilling and facilities.

We hear that production engineers rarely have access to much subsurface expertise, particularly the reservoir simulator, which in theory could tell them how to adjust chokes and other factors to get the best production. The production is also rarely co-ordinated across the hundreds of wells which could be feeding into the same set of facilities, to ensure that the whole system is optimised to make the best use of the equipment, bearing in mind that all of the wells will have different production levels, and different amounts of different fluids.

We hear that it is still rare for all wells to have flowmeters – so often production engineers have to use computations to work out the production from individual wells, using the flowmeter on a co-mingled pipeline.

Computer systems have been developed, some fairly simple, to help production engineers make decisions on what to do during their shift, for example to change gas lift or adjust chokes to reduce slugging.

Technology case study – Solution Seeker – finding ways to improve production

Solution Seeker of Norway is developing software to enable production engineer to better understand the factors affecting production.

The software 'ingests' production data into its servers, and runs pattern recognition algorithms and statistical analysis.

The company originally planned to base its service on reservoir simulation information, but found them 'too slow' to work with. So now it works directly on the field data.

Ultimately it can be used to build a prediction model of the whole reservoir.

If the reservoir only has one well, then it can be easy enough for someone to manage all the variables in their heads. But an oil company might have 150 wells routing production to 2 different separators, all sharing the same gas lift, and some downhole pumping available, and an average annual decline of 5-10 per cent on each well. It quickly gets very complicated.

Case study – working with graph database software

Everybody knows that engineers love spreadsheets. But graph database software can be used for the same thing - manipulating different kinds of data – but with much more power, because you are not limited to rows and columns, you can have many more dimensions.

Joe Chesak from Norwegian software company Fablabs

Joe Chesak of Norwegian software company FabLabs suggests that oil and gas companies can use graph database software like Neo4j for anything from resource allocation simulations to massive topside optimisation projects.

They could be used to work with time series data, but instead of indexing data against time, it can be indexed against key events which happened at certain times.

The graph database can store any kind of 'model' about how a system works, which can be drawn on a whiteboard.

FabLabs worked with graph databases to build a tool to optimise production, building flow models about how wells and topsides are operating, and understanding the various constraints, such as when multiple wells share one gas lift stream, or their production is co-mingled into one separator, and each well has multiple flows, such as H2S or CO2. This is a highly complex scenario, which can quickly get too hard to do in your head or in Excel, but a graph database can handle it.

Case study – well performance reviews in Spotfire

Brunei Shell introduced the analytics software Spotfire to analyse the wells in production, looking at changes in flow rates, pressures, comparing different wells.

Before, the work was done manually, and it could take 3 weeks just to collect the data from different databases, with some data only available on PowerPoint slides, some data with different co-ordinate reference systems, some data just unavailable.

The Spotfire software can be set up to talk to a number of different databases and data stores at once, including modelling software like Petrel. It can build a single visualisation of the results, called a "composite map." There is no 'staging' involved, gathering data into the one visualisation.

Now the company is considering using Spotfire in many other areas of the company.

Facility operations

How digital technology helps maintain safety and efficiency in operations, engineering data management, asset integrity management, and predictive analytics

More money is spent on operations than any other part of the oil and gas chain – and this is a prime focus for many types of digital technology.

Companies see they can potentially save large amounts of money by improving the data 'handover' – the data which is given to the operator by the contractor on day one (at the same time as the physical asset is handed over). We hear there are often delays to getting operation to maximum capacity while the necessary data is gathered.

One big focus area is asset management – getting the best possible data about what the asset looks like, and how the equipment is operating – then making better decisions about maintenance and modifications. This applies to subsea equipment as well as topsides.

Companies are developing ways to bring in remote experts to spot or solve problems in operation – including cybersecurity attacks or operations going out of safe limits.

A big focus is using analytics tools on equipment, to try to predict problems before they occur. Companies are also using analytics on sensor data to try to spot problems before they occur.

Companies are also making big efforts on procurement, finding ways to improve value from suppliers without just accepting the lowest acceptable bid.

Handover

A critical point in managing the data of an offshore asset is day one, when you take data from the design contractor and put it in your operations management system.

It is common today for design companies to provide data in a range of different file formats, or even on paper, which the customer needs to make sense of.

There is a project underway supported by a number of oil companies called CFIHOS, to develop a standardised way for an operator to specific to a designer what data it needs and what format it should be in, and what quality it should be. This can be incorporate as part of the contract.

As we move to the cloud computing era, it should be possible for data to be handed from design to operations staff just by handing over the password to an online store, suggested Trond Straume, CTO of industrial engineering software company AVEVA. This could happen the same time as the physical asset is handed over.

