digital energy journal

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What a "platform" business model would look like

December 2020

- Bill Gates on how to decarbonise industry
- Open Footprint standards for emission data
- An ultrasonic sensor for pipelines which is easier to use

Finding Petroleum

Official publication of Finding Petroleum

digital energy journal

Issue 87 December 2020

Digital Energy Journal
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Production
Very Vermilion Ltd.
www.veryvermilion.co.uk

Subscriptions:
£250 for personal subscription, £795 for corporate subscription.
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Leaders

"Pervasive digitalisation the only way" – SPE president

In his introduction to the Society of Petroleum Engineers Engenious conference, held online in late September, Tom Blasingame, president of SPE and professor of petroleum engineering in Texas A&M University, said that the pathway to digitalisation is "irreversible".

"Pervasive digitalisation is the only way I can envision our future activities," he said.

"If people and organisations do not treat digitalisation as the essential path to innovation and productivity, they will fail to benefit from its gifts - reducing cost, increasing efficiency and enabling innovation across our industry."

"Now, in the middle of this pandemic, is exactly the right time to accelerate the process of change."

"I believe personally the energy transition will be far less painful and more significant if we build the strongest possible digital mindset," he said.

It is time for people in the industry to ask ourselves, "what does the new normal look like for our industry - especially with an unprecedented loss of senior talent? How do we make change happen when we can't work directly together?"

Sian Lloyd Rees, Head of UK and SVP Europe & Africa at Aker Solutions ltd, chair of the Engenious conference, and a former head of global accounts with Oracle, said that the industry has seen a "rapid uptake in digital tools and methodologies".

The Engenious event "is a good opportunity to share our learnings and findings."

"When I worked in IT, I worked with a number of companies in multiple industries, supporting them in their digital journey. For most of these companies, the findings that we made adjusted and altered the end outcome or business model."

For example, "we worked with a large supermarket in the UK helping them bring a business intelligence platform for their customer loyalty platform. We also got to the point with real time sales information of being able to optimise individual store layouts on an almost daily basis."

Ms Lloyd Rees also worked on a project for the UK's National Health Service, helping build its "IT spine". It involved gathering data from multiple sources, including social media. The data was used to "create efficiencies in the overall system". It enabled efficiencies to be found in the NHS supply chain, something which had not been built into the original business model.

The oil and gas industry could learn from other industries in how they use digital technologies, she said.

"We're all aware we need to attract talent into our industry - and will compete with other industries to attract these skills. So we need to show our industry as an 'energising place' to develop your career."

Guide to Engenious coverage in Digital Energy Journal:

Tom Siebel keynote talk - see our Oct-Nov issue p2

In this issue:

Total & Flare Solutions – making acquisition data usable

Total worked together with data service provider Flare Solutions after its acquisition of the North Sea E&P assets of Maersk Oil in 2017, to make the data more cohesive and usable

Oil major Total engaged data consultancy Flare Solutions to help it work through the data from Maersk Oil's E&P assets for the North Sea, which it acquired in August 2017.

The data and information from Maersk included over 320 million files, amounting to 4 Petabyte of disk space.

The project was handled through Total Upstream Denmark (TUDK). It took 18 months.

Flare developed a semantic search system, integrating many heterogenous data stores, including SharePoint, "eSearch", network drives and legacy software systems.

The big challenges of the project were to first understand what data exists and what can be done with it. Everything needed to be done without disrupting daily operations. The project team needed to understand what vendor data Total was entitled to, particularly seismic data. It wanted to develop a simplified method to manage the information.

Flare Solutions used its "Folio" application to scan the entire 320 million file dataset into a graph database to build a representation of the Maersk disks. This provided an understanding of the data landscape prior to integration.

It showed that the data included over 12,000 Petrel projects, more than 200,000 DLIS and LAS (well log) files, millions of reports and a huge quantity of application data.

The Folio software was used to identify vendor data, including seismic data, where the data entitlements needed to be checked.

Several workflows were used to identify and categorise data. Data was grouped together, and a decision made about whether to migrate it into Total systems, archive it or delete it.

Data from other data sources, including OpenText's Livelink and Schlumberger's eSearch were linked to Folio to create a federated search environment.

Personal or sensitive datasets were located by running focussed searches in Folio and the appropriate action taken.

Folio was also used to record a permanent audit trail of what happened to each item.

For around 1.3 million reports and datasets deemed to be of high value, Flare Solutions enriched these items with context tags (type of report or dataset) and geographical tags (well name, field, quad/block, country, basin) to ensure that future searches would successfully retrieve them.

Now, TUDK has a search engine which can search over 320m items in seconds. With enhanced tagging of key reports and data types, the search has been much enhanced.

There is a framework in place for building an effective information management system that will support current and future information needs.

"The scope in terms of the data we had to deal with, from the Maersk OG acquisition, was huge," says Olivier Mairal, Head of Data Integration at Total.

"The time constraint to digest and expose the full content in parallel of the running operations was not compatible with a standard data management approach so we had to find an innovative and efficient approach.

"Using Folio from Flare allowed us to not only index more than 320 million records in a few months but at the same time expose them to full user community that needed this information to maintain operations."

"The indexation, sorting and exposure was very efficient, and we managed to 'connect' various sources such as Livelink, eSearch, and many disks from various regions into one single interface and search tool.

The tool was also used to help data management activities during the clean-up exercise.

In comparison and from parallel experience, a standard approach on a similar scope would have taken about 20 years to do this manually with one-person EFT and a significant saving in term of budget.

"The transition project was a success and delivered on time. My team did a great job, and Flare Solutions consultants and tools were also solid contributors to this success."

"This illustrates the value of a knowledge-based semantic search system, enabling understanding of the content through automation, and delivering a solid foundation to support future integration and search developments," said Glenn Mansfield, Director at Flare.

Bill Gates – too much focus on 'easy stuff' on climate

With climate issues, there is too much focus on the 'easy stuff' like renewables and electric cars, says Bill Gates, founder of Microsoft. Decarbonising cement and steel will be much harder

Too many people believe that we can solve the climate problem with just renewables and electric cars. But this is a comparatively easy problem, compared to making decarbonised steel and cement at no additional cost, says Bill Gates, founder of Microsoft.

He was speaking in an interview with the editor of the Economist Magazine, Zanny Minton Beddoes, held in October 2020.

Other extremely hard problems are working out how to fly a plane without carbon emissions, and maintain reliability of a (renewables sourced) electricity supply.

Climate change happens as a result of "the entire physical economy" – including how we use land, make food and generate electricity. All of these physical tasks are "most efficiently done in a form with lots of emissions," he said. "The kind of activities that create GHG today are pervasive."

It would need much more than behavioural change. "You cannot drive the demand for those services down all that dramatically - and in developing countries you should allow demand to go up."

"This is a much harder problem than is often acknowledged," he said.

"We will rely on government to force the trade-offs – show us what we cannot do, in order to achieve climate goals."

Mr Gates describes himself as "a sort of one trick pony in terms of what I understand – innovation."

"I spent my life working on software and health innovations. I'm putting a lot of time into climate."

Mr Gates is writing a book to be published next year, "How to Avoid a Climate Disaster". He is also an investor in Carbon Engineering, a Canadian company developing direct air capture technology.

Green premium

A useful step could be to make it easier to focus attention on the "green premiums", the amount of extra money we would need to pay to have cement or steel made with no GHG emitted.

This would help focus people's efforts on gradually reducing the green premium, either to zero, or to such a small level that people would choose to do it the green way.

Currently, there is no commercial option available for someone to buy zero GHG cement or steel. Carbon capture and storage is not available as a commercial service. Mr Gates can only think of funding direct air capture of CO_2 as an offset, which costs $600 per tonne CO_2.

There may be some customers willing to pay the premium, even if it was very large, and this would support companies in innovating to find ways to get the premium to reduce. It would also encourage investment in further research.

Software vs green steel

Mr Gates said one intriguing lesson he had learned is that you can't apply a software business model to decarbonisation.

"With software you can always find a user who's dissatisfied. It doesn't take much capital to get [new software] out there" [and make new software for just this client].

"Silicon Valley has been a success. At this stage it's not very dependent on government funded research and development."

But for green steel, "There's not really a bootstrap. These plants [cost] many billions of dollars."

You're coming up with a product not differentiated. Green steel has no benefits beyond its green-ness. And who wants to be the first to put green steel in [their] building? Why should you take a risk it is slightly inferior in some way?"

Government

From government, a carbon tax would be very helpful, "if politically adoptable, if it can practically happen, at quite a high level," he said.

To have an impact today, it would need to be similar to the "green premiums" to make zero CO_2 products – so $100 to $200 a tonne.

"Sadly, the chances that we'll get that clear policy, I don't think is very [high]."

But there are other ways government can help. For example, government departments can purchase lower GHG products.

The European Recovery Fund (for COVID), of Eur 675bn, specifies that a third of the spending should "have some green characteristic," such as making green hydrogen. "It looks like some of that recovery money will go into some of the hard [GHG] stuff."

Bill Gates being interviewed by The Economist

Green finance

The problem with the green finance movement is that ultimately being green means spending more money than you would otherwise need to, he said.

Nobody wants to lose money in a direct numeric way. People who make green investments want to get the same returns as they would otherwise.

Likewise, people don't want to hear that their sovereign wealth fund could have had billions more money, but didn't because it invested it in companies which paid lower interest rates.

Some people choose green investing because they don't personally want to be associated with companies they consider to be bad.

But at the same time, they might consider whether people in India without good housing "deserve some cement and steel to have a house a fifth the size of an average US household," he said.

People say, "we're all enlightened, we'll take capital away from an oil company that [supplies fuel to enable] people to get to their job".

Company behaviour

In terms of company behaviour, we could expect companies which are big and profitable, such as certain tech companies, to "have a department that are thinking these things through," and providing capital to green purchases, "particularly at the start of buying green cement or steel," he said.

The standards for "being able to say you are green" will need to be raised. The demands made for what qualifies as a "green offset" will go up, he predicted.

In future, "companies will have to make a distinction between trying to look good and actually having impact," he said.

"Are they participating beyond the renewable credit thing? Are they starting to have an internal carbon price, taking money from that and putting it into activities which will make a difference?"

If companies take an internal carbon price of just $25, it "can get quite large relative to companies' profits," he said.

Reporting CO_2 data is good in general, but we shouldn't penalise companies who have high emissions. "A steel company or electricity utility is going to report a large number. That doesn't mean 'let's not finance them anymore', or nobody should work there. These services are very important. There's a reason we haven't made gasoline illegal."

China, India, sub-Sahara

China is "hyper-important" in climate discussions, as the biggest emitter, he said.

They have said they will get to zero by 2060. "That's not 2050, but it would be the greatest reduction in carbon emission per year greater than any country has ever achieved. A lot of it is steel and cement. In both categories they are the biggest user."

The Chinese government does not face the risk that it may be voted out of power if it pushes too hard on decarbonisation, he said. And the Chinese government has been very serious about its long term pledges in the past.

But it is important that the rest of the world monitors how well China is meeting its commitments.

"If you don't draw in China and India, you're not going to get close enough to zero to have any benefit. You lose unless you make it attractive to them."

India is a much tougher case than China, he said. Emissions per person are currently very low, and wealth levels are lower than China. It does not make sense to expect people in India to pay a premium for green products.

The bulk of CO_2 emissions are still coming from countries which are well off, and "the problem was created by better off countries."

"It is perverse if you say to an African country you shouldn't have 24 hour power. Sub-Sa-

haran Africa, without South Africa, is 2 per cent of global emissions".

The US

The US needs to be an "exemplar" in moving its own consumption, buying green products, "including in the hard categories".

And also, with "so much of the world's innovation power," the US should "take responsibility for helping reduce the green premiums for the entire globe."

"Leading by example is a necessary but not sufficient part of this movement," he said.

Getting there

"It is very tough to predict," if we will achieve our 2050 net zero targets, he said.

"Innovation surprises people, semiconductor chips magically work. If you said, pre-Marconi, you just jiggle something and someone across the ocean can get information [no-one would believe you]."

"We are missing some breakthrough ideas."

"When we wanted a breakthrough in World War 2 - we succeeded. Here we need more than one breakthrough innovation, we need five to ten, depending on how you do the taxonomy."

"Even [how do you] make an electricity system which will more than double in size, and how [do you] run that system in a reliable way."

We need an electricity storage miracle. "Even if lithium batteries are cheap they are not within a factor of 10 of what you'd need for that."

Or we could find a new continuous zero carbon electricity source, such as a new generation of nuclear reactors, or fusion, "which is still many decades away".

As an example of the unpredictability, consider that 20 years ago, everyone thought cars would be powered by hydrogen. "It turned out we didn't solve the tough problems," he said.

Engenious – how to be "fit for the future"

Speakers from BP, Oceaneering, Cognite and ABB shared their ideas on how the oil and gas industry can be "fit for the future" in the first plenary session of the Engenious event

"In BP we're undergoing probably the biggest transformation in our 112 year history," said Patricia Rangel, Chief Product Owner, BP Upstream, and a member of the digital leadership team.

"We recently announced a new strategy which will reshape our business, going from IOC to integrated energy company. Digital transformation is the key enabler of our new journey that we are starting now."

The company is planning to invest $1.5bn annually up to 2025 in digitalisation.

It now has a "global wells collaboration centre" fully operational, with experts able to access real time data. This "global collaboration centre" concept can now be expanded to other parts of the business.

BP has developed "digital twins" for its production systems in partnership with Palantir, which has delivered "hundreds of millions of dollars" in savings.

It developed a new application for work preparation and execution, particularly for work offshore, called "Skybox".

It is working with Cognite to develop an "Offset Well Analyser", to understand a well better by applying data from an adjacent well.

One of the biggest challenges is "access to capability" – the ability to attract people capable of building these digital solutions, she said.

"We rely heavily on partnerships, we've seen the benefit of those," she said. "Partnering will be key to transformation."

"The challenge is the vast amount of data we are not utilising."

One challenge is getting better at prioritising, seeing digital investments as business investments, and only invest in the opportunities which provide the highest value. "We're not short of ideas," she said.

Success can be measured in terms of benefit from optimising work, or driving carbon goals.

Three best practises the company has identified are the importance of evolving from working in silos to having an end to end value chain; focusing on integrated business transformation (including workflows and change management); and focussing on agile ways of working, including bringing people from multiple disciplines together.

"The amount of open source development we have in our industry is quite eye opening," she said. "Our geoscientist community in BP has been one of the most creative communities we have. I'd like to explore more of what we can do in the open source space."

"Recently we made a decision to accelerate investment on data ontology. We believe that's a significant data transformation opportunity in our digital journey. [But] we've learned that if we're not careful, we end up building the same data ontology multiple times."

Screenshot from "Fit for the Future" session at Engenious. Clockwise from top left: John Lervik, CEO, Cognite; Satyam Priyadarshy, Technology Fellow & Chief Data Scientist, Halliburton (moderator); Bernhard Eschermann, CTO Industrial Automation, ABB; Patricia Rangel, Chief Product Owner, BP Upstream; Ananya Roy, Co-Founder, Earthpeel; Roderick Larson, CEO, Oceaneering; Steven Calder, CEO, Streamba

Oceaneering

Roderick Larson, CEO of subsea equipment company Oceaneering, highlighted what he considers digital "blockers".

Oceaneering is best known for its subsea remote operated vehicles (ROVs), but it also does inspections, work on vessels, manufacturing, marine logistics and entertainment, and builds robots for factory floors and warehouses.

One blocker is, when the company is working offshore, there is a "chain of command of information." For data to go through the communications system between offshore and onshore, it might need to go through the customers' network, and it is also going through

Oceaneering's network, so multiple security systems. "The security infrastructure or protocols on systems not built for that can be challenging."

In one project, Oceaneering was positioning an offshore rig working from onshore. Someone raised a concern that if the communications link broke, perhaps due to cybersecurity controls, it would not be possible to send the instructions to move the rig, and so money would be wasted.

The decision was made to put the workers managing the positioning on the rig. But this meant incurring many more costs and risks. It might have been better to invest in a better cybersecurity infrastructure which would be reliable.

The root of some cybersecurity problems is a belief that all data should be treated as "essential / critical".

Another "blocker" is a drive for "modern and cool" – such as when people ask for something which looks like it does on Amazon. It would be more use focussing on something which delivers real value. "If the value is not there, I don't think we're going to have a lot of traction with people offshore," he said.

And also, if you focus only on something which feels "modern and cool", it will be replaced as soon as something which feels more modern comes along. "Like the Palm Pilot I have in a drawer somewhere".

A lot of information is gathered and archived which is never used. "Just because we can [store it] doesn't mean we should".

Another blocker is that when people try a bit too hard to achieve a "minimum viable product" when defining a new technology, and end up "polluting" the plan with "low value bells and whistles."

"It clouds the value you're trying to deliver and confuses the user," he said.

It is important to focus on "solving problems that need solving – where people haven't found a workaround," he said. These "will get the best traction in terms of moving forward".

"It is important that we focus on iterations. We want to get it out in the market and see what works."

It is important to understand why people are doing things the way they are currently doing them. "The history is really important," he said.

"As soon as you start to reach people and addressing their concerns you're going to have a better rollout."

When doing analytics / AI, often getting a clean set of data is the biggest part of the work, said Mr Larson. "It is larger than the cost of building the algorithms, setting up the hardware."

"It should be an ongoing process, otherwise you always have this daunting challenge of getting it clean enough to start the work."

Cognite

"Industrial digitalisation is the next big wave that the world needs to solve, both for environmental reasons and for economic reasons," said John Lervik, co-founder and CEO of Cognite.

Cognite describes its offering as "software as a service", with a focus on oil and gas, and asset intensive industries. It works with "large companies like BP, Exxon, Aramco, and a wide range of medium sized companies." Its service offering, expressed simply, is to help companies gather and integrate their data, so they can do more with it.

As an example, one customer had 300 wells and 30 platforms, and lacked an ability to get an overview of maintenance activities and the ability to communicate with workers. The onshore planners wanted a tool to get a quick overview of maintenance status for all of its wells, including related risks, and a means to schedule work order.

Cognite provided a maintenance planner application, so that maintenance work can be explored, planned and executed more efficiently.

The application can be used to plan work tasks, based on a number of different priority factors, including the risks which may arise if the work is done later. The work orders can then be bundled, and maintenance "campaigns" planned.

The schedules can be built using simple drag and drop charts, and visualised on a 3D model of the offshore platform. "Previously it was done in an Excel spreadsheet which is not effective or optimal," he said.

It takes data from many different sources including SAP.

The company has calculated that the solution helps reduce planned shutdowns by 30 per cent, which equates to a saving of up to $38m a year.

A similar system for production optimisation for a Middle East operator with "quite a complex oil field" was estimated to drive savings of $15m to $22m a year.

This operator needed to do complex calculations about gas lift and liquid capacity, which they were doing with a number of physics based simulators. "This was often manual and cumbersome," he said.

Cognite built a tool to combine the physics based simulators with data-driven analysis (what the company calls "physics based AI"), so it was possible to optimise multiple compressor and separator systems across the field. The annual value was estimated to be around $20m.

"This is a pattern we see across a lot of clients. We combine the best industrial expertise with modern AI based data science."

A problem which keeps emerging is the difficulty of integrating different software products and file formats together, which the company calls "application lock-ins".

It means that operators have to spend time converting data between different file formats.

"We should focus on providing data via open APIs, rather than live in a locked in world."

"We cannot have [software] companies locking operators into their whole [software] stacks," he said. "No company is able to build all the solutions themselves. We need interoperable architectures."

Another problem the oil and gas industry has, in Mr Lervik's opinion, is too much of a focus on 'one off' digital projects. "You may deliver something that works well but it will not be continuously delivered over time," he said.

"You may come up with one good use case for a piece of equipment, but to get good ROI we need to be able to scale them."

"Amazon, Microsoft and Google deliver software as a service, software which is continuously improved over time. This is something we need to adopt in the industry to be competitive. We can leverage all the great improvements coming from the software world."

Mr Lervik defines this approach as "product based not project based".

Software as a service potentially means that the bugs can be fixed, and new features added while you are asleep.

"We need to move from proof of concept to operationalisation. Put the use cases that work into production in a robust and scaleable manner so it can be used day to day."

Putting something into production involves embedding systems to maintain data quality, data reliability and fidelity, and security.

If you can develop an application for one asset, and then scale it to run on a number of assets quickly, you can get a clear return on your investment in the technology quite quickly.

It is important to focus on concrete and quantifiable value capture. For example, you may have targets such as increasing production, reducing the people in the field, or reducing emissions. But you are only achieving business results when you can see that you do actually have more production, less people, or less emissions.

When planning a project, you should start with a business case, and then work out what data sources you need to make available to achieve it, he said.

There may be more use cases which use the same data. "If you do it properly, you can incrementally build a data asset that is clean, contextualised and available."