If you start operations on day 1 with all the data you need, it gets much easier to maintain the data over the lifetime, adding in operational data and data about any modifications or maintenance work, he said.

You have an up to date digital representation of the plant, or 'digital twin', which can be a great help in understanding the behaviour of the plant.

Using software "automation" in operations

The word 'automation' is mainly used to mean machines which do a task automatically, like a robot making a car. But in the software world, 'automation' can mean something different – following an algorithm, or automated process, to generate some useful advice.

Physical or mechanical automation has a role in the oil and gas industry – guiding drill bits, dynamic position of vessels, driving a drone along a pre-programmed path, injecting chemicals. But software automation could have a much bigger role, because it can support decision making, and every part of the oil and gas industry has plenty of that.

Perhaps the best example of software automation is Google Maps, said Peter Zornio, CTO of automation company Emerson Automation. It is getting better and better at suggesting routes to us, based on a wide variety of information. But it is only guiding us, not actually driving the car.

Peter Zornio, CTO of automation company Emerson Automation

Software automation in oil and gas operations is already doing something similar – giving operators guidance on what their next steps could usefully be, rather than telling them something.

Over time, people are far more likely to use the suggested guidance (who would do a drive through unpredictable traffic without online guidance today?) It is important to be wary about systems which force people to follow the guidance, because these can be very frustrating when the guidance is less than perfect.

In operations, Mr Zornio sees the human's strength as 'synthesis' putting together a wide range of information – similar to how a baby doctor can look at data on a number of machines monitoring the baby's health, together with other reports and conversations, and decide on the best course of action.

Automation on US onshore wells

US onshore operators are making big strides in remote monitoring and automation techniques on their land wells.

Some companies are using blockchain based software to keep track of water collections, made by tank truck. Amalto, a company based in Paris, Houston and Calgary, has developed a blockchain based solution for everybody to keep track of exactly which tanker truck collections have been made, so there

is no discussion needed afterwards, and payments can be easily made.

US company WellAware is supporting development of automated chemical injection solutions which can inject the right amount of chemical to keep wells from freezing up, using data about temperature and the pump flow rates. The pump flow rate can also be adjusted remotely.

Case study – managing engineering data for the well head

Brunei Shell developed an integrated system for all of its well head data, aiming to have a "single source of the truth" for data about the well head.

This will enable better calculations, better and faster decision making, and fewer problems due to bad data.

The data covers the well head configuration – both vertically (e.g. well hangers, hanging from the well) and horizontally (taking flow to the production tubing, including annulus valves).

Brunei Shell has about 1600 producing wells in total, producing 350,000 boepd.

Before the project, data was stored in a number of different formats, both electronic and digital.

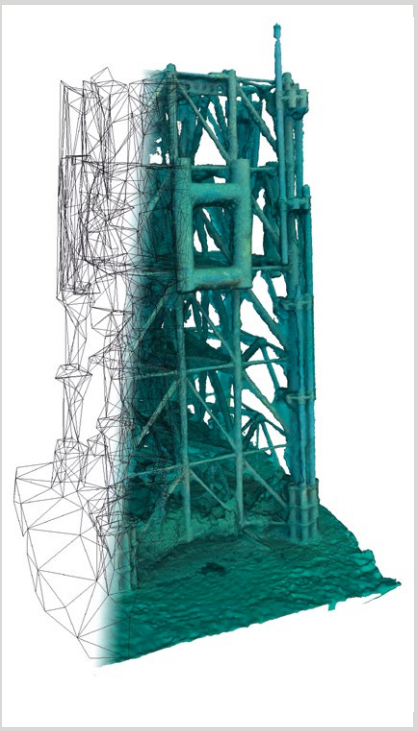
The work to develop the electronic system included cleaning up all the data, and perhaps more importantly, making sure all new data was entered according to a 'standard operating procedure', on the Engineers Data Model software (Halliburton), with processes for checking data quality.

Putting data on old paper documents into electronic format

Many oil companies are purchasing services to convert old paper document archives into modern electronic systems – and a number of software companies are developing services to do it.

The work is manually intensive, but there are methods to speed it up.

A starting point is usually optical character recognition (OCR), when a computer attempts to take scanned images of the documents and create



A 3D model developed from subsea (2D) imagery by Rovco

a text file from it by recognising letters. By doing this work twice, and comparing the different versions, can lead to improvements in accuracy

One technique is to understand the process that the old company used to generate the documents – for example the company might create a new document every time a new project was approved. This enables you to better understand how the documents fit together.