ABB

A common problem with digital projects is people focussing too much on what they see, not what makes it work, said Bernhard Eschermann, CTO Industrial Automation with ABB. So they are focussing their effort in the wrong place.

An analogy is a homeowner focussing on the design of a water tap, rather than the water supply to the house and the plumbing system.

By creating open standards, it becomes possible to "productise" the digital plumbing. It means we can choose between different products which all interconnect. "That should result in a much simpler way to do this plumbing and really focus on getting the value add," he said.

ABB is looking at how it can provide "productised solutions" in this way, such as for cybersecurity.

Typically, the biggest value in a digital project comes from combining data from different sources together – such as combining sensor data with IT data (such as maintenance plans).

In order to create value out of that, you need to have an information model "that allows you to tie data together in a meaningful way", he said.

To make the work financially viable, you will typically need to develop "products" that can bring the data together, not do it as a custom project every time.

A challenge when bringing together information from different people, is that people in different domains typically have different terminologies and different ways to approach problems. "There's always the issue of avoiding misunderstandings and wrong expectations."

Another common problem is that people always want to wait for the next technology upgrade, which means they never start. "It is necessary to start today with what is available today, and learn while we are going."

There is enthusiasm around the idea of working in an agile way, but it is important to understand what that means. "It doesn't mean that [work] is without a clear plan and structure," he said.

It means that a problem needs to be subdivided into something which is tractable (manageable), "you don't try to boil the ocean." You have to find a problem which can be solved with meaningful effort.

You need people with the "credibility and stamina to drive success in spite of challenges," he said.

"Having the right mindset, of pulling together to achieve a common target, is one of the most important assets that you need."

This article is based on discussions at "Plenary 1: Fit for the future – Oil & gas learning from others in the Energy industry at the online Engenious event, organised by the Society of Petroleum Engineers, on Sept 22-24. Online sessions can be viewed by registered attendees only. The event website is **https://www.engeniousglobal.com/**

Engenious: Equinor, Aramco, Microsoft and Wood

Senior speakers from Equinor, Saudi Aramco, Microsoft and Wood presented digital transformation case studies and stories from their experiences, in a session at the Engenious event in September

Torbjørn Folgerø, SVP & Chief Digital Officer, Equinor, said that the company decided to accelerate its investment in digital in 2017.

It identified that value could be created in four areas - safety and risk assessment, reducing operating costs, increasing recovery from fields, and reducing greenhouse gas emissions. It built a companywide road map.

But using data to drive better decisions in the real world can be harder than you expect, he said.

The efforts by policy makers to make the right decisions about Covid-19 is an illustration of this, he said. We have all seen plenty of statistics about mortality rate, demographics, tests and infections, and how hard it is to use this to make the right data driven decisions.

We have seen how much it matters which data is not collected, such as of people who get infected but do not take tests.

It is also difficult making predictions when you don't understand the underlying problem, as we have seen with Covid, where there is little understanding about how the virus actually spreads.

"Data driven techniques struggle in completely new situations," he said. "Human judgement matters."

When it comes to AI, Equinor sees it as about "finding the sweet spot between getting the best out of our people in combination with the best from our machines."

"We are seeing the role of AI is constantly evolving - we are learning in parallel," he said.

Equinor has three principles for how to build systems involving AI and data driven decision making.

First, there must be high quality data available (preferably through Equinor's cloud platform).

Second, the people involved must have necessary competence – including to understand the technology, its potential and challenges.

Third, there should be clarity on where and how the AI should be applied.

When it comes to AI, "If you think it is a silver bullet you're going to fail," he said. "You need a solid understanding of what you want to solve. Is it production optimisation, is it better trading?"

"AI requires an extensive set of quality data. A good place to start is when you have that data set available."

"We believe that in the next few years, AI is going to enhance humans not replace us. AI can deliver some low hanging fruits. Maybe don't start at the most complex first."

For example, "if we can have predictive maintenance guiding our engineers but they are still taking decision I think that's a good approach to take."

For data, the company historically had about 3,000 different data systems. It set up its own cloud data platform, called Omnia, with the ambition that all of its data should be moved there. Having the data in a centralised location "opens up many opportunities to present and analyse the data in easier ways," he said.

It is important to define "clear governance and data management principles," so data is treated as a strategic asset. "Our ambition is to make data available for anyone in Equinor - anytime, anywhere, for us and external partners".

In terms of competence, "we need to build basic digital competence, and also advanced knowledge in how [technology] can work together with us to do our jobs faster and safer," he said.

"Everyone must get a chance to get on a digital learning journey, be curious and understand the technologies".

The company has a digital academy, also covering data science and data engineering, which has done 50,000 "training activities" so far. It wanted to be able to train its own staff to implement and use digital tools, rather than buying in capability from outside.

Safety

In safety, the company is trying to combine its operational competence with data science.

"We have thousands of safety reports in our databases. If the right information doesn't get to the right person at the right time, accidents may happen. "We are developing ways to make sure our information reaches people

who really need it."

One of the company's data scientists is writing a doctoral thesis about how Norwegian language is structured, which should help build systems for computers to analyse written safety reports.

The company has built a way to integrate all text-based reports written since 2008 in one system.

The idea is that the system could automatically present someone with a report telling them that last time someone in the company did something similar, something went wrong.

"Humans can do the nuancing of the importance of that information and context."

This system is part of a larger operation and planning tool, which is used for all operations in Norway.

Applying data analytics

Equinor believes that its digital solutions so far have delivered a $400m impact on its cashflows. This is mainly due to getting a one month earlier start-up for its giant Johan Sverdrup field, getting faster production ramp-up, and from getting increased uptime on its assets, all attributed to better use of digital technology.

It has an integrated operations centre in Bergen, receiving operational data from over 25 assets.

Through analysis of this data, "our models are starting to predict turbine breakdown, which can be used to take measures to avoid damage and associated shutdown."

"Reducing maintenance cost is one of the largest factors to reducing our operating cost," he said.

Workers can access operational data onto their tablet computers, downloading apps from a company internal app store.

The company also applies data analytics in the subsurface, combining drilling data with subsurface data. "We are working with AI to find opportunities faster."

"Our ambition is to be the energy company that scales the fastest and dares to radically change the way we work."

Data sharing

Mr Folgerø thinks we are still in early days with data sharing. "You have to work on how you are going to share data then talk about what data you are going to share. I think the 'how' is not yet solved."

The Open Subsurface Data Universe project should solve some of this. But it is only making standards, you still need to have a data architecture to work with it.

Equinor is sharing more and more data with suppliers. "Equipment suppliers need to access the operators' data. It is happening, we need to make it happen faster."

It has a website data.equinor.com, where it releases oil production, subsurface data, and carbon capture data from the Sleipner field. But "these data sets are more to drive innovation from academia," he said. "We hope in the end that triggers some solution we can get back to Equinor and others."

Saudi Aramco

Saudi Aramco's digitalisation journey has an objective to increase hydrocarbon discovery and recovery, reduce development cost, enhance safety and protect the environment, said Sami Alnuaim, Chairperson, Executive Advisory Committee with Saudi Aramco, and 2019 president of the Society of Petroleum Engineers.

It has "fully digitised" its drilling processes, from well planning and design, to drilling operations, monitoring and completion, including methods to improve drilling efficiency, resolve problems and improve safety.

The company can improve its geological models in real time while drilling. "This enables us to place thousands of horizontal sections within less than a few feet in the reservoir."

"This enabled us to reduce the number of required wells, and reduce development cost and the environmental footprint of our developed oil and gas fields."

The most important success factor is "basically strategizing" he said, aligning the digital strategy with the corporate goals, whether that is increasing recovery, reducing cost, improving discovery or reducing environmental impact.

A second factor is "visionary leadership – people who can see the future".

An example of that is the people who agreed the budget for digital oilfield technology 20 years ago, installing devices on wells. The company is seeing benefit from that still today.

A third factor is to have "skilled talented people who believe in your strategy," he said.

Microsoft

Uwa Airhiavbere, director of Microsoft's Worldwide Oil and Gas sector, explained how oil services company Petrofac exemplifies an "operate for the future" story.

Petrofac had a vision of a "holistic data platform", with integrated data about all the phases of operations – design, build, operate and maintenance. It would also include data from all systems and IOT devices.

Petrofac used Microsoft's Azure cloud services to build a "hub platform" for this.

Microsoft has worked with Petrofac on a "Connected Construction" project, monitoring people, equipment and materials around the construction site.

Oil major Repsol, he said, has an illustration of a "transform your workforce" story, as it conducts over 150 digital initiatives, "with the intent of driving a culture of transparency, efficiency and safety."

Repsol wanted more transparent communications between and within its teams, breaking "communication silos". The fact that it had a number of different devices and communications platforms in use made it harder.

Now, it only uses Microsoft Teams for this.

There is a dedicated area on its Microsoft Teams platform for communications associated with shift handovers, so people don't need to look for handover notes, he said.

BP exemplifies the "Reimagine Energy", Mr Airhiavbere said. It is finding ways to reduce energy demand, minimise environmental impact, improve sustainability, water and waste management. Microsoft has a strategic partnership with BP to "drive "digital energy innovation and advance net zero goals".

Looking globally, before COVID, about 45 per cent of CIOs and Chief Digital Officers (CDOs) were considering digital transformation, but now it is 89 per cent, he said. "There's a broad understanding and desire to move in this direction. It's very clear why."

Microsoft saw a big ramp-up in demand for its various online services, including Microsoft Teams, Azure's Virtual Private Network, Microsoft Learning and LinkedIn.

Wood

Rob Kennedy, digital technology program manager at Wood, talked about how the company is deploying digital twin technology.

"We see a digital twin as a group of connected systems that provide a virtual representation of a physical asset or system or process right through the lifecycle," he said.

"It should provide the user with the past history, current state and predictions of the future state of the asset, and may also enable users to investigate what if scenarios. All of this should happen in a single unified interface."

Sales of digital twin software have "annual growth rates of just under 40 per cent", he said, with the vast majority in "energy and built environment".

On many assets, CAPEX is only 20 per cent of the total lifetime expenditure, with the rest being spent on operations and maintenance.

So reducing the costs of operations and maintenance can be a "significant opportunity".

There can be an opportunity to better adapt digital twins (developed during the CAPEX phase) to operational use cases.

Digital twins are created differently for new builds and brownfield assets, and also if you want to optimise a brownfield asset, he said.

Screenshot from the "Digital Transformation Case Studies" session at Engenious. Right hand column from top: Uwa Arihiavbere, Director, Microsoft; Rob Kennedy, Digital Twin Programme Manager, Wood; Torbjørn F. Folgerø, Chief Digital Officer, Equinor. Bottom left: Sami Alnuaim, Representative, Saudi Aramco. Bottom middle: Stephen Ashley Digital Transformation Solution Centre Manager, The Oil & Gas Technology Centre (moderator)

For new builds, the focus is on gathering and managing information and setting up a system which will support efficient operations and the capability to optimise.

For brown field assets, you additionally need to create a digitised version of the existing asset. Its plans might be only on paper documents and drawings. You might add new sensors to the asset, which provide data you can use to optimise it.

If the project is to optimise a brownfield asset, the focus will be on integrating and contextualising data which already exists but is probably in different systems.

The work to make a digital twin for a new build can start early, including before the detailed design work for the asset is started. But if you are optimising an asset which is already operating, making the digital twin needs more of an agile approach, making something and gradually improving it.

Mr Kennedy gave 3 examples of digital twin projects completed by Wood.

The first is a newbuild chemicals facility in Europe, where Wood was engaged at a pre-FEED stage to design and implement an "industrial digital strategy" for the asset. It is also integrating data and systems from design through to build and operations.

The second example is a brownfield energy complex in the Middle East, undergoing significant modification. Wood conducted 14,000 laser scans, on 28 different facilities, and also digitalised over 20,000 documents and drawings. It used AI techniques to read and contextualise the tags, which reduced man hours to digitise the documents by 90 per cent.

Having a picture of the existing facilities meant a 90 per cent saving in budgeted rework, he said.

A third example is an existing oil and gas facility in the North Sea, which the operator wanted to optimise, reducing the number of personnel needing to be sent offshore.

It wanted to try to do more planning work onshore, such as risk assessment, isolation planning, issuing permits to work. Also reducing the amount of work which needed to be done using "smart" maintenance techniques.

The work was forecast to save $20m over 3 years, or reduce the number of personnel offshore by 10 per cent.

An example of how digital twins might be used is the planning and preparation activities for offshore work. A 3D model of the facility could be used, for example, to work out where temporary equipment can be located.

Offshore staff "can get to the worksite and start delivering high value work without losing a lot of time to paper work and administration," he said.

On the subject of AI, Mr Kennedy said, "I think AI is at its most useful when it is enhancing the human's job. We're not at the point where we can have AI replacing a domain expert. I think that's key. We're not in a position where we can feed data into a machine and et a sensible answer. Nor, I would argue, should we be, at this point."

"We still need the domain experts to fundamentally understand the problem that we're looking at. AI becomes useful to automate some of the steps that the domain experts will go through when looking at a problem or optimising something.

For example in predictive maintenance, "you use an AI model to do maybe 80 per cent of the heavy lifting for you. In some cases it can tell the human the particular problems they don't need to look at, rather than flag the specific pieces of machinery that are going to fail."

"This concept of explainable AI is incredibly important. We need to interrogate the answers the machine is giving us."

This article is based on discussions at "Session 1: Digital transformation case studies" at the online Engenious event, organised by the Society of Petroleum Engineers, on Sept 22-24. Online sessions can be viewed by registered attendees only. The event website is **https://www.engeniousglobal.com/**

Engenious – AI applications in inventory and drilling

Optimising inventory for an oilfield supplier and optimising well positioning while drilling – two very different applications of AI were discussed in an Engenious session on AI applications

Baker Hughes embarked on an AI project to optimise inventory, in partnership with AI company C3, said Scott Fedor, digital transformation leader for enterprise excellence with Baker Hughes. The project began in summer 2019.

Baker Hughes operates in over 100 countries, with 30 different ERP systems, 1 million part numbers, and 4 bn dollars of inventory. "The ability for us to maintain or improve customer service, while minimising that inventory, is critical to our overall success," he said.

Optimising inventory involves making re-orders at the right time and quantity, taking into account the need to keep a "safety stock" in reserve, and take delivery times into account, so that nearly all the time, you have whatever you might need available in stock.

Safety stock levels are normally calculated using a basic equation which has not changed much since the 1950s, he said. It takes into consideration the time between making a new order and the delivery (supply lead time), the variation in the demand in the past, the desired customer service level and any minimum order size requirement. This is taught in supply chain and operations management courses.

You can then calculate the optimum re-ordering date. Like (probably) the milk in your family fridge, the level of inventory

follows a sawtooth pattern.

Mathematically this can be described as a "highly deterministic approach using static data." The method is embedded in ERP systems.

Also (perhaps like milk in your family fridge), sometimes you over forecast demand, sometimes you under forecast, sometimes you might get it right. Statistically, you would describe this as deviation from the mean (average) demand levels. Over time you will build up a picture of what drives the demand.

Baker Hughes wanted to explore how AI might be used to make better decisions about safety stock levels.

The project involved analysing historical data to calculate the level of uncertainty, and calculating a "uncertainty distribution". Uncertainty is not just in the demand levels. There is also uncertainty in your supplies, whether you get the amount you ordered at the expected time. Supply uncertainty can be calculated for each supplier, and each combination of plants and product.

Then, the project team ran multiple simulations to find the safety stock level which allows you to satisfy a customer service target for the most time, at the lowest cost.

It can simulate how safety stock levels should change after purchase order cancellations, order pull-ins (when something is needed earlier), late deliveries from suppliers.

There are other issues you may want to include in the model, such as a plant making parts out of steel which is itself dependent on a supply of scrap metal, which has uncertainty. "If we can measure it, we can include it," he said.

The project team used two years of historical data, including daily inventory levels, work order receipts, customer complaints. Two thirds of the data was used for training, and a third for testing. It will typically run about 500 simulations.

The developed model could be considered a "digital twin for Material Requirements Planning".

Once the optimum solution is developed, it can be run through the whole testing period, and provided to the customer with full explanations.

"Explainabilty is critical for success when it comes to AI," he said. "Like I'm sure most of your companies, Baker Hughes has a group of highly skilled supply chain experts working at our plants. Many of these people know their inventory items like the back of their hands. It is important that when we give them a set of recommendations, it doesn't feel like it comes from a black box."

Screenshot from the Engenious panel "AI Applications". Clockwise from top left: Jurgen Weichenburger, Global AI Lead, Accenture; Patrick Bangert, VP of Artifical Intelligence, Samsung SDS America (moderator); Scott Fedor, Digital Transformation Leader, Baker Hughes; Behzad Alaei, Geophysicist - Founding Partner, Earth Science Analytics; Hugh Winkler CEO, Factor Technology

"In order to make this easier we've developed a series of charts and data elements, as well as a customised user interface. It helps them understand the uncertainties which drove the safety stock up or down."

"In the end, the inventory planner remains responsible for inventory, they will be blamed if we stock out on a critical item and get credit for inventory savings. So they can accept, or refuse recommendations. It is possible they know things which the models don't."

"It is hard for people to not say they need inventory to protect themselves from customer variations or supply variations."

"Finance might like it, generally speaking the supply chain team does not. We're trying to find ways to build [their concerns] that into the process itself."

The project team has spent a lot of time travelling to visit inventory managers around the world. "We believe time we spend on change management will be well rewarded. As exciting as the technology may be - don't forget to bring the users along with you."

For any project, you will often find you get a small group of domain experts who take an in-depth interest in the AI itself, getting involved in the development of the system, the model and its outputs, he said. "But at the end of the day, that narrow group isn't the group that has to adopt and use the application or output."

The data can be used to drive continuous improvement, for example if they see that the uncertainty in supplier response time is driving a need for higher safety stock levels, they know they should be focussing on that.

"We've built an interface where any rejection requires justification or codes which allows us to continuously improve the model."

The target is a 10 per cent reduction in inventory, of which 6 per cent is achieved from optimisation itself, and 4 per cent achieved from finding process improvement opportunities.

The project started with 5 plants with 300,000 different items, and is being scaled up to be used in 15 plants with 3m items.

Geologic well positioning

Hugh Winkler of Factor Technology talked about how Bayesian networks (based on probability) can be used when drilling wells, to make sure the well is positioned in the right place.

The technique of steering a well through the target zone is known as geosteering, and it is both a science and art, he explained.

You start off with a geologic model. You also have seismic data of the region and well logs from neighbouring wells. Then you have gamma ray or other logs gathered from "logging while drilling" devices above the drillbit, and directional surveys which tell you the direction you are drilling in.

The traditional way of doing geosteering is for a geologist to manually load directional surveys and logging data into desktop software, see if the geologic model needs to be updated, and if necessary issue new instructions to the driller.

The basic process is to compare the recorded LWD (logging while drilling) with what you would expect the curve to look like, based on your geological model, and logs from neighbouring wells. The closer the match, the higher the probability that your model is correct.

This was possible where surveys are taken every few hours, and a geologist only needs to supervise 4 drilling rigs at once.

Now, in North America shale operations, the drilling pace is 350 to 400 feet per hour, and the time between surveys can be as little

as 20 minutes, which is not enough time for a human interpretation, Mr Winkler said.

"Geosteering is a really hard problem. Any geologist can contrive several geologic structures that fit the data - so we have non unique answers."

Geologists can't consider all of the possible options if they are reviewing data manually – they need to prune the options to a limited set of realistic answers.

A further complication is that new data generated in the well might indicate your entire geological model needs to be changed, and then the well placed somewhere different.

"You can be drilling along and believe you are in the lower bench, you get some new data at the toe of the well that indicates you've been in the upper bench all along. You've got to go back and re-compute your geologic interpretation in a global sense."

Probabilities

The AI method Mr Winkler has developed is about using probabilities (Bayesian networks) to try to establish the most probable structure of the subsurface – the dips and faults - based on the continually evolving information.

Rather than just compare the LWD data with the expected log, it can generate millions of subsurface models, or hypothesis, see what the log would look like if the subsurface actually was the same of the model, and see how the LWD compares to this.

The software can produce a visualisation of whether you have a broad number of possibilities or a narrow number, shown as a "river of flame" type display. In some places the river channel is narrow and then you can have high confidence our "answer" there is accurate. Other places the channel may be broad, meaning you should have lower confidence that the answer is precise there. And still other times, multiple channels appear, showing you that you might need to consider these alternate interpretations.

If the river is narrow, you can probably accept the software's calculation of the most likely structure, but if the river is wider, it makes sense to bring in a human geologist to try to come up with the best interpretation. This means there is a "manage by exception" workflow.