Many companies promise some kind of 'machine learning', where the computer gradually gets better at understanding what the documents mean (although none have yet released much information about how this machine learning works, or whether it is in fact machine learning).

Subsea equipment scanning

For years the standard way to assess the condition of subsea equipment and pipelines was using a remote operated vehicle with a video camera. First the camera is driven around the equipment or along the pipeline, recording video all the time, and then the video is painstakingly analysed.

A number of companies, including Rovco and Whitecap Scientific, think this task could be ripe for automation, envisaging a world where the computer 'drives' the ROV and automatically analyses the imagery, working with experts with experience working on the Mars Rover.

There are many technology parts to develop before this can happen. A big one is being able to generate 3D models from 2D ROV camera images. (Of course you need more than one 2D camera to make a 3D image. Or you look at the same object from multiple directions).

Rovco envisages that it might be possible for a ROV operator to have an 'impossible view' generated by computer, where they see the object that the ROV is working on, and the ROV, in the same steady image. Currently operators can only work with the camera inside the ROV, which can make it very hard to manage, when the ROV is itself moving, as it films the object and does manipulation work on it.

Case study – how ABB is bringing in remote experts

Engineering conglomerate ABB is offering a wide range of services to bring in remote experts to a company's operation – including monitoring cybersecurity, improving process performance, monitoring and calculating hydrocarbon floes, and managing subsea power.

ABB staff can provide ongoing operation support, such as helping companies diagnose alarms. Or they can provide advice about how performance can be improved.

With the cybersecurity service, ABB experts understand the communications patterns which different viruses make in a corporate network. So if a bad event happens, such as a rogue employee inserting a USB stick where they shouldn't, it can identify the network communication platforms and give the company a call.

It can also help companies monitor their performance, monitoring certain parameters continuously, and warning the company if one of the factors has passed a threshold, which might make it harder to control the plant. It can

also analyse the data to determine the root cause of the change, for example someone changing a setting on a valve which led to a chain reaction of different changes in operating parameter in the plant.

Working with predictive analytics

Predictive analytics, or taking data about the condition of equipment and using it to try to work out what is going wrong (and what might be about to go wrong), is perhaps the biggest application of advanced digital technology in the upstream oil and gas industry.

Peter Zornio, CTO of Emerson Automation, says that the top quartile of companies tend to have both higher equipment reliability and lower maintenance cost, typically spending half as much on maintenance compared with average performers and operating with an extra 15 days of available production each year, and spending 20 per cent less on production related expenses. This is partly because about a quarter of companies are now active in using condition maintenance, he says.

A lot of what is required for good quality operations can be simply expressed as 'deeper insight' – an obvious point but very difficult to deliver. You don't necessarily need clever analytics and machine learning, but you do need to know what is going on and what to do about it.

The computer systems need to be able to access the operating data, and run models to understand trends, or make warnings about specific events. They should monitor sensor data continuously. They should ways to compare one asset's performance with another similar one.

You should have tools for process and reliability engineers, to do visual analysis of the data. There should also be ways to bring in internal and external subject matter experts.

One approach to try to spot equipment failures in advance, developed by Near Miss Mangement of Philadelphia and OPEX (Operational Excellence Group) of Aberdeen, Scotland, among other companies, is to scan large amounts of sensor data looking for patterns.

The software can 'train' itself using perhaps multiple years of sensor data, understanding the patterns seen when the system is in normal operation. For example the way a temperature rises slowly during an operating cycle, and how this temperature rise is recorded differently in different sensors.

If a problem is emerging, perhaps the first place it can be detected is in small changes in these patterns. A piece of equipment is responding slightly differently, a pressure reading is slightly lower than would be expected.

Then if you have a large amount of historical data, perhaps you can determine something else which has changed which might cause this change. Have you been working with a certain component without replacing it much longer than you usually do? Has the weather changed?

Safety reports usually indicate a root cause of an incident, something like a maintenance task which did not put equipment back together right, or using a component of a different quality to the one usually used. If the computer can get early warning of a problem, and track that back to a possible cause, that can be very powerful in preventing problems.

Analytics for equipment manufacturers

Arundo Analytics of Norway / US has a business model providing analytics services which can be partnered up with products sold to oil companies – so the manufacturer basically provides both a product and analytics.

This means that the manufacturer of (say) a pump can provide advice on how the pump can be operated more efficiently, or a problem about to happen. A supplier could also offer a performance agreement, promising that an investment (for example in a new pump coating) will provide a certain return (in lower fuel consumption), or the manufacturer will cover the costs.

The company sees the service as possible in several stages – just data, data plus diagnostics, and then data, diagnostics and guidance of what to do about it.

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