Factor Drive is able to take into consideration noise in the readings - because it can account for it as part of the probability calculation. You "declare" a noise distribution (range of noise which you expect). Any spikes outside the expected distribution can be automatically removed.

This calculation can also work out the probability that there is an error in the measurement of the position of the drill bit within the subsurface. If you can see the LWD data would give a much better match with the expected data if the position was adjusted a certain amount.

The outcome is that the system, perhaps supported by a geologist, can show whether the model needs to be updated, and whether new instructions need to be issued to the driller, to 'steer' the drill bit.

The results of this automated system prove similar to the results from having a geologist doing the comparisons manually, but require less of a geologist's time.

Drillers do not want multiple options with different probabilities, they just want to know where to put the drill bit, so the instruction they are given is based on the hypothesis of the subsurface which is calculated to be most probable.

But in future, the advice issued to directional drillers could take the probability of the drill path being better, and by how much, and balance this against the cost of adding more tortuosity (simplified definition – bendiness) in the well.

"It could compute how to make the best bet, that would give you the highest pay off with least amount of risk," he said.

Accenture

Oil and gas consultancy Accenture has a concept of "intelligent asset management", using digitalisation to work out the most effective way to operate an asset.

It is based on four "master topics" of yield, throughput, energy use and quality, said Jurgen Weichenburger, global lead data scientist for oil and gas with Accenture. There are underlying topics, like reliability, production planning and maintenance, which drive these master topics.

Companies need to make decisions about which plants to take offline (which might mean it would take months to bring them back online), or "hibernate" them where you can bring them back quickly if you want to.

There are questions about when the economic recovery might happen, when it becomes feasible to make a profit margin again. It all means that operations need to be "superagile", he said. "The normal first principle based models are no longer as efficient."

Some industries have mastered this much more than oil and gas. For example baby food is "one of the most complex products to generate", with very high regulatory standards.

"If you could transport what [baby food manufacturers] have achieved into a chemical plant, you would see a natural uptake in yield and quality, that massively helps you."

Oil and gas companies can work together with engineering data scientists, people who are "engineers by trade" but "also love data and know how to turn it into insights and value."

"It has to be multifunctional and multiskilled. You don't want five petroleum engineers. If you bring together a combination of mechanical engineers, material scientists, chemical engineers, that blows it out of the window."

Mr Weichenburger gave an example from the mining sector, where one of its clients asked Accenture if they could find better ways to detect geohazards in the formation, which can cause a cave to collapse and shut down production, and may cause injury.

"Combining disciplines allows you to predict where these geohazards are," he said.

As a result of the work, the client achieved $200m increased production for the same cost.

A second example is a client who wanted to run a remote oilfield in North America in the most efficient way, with high production efficiency while reducing cost.

The solution developed was a remote operating centre, with a group of people who manage the field and take proactive decisions. "They achieved $60m in additional revenue and saving in the first year of operation," he said.

"Intelligent asset management is all about bringing it together, transforming the operation from reactive to proactive."

Accenture aims to work directly with raw data, without any pre-cleaning steps, he said. "We need simple APIs to consume data from the source systems. The major cloud platform providers give you all that. Data from historians, control systems, I can get that in 20 minutes."

"Then I can tell the data science team, that's the problem let's get to work."

When scaling up a pilot project to run across the company, one of the most important factors is mindset. Many people develop pilots with a mindset of exploring whether or not something is possible. But it takes a different mindset to work out how to scale it across the whole company, he said.

This article is based on presentations and discussions at "Session 3: AI applications" at the online Engenious event, organised by the Society of Petroleum Engineers, on Sept 22-24. Online sessions can be viewed by registered attendees only. The event website is https://www.engeniousglobal.com/

Engenious: changing the way we work

Speakers from Shell, Step Change Global and Petrofac shared their perspectives on how the industry is changing how it works, in a session "Changing How we Work" at Engenious

Hani Elshahawi, Digitalisation lead - Deepwater Technologies with Shell, explained how machine vision is becoming part of how people at Shell work, being used to monitor equipment and assets.

It is only useful if it can tell people what action to take, such as by giving alerts, making predictions or advising on interventions. "Data is a raw material for producing that end result," he said.

The data being sensed can be quite diverse, including time based data, and data related to reliability, safety, integrity and optimisation.

The image processing technology is a critical component of working with machine vision.

A simple example was to use machine vision to digitise the output of a switch, which is usually shown on an analogue gauge, and read manually. A camera is pointed at the gauge and its image interpreted using machine vision.

Another example was using a high resolution camera for monitoring vibration on rotating equipment. Machine vision with image processing can be used to detect slicks.

You can analyse video of equipment captured from a drone or underwater autonomous vehicle, for example to do inspections of enclosed spaces, and count inventory in a yard, such as of piping and casing.

Machine vision can be used for asset integrity monitoring, with a fixed camera or drone capturing imagery to look at the status of equipment, such as checking for deformation or moving parts. "This allows us to get ahead of catastrophic failures and perform proactive maintenance."

Shell did a project with subsea video data collected over 3 years, gathering 1300 hours of video. The video analytics could detect 15 different classes of subsea anomaly.

Another application is doing video analytics of petrol retail sites for safety and security purposes, or monitoring workforce performance.

When it comes to what makes a project successful, many of the mantras such as "fail fast" have been repeated so much they become cliches, he said.

Something worth adding is that "it is really important for the leadership in organisations to not just sponsor but they have to own the digital agenda. Sponsorship is not sufficient," he said.

And don't think that all that is needed is to create tools or apps. "You need to transform the entire workflow. We need to think in terms of workflows," he said.

"Don't [try to] execute in one big bang. [Like the joke] how do you eat an elephant – one bite at a time. [But] you need to make those bite chunks substantial enough."

Tony Edwards, Step Change Global

Tony Edwards, CEO of consultancy Step Change Global, talked about his experiences designing integrated operations centres / collaborative work environments for oil and gas and mining companies.

These centres are needed if you want to reduce the staffing levels at operational sites. The company has designed such centres in Pennsylvania to manage shale gas operations, and for the Escondida mine in Chile, the highest producing copper mine in the world.

There are different operating models. One is when you have staff onsite but supported by remote engineering experts. "This is now the normal operating model for both brownfield and greenfield, onshore and offshore," he said.

The second level is where you build in the capability for full remote control, but don't necessarily use it all the time. "This is increasingly considered for new greenfield operations and some brownfield operations."

A third level is where you keep the asset minimally manned or unmanned, with all operations happening remotely. "It is possible to unman increasingly complex facilities," he said.

Another model is where you have a regional or global support centre for all of a company's activities, particularly for subject matter experts, such as in rotating equipment or drilling.

When building a facility where you expect to do remote operations, it is important to start planning for remote operations earlier, he said.

A typical oil and gas operations centre might have one room supporting production optimisation, one room for engineering support and planning, and a room for managing events.

In a traditional model, one operator would look after 20 wells, but with a set-up like this, you can have one operator looking after 120 wells.

The Martin Linge platform in the Norwegian sector of the North Sea, designed by Total and since acquired by Equinor, is entirely remotely controlled from the shore, with power generation form the shore. There are normally 17 people on the asset, but only doing maintenance, not managing the operations.

Offshore gas operations can be designed to be fully unmanned today. Oil assets will typically have a minimum manning of between 0 and 20 people, he said. It can mean OPEX reduced by 50-80 per cent and CAPEX reduced by 25-40 per cent, because the platform itself does not need so much infrastructure with less people living on it.

In rolling out remote operations systems, every company and asset is different. There can be a disadvantage to companies which have a diverse portfolio of assets, such as a mixture of offshore and onshore, and different types of reservoirs.

Conversely, companies which seem to find remote operations easier are often companies with more homogeneity, such as only having North Sea offshore platforms in their portfolio, lower asset diversity and cultural diversity.

Some companies have organised their remote operations centres around asset types rather than regions, because they see that there is more in common with (for example) two iron mines in different parts of the world, than two mines in the same country mining a different commodity.

The main reasons for failure of projects arise out of the way companies are organised to extract value from the technologies, he said.

The companies which did well in the first wave (from about 2012) did not see them as technology or IT projects, but as organisational transformations.

"The ones who fully embedded it couldn't go back."

But many never actually reached that point. You'd see the charismatic leader, who'd led it, would move onto better things. Before

Screenshot from the "Changing How we Work" session at Engenious. Clockwise from top left: Jon Carpenter, Group Head of Strategy, Petrofac; Tony Edwards, CEO, Step Change Global; Fiona McKie, Senior Vice President Digital and Technology Operations, Wood; Hani Elshahawi, Digitalisation lead - Deepwater Technologies, Shell; Susan Nash, Director of Innovation and Emerging Science and Technology, AAPG (moderator)

you knew where you were, you had a bunch of technology in a shiny room with a bunch of data, no-one really knew what they were doing. We really see that an awful lot."

Although now, companies see that doing digital transformation is a matter of organisational survival, he said.

History shows that people will typically only engage in digital projects if they see there is no other way to do what they want to do. Just promising an asset manager enormous financial benefits may not be enough to persuade them to change, he said.

An example of this is when a Western oil major was struggling to get a project running in a part of Africa which staff did not want to relocate to, and the local workforce were inexperienced. The project could only be done with remote support.

Another example is Australian companies embrace of remote operations between 2012 and 2016, when there was a big shortage of competent engineers and many big LNG projects in development. By building integrated operations centres, one engineer could supervise a larger number of projects and work from a comfortable city office rather than a remote site.

Petrofac

Oil services company Petrofac is developing digital applications which can be used to reduce cost, downtime and emissions, said Jon Carpenter, group Head of Strategy.

Petrofac has 11,500 employees, and its main services are designing, building, managing and maintaining oil and gas infrastructure.

The company set itself a goal of using digitalisation to increase uptime on assets, reducing the costs of projects by 50 per cent, and reducing the emissions from assets by 50 per cent.

It developed an application called "Petrofac Go", to support improved communication with workers. They can choose jobs based on their experience and skills. The software tells them which hotel to check into, and which heliport to go to. It orders their PPE, and manages their expenses and time cards.

There is a method for the company administration staff to get messages to workers, and see who has read and accepted their messages.

"This has been critical in maintaining our operations throughout COVID," he says. It has also enabled the company to operate with a smaller administration team.

The company also developed an application "Petrolytics" for maintenance analytics. It aims to gather data from sensors and control systems on the asset, and analyse the data, so it can be used to make better decisions.

This includes looking for anomalies in the data, or where data goes outside a safe range, or where signs emerge which link to previous failures. It can show the energy usage and emissions of different assets, making it easier to understand what is driving the emissions.

It also uses automated workflow tools, which can give instructions to workers on mobile devices, enabling them to take photos of what they are inspecting, contact remote experts, and collate data for reports.

The company has seen 100 to 200 per cent increases of productivity, and 40-50 per cent cost reductions, from using some of these tools.

"Having strong sponsorship and support from senior management is pretty critical to ensuring that you get the benefit, time and patience to try this out and prove the value," he said.

Having "big overarching goals" – a "North Star to head towards" is a useful driving mechanism.

It is also helpful to closely work with people who will be using the tools, when developing them. "We did a lot of workshopping with guys who do the jobs, the inspections, the project delivery, to understand their pain points and what technologies can be used."

"As a result we've seen a fantastic adoption rate and engagement. They've been a big source of ideas and opportunities. They are very big champions for a lot of work."

To test out how well the workforce would adapt to the tools, it picked an asset thought to have a workforce with the highest resistance to change, to try out a new system using headset devices with cameras to try out.

During the trial, a gas compressor failed, and the headset devices could record video to send to shore based experts, so they could identify the problem.

"The guys offshore didn't want to send it back," he said. "They got into walking around with headsets on, taking photos and videos, it becomes a really good experience."

The company wanted to do a before and after comparison, which meant asking people to go back to working without the headsets. "They said, 'we've done twice as much work with the new tool there's no point in going back, we just refuse.'"

"If the solutions you're creating are intuitive, demonstrate value to people on the ground, you've got something you can roll out."

"The path isn't always a linear one to get to the value you are looking for, you need to be fairly agile in development," he said.

"Once you've got greater assurance, efficiency, you can move to outcome based work [payment based on results]. It gives better assurance to the operator."

This article is based on discussions at "Session 2: Changing how we work - digital transformation in practice" at the online Engenious event, organised by the Society of Petroleum Engineers, on Sept 22-24. Online sessions can be viewed by registered attendees only. The event website is **https://www.engeniousglobal.com/**

Engenious: remote working and self-service digitalisation

A discussion at Engenious called "Borderless Workspaces" included Gartner's perspectives on how the industry is moving to remote working; and a Wintershall digital leader on creating self-service digital environments

Just a few years ago (2014), the mainstream oil and gas industry saw digital technology as "just a curiosity", and no oil and gas company had a formal digital strategy," said Rich McAvey, Gartner's Research Vice President for the oil and gas industry.

"There were a lot of learnings during the 2016 and 2017 downturn. By 2018 and 2019, 90 per cent of the industry had some sort of formal digital strategy, and digital had risen to be the third priority in oil and gas, just behind making money and operational excellence.

A main area of digital investment is improving operational transparency – better ways to gather information, organise / consolidate it into important business metrics, then displaying it through dashboards, he said. Related to the drive for operational transparency is investment in remote operations and remote collaboration centres.

There has also been significant investment in technologies to improve human productivity, in particular "all sorts of new devices that people wore or carried with them", and connectivity for those.

These investments made a foundation for enabling what we call today "distributed workplaces" – people doing work in different places.

Most digital strategies also included investment in analytics and AI. "There were lots of different use cases".

So, we can say that the industry started 2020 with a robust program of investment in mind. But then it all got derailed by Covid 19. Companies started moving workforces into "pandemic safe environments", there was a destruction of oil demand beyond any historical precedent.

Today, the weak cashflows in many companies "has brought to a halt most of the programs that we just described." That hasn't happened in every company, but "that's the typical state within the industry."

Oil and gas companies are proud about how quickly they managed to move to home working – a Gartner survey showed in most companies, 10 per cent or less of their work was being done from home before Covid, but by April 2020, the majority of firms were doing 90 per cent or more work from home.

A survey of 5,000 employees found that there is something of an experiment going on in finding the right balance between home and office working over the longer term.

There are also changes in how work is done. Meetings, where work is shared with everyone at once, are being replaced by "asynchronous workflows", with work passed from person to person. Some companies have been surprised to find out that this can be more productive than having meetings.

There are experiments in when work is done. Some people find it helpful to do work at different times, and been more productive as a result.

Some companies have started to change how people are managed, for example focussing more on outcomes rather than the hours in the office, or giving people more flexibility over where they work over the long term.

Reported negatives from working from home included people having difficulty switching off from work outside working hours, including from fear of unemployment driving people to do extra effort, which was easier to do at home. Some people felt there was less collaboration and communication, and a sense of loneliness and exclusion from team decisions. Many people had other distractions at home.

Companies may have to change their "operations strategy", with changes in governance, leadership style, the way managers operate, and HR policies. "There's a bit of work to operationalise new forms of work," he said.

There's also a significant amount of work needed on talent management – choosing who you hire, working out how to "onboard" them and reward them.

Gartner did a survey to ask why the oil and gas culture can make implementing new digital technologies harder. The top response was that people are very risk averse in a dangerous industry, he said. "If the ATM machine gives out Eur 20 more than it should, the bank isn't going to fold. But an operational failure in oil and gas can be disastrous."

Another factor is that "this is an industry led by strong leaders in silos. They all have different ideas of what the right thing to do is."

The industry is very reliant on its experts, but conversely the experts enjoy this reliance and are not very enthusiastic about the idea that they might be replaced by digital technology, such as a planner being re-

Screenshot from "Borderless Workspaces" session at Engenious. Clockwise from top left: Rich McAvey, Gartner's Research Vice President for the oil and gas industry; Tony Edwards, CEO Step Change Global (moderator); Susan Peterson-Strum, SVP Digital Transformation, Wintershall DEA; Alexander Tharaldsen, Product Manager GeoCloud, Cegal

placed by an automated scheduler.

Digital maturity and profitability

Mr McAvey was asked if he saw any relationship between a company's "digital maturity" and its profitability.

He said it was a hard question to answer, given the diversity of companies. What counts as 'digital maturity' for a small onshore operator and for an oil major is very different.

A basic level of digital maturity could be defined as where people have the data and tools they need to do their jobs. "That's the part of work that's added most to the bottom line in the last couple of years."

The next level is when companies develop comprehensive strategies, working out their opportunities to use digital technologies to get a big impact, and how to get there, following "swim lanes", perhaps involving a consultancy. "That's what everybody was getting ready to do in January [2020]. Money was starting to flow into those."

"To be good at that, it is different. You create an organisational structure of your own around each of those swim lanes. You want to put your best talent into each of those programs."

A yet higher level of maturity is where "we're talking about shifting from a silo based company to one with an enterprise platform," he said. "That's where you get reliability and efficiency. That's a model which is well proven in other industries. But it takes a lot of money to do that, hundreds of millions of dollars sometimes."

Mr McAvey said that companies sometimes over-emphasise stability over experimenting.

They could be using software algorithms to reliably predict the performance of different assets, which could be anything from one pipeline to a whole plant, based on sensor data. "There's huge opportunity," he said.

Offshore platforms can have thousands of sensors, with all the data going into different streams, and companies struggling to "re-assemble it at the end".

"This is a mess. We have a lot to change about how we do things," he said.

Ultimately digital maturity "manifests itself in key business metrics like cost per barrel."

In conclusion, Mr McAvey we should "use digital to simplify physical. The more you do that, the better things get."

Susan Peterson-Strum, Wintershall

Susan Peterson-Strum, SVP Digital Transformation, Wintershall DEA, talked about the importance of creating "self-service environments and tools" – so company domain experts can build their own workflows, visualisations, and machine learning systems, with these tools becoming a part of their daily work processes.

"I believe this is a critical step," she said. "It is much less about the technology in my mind."

"I really want to put the power in their hands. That's the part that makes me super excited," she said. "Too often colleagues say, "I'm the recipient of this thing, ugh".

Ms Peterson-Strum developed this view after an experience in 2001, working for a power company in a plant optimisation team.

This company made big investments in structured, enterprise-wide data and connectivity systems, which provided a framework which could be used by people involved in maintenance, trading and sales to get the data they needed and build their own tools to work with it.

This data framework meant that there was a common view of the truth across the company, which could help resolve the various goal conflicts which may arise.

For example, a plant maintenance engineer might get rewarded based on the availability factor of the asset, and a power trader gets rewarded based on how profitably they can trade its power.

The data can provide both with a common understanding of how much it costs to operate the asset, which helps them get aligned rather than in conflict.

Ms Peterson-Strum believes that this digital framework, and the working methods it supported, made a big contribution to helping the company get through a difficult economic period in the early 2000s.

In the current difficult economic period in the oil and gas sector, companies are looking for a new "blueprint".

One way to do this is to look at improving operating practises. Perhaps they can be designed differently, enabled by digital technology, with very clear decision points and roles, and maximum automation of workflows, she said. There can be different types of collaboration, all supported by digital tools.

The factor which distinguishes companies which successfully emerge from the current crisis will be their ability to "engage broader teams and focus on adoption," she said.

When developing self-service tools, it is important to have a "product development mindset", she said, and "think about the users as customers".

The more you understand them, the better it will go.

Perhaps you will find that some people have already started developing their own tools.

"There is no way we can use classical structures for decision matrix and move anywhere near the speed we've had to move at."

Getting it used

It is important to monitor how much digital tools are actually being used. "I think it is important that we take an honest look at how digital is perceived in our organisations," she said.

"Our goal is to create sticky new tools which are embraced in the daily work of our colleagues. If successful this collaboration will inspire new workflows and create new trust."

Many digital projects have been started by specialised teams, with a mandate to achieve high returns on investment, with expectations of a 10x return "pretty common". The teams managed to demonstrate pilots or use cases with significant returns, but did not get much further. "Exposure to these solutions is yet to reach the bulk of our colleagues in operations."

Scaling and sustaining the pilot projects is as hard as running the pilots themselves, and many digital teams "did not have the resources or skillsets" to do it, she said.

This article is based on discussions at the "Borderless workspaces" session at the online Engenious event, organised by the Society of Petroleum Engineers, on Sept 22-24. Online sessions can be viewed by registered attendees only. The event website is **https://www.engeniousglobal.com**

Engenious – digital technology for decarbonisation

An Engenious session "The digital energy transition" looked at how digital technologies can help decarbonise, including managing the new energy system, helping handle new subsurface issues, and better managing methane data

Currently the oil and gas sector operates very independently to the offshore wind sector – but there would be benefits from closer integration, said Luca Corradi, director, Innovation Network with the Aberdeen-based Oil and Gas Technology Centre (OGTC).

By 2050, there could be an integrated net zero offshore energy system, also with carbon capture and storage and hydrogen production, he said.

Mr Luca hopes that with oil and gas companies such as BP getting more involved in renewables, it should gradually reduce the perceived barriers between the sectors, and "take away the discussion of 'oil and gas bad, energy good.'"

And while young people might not find working in "oil and gas" very appealing today, they could be more interested in working for an "integrated energy industry" which also includes wind and hydrogen, he said.

People who say, "I only want to do renewables" are in a way ignoring the problem, saying "I play the nice and clean part and leave someone else to deal with the dirty part," he said.

Hydrogen

"Hydrogen is crucial to solve the challenge, including for petrochemicals and cement. It is an energy vector which can solve the challenge of the difference between when and where you can produce energy, and where you need it.

Hydrogen is also important for heat, which is a seasonable demand, and for transport (such as where batteries cannot be used), he said.

The UK government's Committee for Climate Change is calling for 217 TW of hydrogen production by 2050, including green hydrogen from renewables and blue hydrogen from methane reforming, with associated carbon capture and storage.

The hydrogen sector represents a completely new industry, and it could be developed "digitally" from the start, with advanced methods to acquire and use data, analyse it, and develop digital twins to monitor what is going on, and do remote operations.

In carbon capture and storage, each stage of the process needs careful monitoring for leaks. The CO_2 injection wells could be entirely underwater and fully automated, rather than using platforms. The compression power could be generated locally.

Growing industry

Today, the UK Continental Shelf oil and gas industry is a £24bn industry, wind a £2bn industry, and hydrogen and carbon capture very much in the early stages. So we can say we have a £26bn offshore energy industry now.

OGTC estimates that the economic value of offshore energy in 2050 will be £11bn oil and gas, £16bn wind, £13bn hydrogen and £9bn carbon capture, utilisation and storage, so total a £49bn industry, much bigger than today.

Reducing our own emissions

The oil and gas industry "urgently" needs to decarbonise emissions from its own operations, he said, estimated at 18 mt CO_2 equivalent per year to produce oil and gas in the North Sea, mainly for offshore power generation.

To illustrate how much fuel consumption can be reduced, Formula 1 racing cars managed to improve their efficiency from 29 per cent to 50 per cent, or generate 100 bhp more with the same amount of fuel. "That is the kind of performance we should aim for," he said.

Over a longer term period, the offshore industry should be replacing gas turbines with electrification systems, taking power from renewables or from shore.

The industry could also do more with remote operations, so people do not have to fly offshore, which would reduce helicopter flights as well as achieve safety benefits. There could be more use of robotics and automated systems offshore. There have been projects in the wind sector to use both autonomous vessels and autonomous drones, with the boat taking the drones to the wind turbine, and the drones inspecting them.

There could be more effort to find methane leaks.

The industry could reduce emissions from logistics, by improving the capacity utilisation of vessels, he said.

Ian Phillips

Ian Phillips, Chief Executive, Oil & Gas Innovation Centre (OGIC), said he was involved in a "blue hydrogen" project, which is equivalent in size to the largest hydrogen production facility in the UK, but needs units ten times bigger.

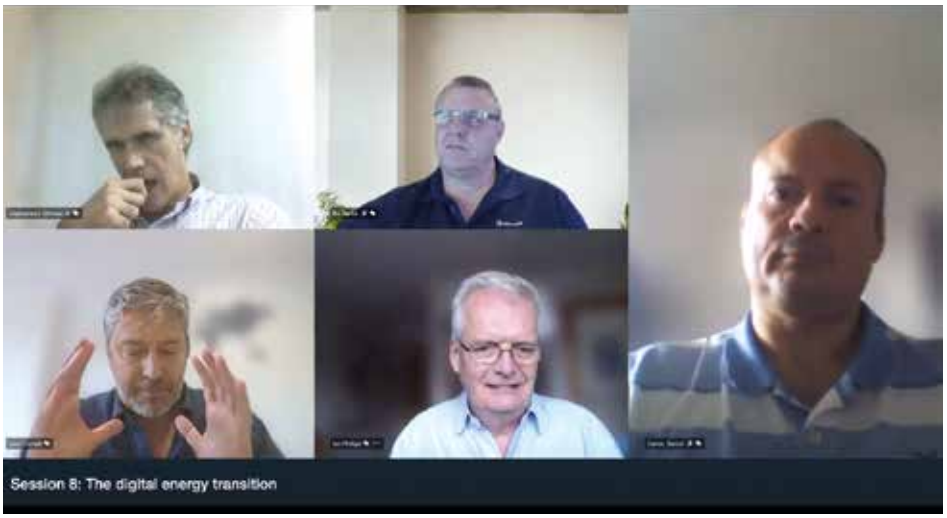
But each unit is being designed as a "one off". This means there is not much economy of scale, as there would be on a wind project, with many identical large systems being made.

His project has been engaging people with traditional oil and gas skills, such as process engineers and pipeline engineers, he said.

Mr Phillips noted that when he attends renewable energy conferences, people don't usually mention the oil and gas industry at all. "The general view is our product caused the problem and we are by definition not part of the solution," he said.

BGS

Decarbonisation efforts could lead to a number



Screenshot from the "Digital Energy Transition" forum at Engenious. Clockwise from top left: Mike Stephenson, Executive Chief Scientist, British Geological Survey; Bill Barna, data scientist at Microsoft; Daniel Carter, Director, Business Manager, Wood; Ian Phillips, Project Director - Acorn Hydrogen and CCS Project, Pale Blu (moderator); Luca Corradi, director, Innovation Network, The Oil & Gas Technology Centre

of subsurface challenges to arise, such as making sure CO_2 storage does not conflict with any nearby gas production, and making geothermal products operate most effectively, said Mike Stephenson, Executive Chief Scientist with the British Geological Survey.

One issue is that companies may want to store CO_2, and generate geothermal energy, in the same part of the subsurface, and the goals may conflict. With CO_2, you want to confine subsurface flow, to stop CO_2 moving around. With geothermal, you want to allow subsurface flow, so heat can travel to the wells.

This requires much understanding of the rock properties, including how fluid flows through them, and chemistry, understanding how CO_2 will interact with rocks.

It is also possible that a CO_2 injection well could interfere with local gas fields, or make them impossible to produce.

A 'digital twin' of the North Sea basins could be a helpful planning tool, gathering together all of the relevant data, he said.

Integrating databases

In the geoscience world, there are a number of very large and well organised databases, but also a long tail of smaller databases and data sources, developed by different academic groups and institutions.

Not all of this is easily available, sometimes for commercial reasons, because a company sponsoring them wants to keep the information for itself, or because the research groups are in competition.

Much of the data is in analogue form, collected over 100 years, for example, models of fractures. But it is very difficult to put together, and not amenable to advanced data processing techniques like AI.

The medical data world was also quite siloed in the 1940s and 1950s, and people realised that the silo-ing was reducing the value that people could get from it, he said. Geoscience should go through the same process.

Geoscience can be considered a laggard compared to other some sciences "where enormous amounts of data are routinely collected in homogenous ways, amenable to large scale data crunching," he said.

The industry has not done many projects to optimise entire basins so far, it does not usually go beyond the reservoir scale.

The International Union of Geological Sciences has stated a goal to harmonise and make global data models more accessible. It has a program called "Deep Time Digital Earth", to create connectivity between the existing databases.

"The interoperability will bring geological data together much more efficiently than in the past," he said. "This could be revolutionary for the geosciences."

With more connected data, it might be possible to get more detailed understanding of plate tectonics and deformation, how geological materials evolve over time, how metals develop in subduction zones, and how the development relates to the rate of subduction, and how facies develop in sequences in sedimentary rocks.

The project has $75m funding over 10 years. It will be formally launched at the next IGS meeting in 2021, planning to report in 2024 and 2028.

Mr Stephenson is president of the governing council for the project.

Wood's decarbonisation maps

Engineering consultancy Wood is developing a process for clients to have a road map for decarbonisation targets, which it calls "SCORE", explained Dan Carter, business development director for Wood's engineering consultancy group.

"The investment proposition around decarbonisation is very difficult to fathom at the moment, depending on geography, the policy regime that's in place, and the opportunities which may be appropriate for any particular asset to adopt," he said.

A first step is to optimise your processes and use of energy in them, including detecting and repairing leaks. You might look at using less carbon intensive fuels, perhaps bio-fuels, or CO_2 capture. You might look at offsetting emissions.

You also want to better understand your emissions, in Scope 1, 2 and 3 definitions.

A second step for decarbonisation is to look at potential modifications for existing assets, designing and building new solutions. For example, you might want to substitute electricity resources for renewables.

"Whatever your decarbonisation journey, it is important to apply a structured process to be able to map out how your goals will be achieved," he said. You probably have a target of a certain percentage reduction over a time period.

"Data quality is key to understanding all of this process," he said.

People will also need to understand the data's auditability.

Wood has developed a software platform combined with a consultancy offering called "EN-Vision", which gathers emissions data, and can give you real time insights into it, giving you a "clear, auditable and accurate view of an asset or organisation."

Microsoft – helping with methane data

Microsoft is offering free tools to oil and gas companies to integrate methane leaks data from different sources, including public data, on a cloud based GIS system so it can be further analysed. Bill Barna from Microsoft explained

Microsoft is developing free tools for oil and gas companies to help them gather and integrate data about methane leaks, including both their own data and public data, and put it together on a GIS system which they can use to try to pinpoint where the leaks are.

Bill Barna, a Microsoft data scientist supporting upstream oil and gas companies in US, explained how it works. Mr Barna is based in Dallas, and works with companies operating the Permian basin.

The background to the project is Microsoft's plan to be carbon negative by 2030, and remove all the carbon it has ever put in the atmosphere by 2050, and to invest in technology which can help customers reduce GHG emissions. "This program is a result of that commitment," he said.

In projects, it will normally work together with customers, including sending its data architects to customers' sites, co-developing a solution with the customers' IT teams. "We learn from them and they learn from us," he said.

Nobody knows for sure how much methane is leaked, but there have been high estimates. Mr Barna quoted a study from the Environmental Defense Fund which estimated that 3.7 percent of all the methane produced from wells in the Permian basin is emitted, unburned, into the atmosphere.

Another study published by US National Academy of Sciences in 2015 on one gas

producing region, found that 10 per cent of natural gas leaks contribute 90 per cent of emissions, he said.

Technologies

Technologies which can be used to detect methane leaks include private and commercial satellites, sensors on aircraft, drones, fixed sensor networks, SCADA anomaly detection systems, and infrared cameras continually scanning assets.

"Most companies use a mix of these techonlogies," he said. But the challenge is gathering the data together, or as he puts it, to "leverage these data sources holistically".

The methane detection technologies all have strengths and weaknesses. But they can be put into two groups of "high cost, high precision, but very small scale methods", and "low cost, low prediction but highly scaleable methods."

In the first (high cost) group, we have commercial satellites, aerial and drone surveys and infrared cameras.

Commercial satellites are expensive, have limited coverage and medium sensitivity.

Aerial surveys have good sensitivity and poor revisit times and must be purchased. UAV (drone) sensors have a limited range. In the US regulations say they must be the operator's line of sight, he said.

Infrared cameras are accurate, but they are expensive, and usually operated by technicians, so cannot be used at high scale.

In the second (low cost) group of technologies, we have public satellite data, which has "excellent revisit intervals," but poor sensitivity.

Analysing SCADA data for anomalies (such as a reduction in flow rates which may indicate a leak) can give imprecise results, but the implementation costs are low, particularly if you can use existing data.

Fixed sensors can potentially provide good sensitivity, but usually with limited coverage.

Public data

A useful public source of data is the Copernicus Sentinel-5P satellite, launched in 2017 for monitoring the earth's atmosphere. It contains an imaging spectrometer for tropospheric (ground to 18km height) monitoring. It overflies the planet every day, and can measure many atmosphere gases including methane.

But the spatial resolution is only 7km, and you need to be emitting 4000 kg per hour of methane for it to be detected. This means you can't use it to find one methane leak, you can only monitor the change in large areas over time.

Also, natural gas travels from emissions point and settles in different areas because of wind, atmospheric conditions, and geography, he said.

Another useful public source is production data reported to authorities. For example, operators in Texas and New Mexico are required to submit production data to state regulatory bodies on a monthly basis, and the data is then available for public download, covering all wells in the region for all operators for more than 10 years.

Integrating data

The challenge is to combine all these data sources onto one platform. Microsoft suggests a geographic information system (GIS), such as Microsoft's Azure Maps, or ESRI's ArcGIS maps. The data can be viewed as different "layers."

The first step is to 'ingest' the data. Microsoft has developed a number of tools. It offers scripted processes for ingesting publicly available data relevant to methane, including production databases from the states of Texas and New Mexico, satellite data from the ESA's Copernicus system, so it can be viewed as layers on a geographic information system.

Companies can then expand on this, adding in their internally gathered data, or by purchasing commercial data.

Data analysis

One data analysis step you may wish to make is to take the current atmospheric concentration of methane together with historical wind data, which is publicly available, to work out where the methane is likely to have originated from.

You can also use a low resolution form of data, such as public satellite, to get an indication of where to spend money on a high resolution form of data, such as an aerial survey, then leading to higher resolution analysis, such as going through control system records or fixed sensor data in detail.

With data shown in layers, "users can leverage the strengths and weaknesses of each data source without being negatively impacted by weaknesses of any data source," he said.

Microsoft plans to develop AI tools which could go through data automatically, similar to the tools it has developed for agriculture, combining data multiple sources to get insights on how to increase yields while minimising long term environmental impact.

This article is based on discussions at "Session 8: The digital energy transition" at the online Engenious event, organised by the Society of Petroleum Engineers, on Sept 22-24. Online sessions can be viewed by registered attendees only. The event website is **https://www.engeniousglobal.com/**

Engenious: learning from other industries

A session at Engenious "learning from other industries" reviewed how Accenture thinks oil and gas is more advanced digitally than other manufacturing sectors, and had interesting ideas from C3.ai's president about how oil and gas should become a 'platform' industry

Accenture has just published research about how the energy sector compares to other producing / manufacturing industry sectors, called "race for digital operations," said Tracey M. Countryman, Industry X.0 Global Manufacturing & Operations Managing Director, Accenture.

600 companies were analysed, of all sizes, and all over the world. The results, with sectors rated most "digitally mature" first, were oil and gas upstream, aerospace and defence, chemicals, high tech, oil and gas downstream, automotive ancillary / parts, automotive manufacturing (OEM), industrial equipment, life science, consumer goods and services.

"We wanted to understand the economics and success drivers related to digital programs, and the level of change required to get after it," she said.

A "digital index" was created, where companies were scored zero if they were not doing anything digital at all, and then higher scores were achieved for doing lots of trials and pilots, going up to "end to end embedded deployment."

The average score was 39 per cent, which puts companies somewhere between piloting technologies and "moving to some form of scale", but not yet getting to a big transformation.

It turned out that the oil and gas industry is "number one on the list for advancement" – with digital implementations on average still at the piloting stage but "not anywhere close to scaling", but further ahead than other industry sectors.

The consumer goods sector, which came last in the survey, accounts for 300 to 900 plants, with lots of variation in how much automation is used, how much capacity there is to optimise between process control layers.

Upstream oil and gas has done a great deal of digital planning over the past 5 years, including roadmaps, strategies, vision and digital education. "That is now starting to trickle to [other industry sectors] consumer goods and life sciences."

"There is so much automation and data in oil and gas - and so critical to how they operate. That's what people have been getting after for quite a while."

Some oil and gas companies are doing 200-300 "proof of concepts".

"We're just starting to see where clients are moving to a closed loop and redesigning actual work processes. That's where the scaling will happen," she said.

Companies have learned the importance of "not leading with tech", implementing technology around solving a specific pain point. So their goal is a certain business outcome, "enabled and underpinned by digital".

"It should be considered more a transformation than a technology problem," she said.

The oil and gas industry has done quite a lot of "bottoms up citizen development – let everyone try things" approach, she said.

But when you want to take projects to scale, you need solid foundations, reskilling people, challenging existing operating models.

Investment proves very important. Companies are spending between 1.5 to 2.4 per cent of their sales in digital per year. "The companies which moved the fastest had the most investment," she said.

When it comes to working with domain experts, Ms Countryman said that people shouldn't feel that digital is something which is being done "to" them, they should feel at the heart of the design.

Sometimes domain experts are sceptical about tech concepts like design thinking and user experience, with good reason.

"We pay these people a lot of money to have a lot of knowledge. We want to institutionalise that," she said. "The people who understand how the business works are vital. And who teaches the AI model?"

Ed Abbo, C3.ai

Ed Abbo, president and co-founder of US enterprise AI company C3.ai, emphasised that leadership is really critical in digital transformation.

"This really [needs to be] a CEO led initiative, it requires fundamentally changing the business," he said. "It has significant implications on the competitiveness of the company and whether it survives or not."

Screenshot from Engenious session "Plenary 2- Fast track to the future - learning from other industries". Clockwise from top left: Ed Abbo CTO, C3.ai; John Murtagh, Head of Strategy for Intelligence, Connected Intelligence, Airbus Defence & Space; Will Blench, GM Enterprise EMEA, Microsoft

C3.ai works in energy, oil and gas, power, banking, manufacturing, defence and aerospace sectors. Mr Abbo has worked together with industry veteran Tom Siebel (founder of Siebel Systems, and now CEO of C3.ai) for "2-3 decades", he said.

They started C3.ai in recognition that there could be a "step function change in technology with the cloud that would allow businesses to transform and change the way they operate."

"What we found over the past decade in deploying these technologies [is that] those companies which basically engaged us at the CEO level, and been bold enough to make the changes, are the ones which have gone the distance, crossed from prototype over the chasm to large scale transformation. That's not to be underestimated."

"In the past, IT was really the CIO's domain. The CEO was updated quarterly, maybe to look at the budget periodically."

Another important element is "continuous learning of the organisation, both at executive level and at working team level."

People need to be able to understand "exactly what AI and ML can do in the context of their businesses, [not just] recognising images of cats."

"This is not static, not 'take one class and you're done'. It is continually evolving."

C3.ai spends a lot of time qualifying which projects to do. "Out of 10 projects proposed, we'll eliminate as many as 7. There will be an engagement at the executive level. It is not a technical discussion, it is more about what would deliver a competitive advantage for the business.

"We spend a lot of time figuring out what's the economic benefit of tackling that project."

"When we move it forward, we scope it in a way it can be done in 2-4 month periods. We're not tackling that project for the entire of a corporation, we might just pick a division, or country, or product line and basically demonstrate the economic value in that one area."

"We call these things production pilots".

Then, in very large companies, "the key is to figure out how to go from the prototype and scale it up, so it does go across an entire operation successfully."

One example was a project with Shell to gather data from control valves, looking for anomalous behaviour. Shell had half a million control valves in the company. "This is pretty large scale," he said.

The production pilot was able to demonstrate economic value within "a couple of months", including putting some machine learning models into production.

Then the same concept could be applied to other equipment, such as submersible pumps, and refinery subsystems, without extensive rework.

When it comes to user adoption, it is important to note that encouraging people to use AI and ML enabled tools is different to encouraging people to use traditional applications. For example, when implementing a software like SAP, normally an accounts payable person would be told they are to use the software.

"With ML applications you're putting it in front of someone whose done this job for decades. They may say, 'I've been doing this for decades and this doesn't make any sense'".

"You have to present them with an evidence package of why the computer's advice is useful, and get feedback, then refine and tune the algorithms."

Platform companies

Mr Abbo sees that oil and gas companies could look to what many power companies have done, in using digital technology, particularly sensors, to transform themselves into what he calls 'platform companies'.

The sensors give them visibility about what is going on. But "it is much more. What you're really doing is taking a physical asset and putting a virtual layer above it. A digital infrastructure and IT infrastructure that represents the state of the [power] grid."

Power companies use the data to get awareness of problems, improve efficiency of generation, and perhaps help customers use electricity more efficiently. The data can be analysed to develop predictions of where the demand is going to be.

Ed Abbo, president and co-founder of US enterprise AI company C3.ai,

An example of a power company evolving its services in this way is ENEL, he said. In October 2020, Enel said it would invest Eur 1.1bn in addressing "the increased demand for value added services brought about by decarbonisation and electrification and leveraging on the enhanced role of customers who are increasingly at the core of the power system."

Before the sensorisation, the only time the power company knew that there was a problem was when they had a call from a customer saying that the power was out. "When they got lots of calls – they knew they had a bigger problem."

All of this gets more useful in a future world where electricity generation is decentralised, with "microgrids" of renewable power generation, perhaps with customers generating power as well as consuming power, rather than a scenario with all power being generated centrally and transmitted.

The core asset of the company becomes more what it is able to do with its digital systems, rather than delivering power, and in this way it becomes a "platform company". Oil and gas could do something similar, Mr Abbo suggests.

We see a similar pattern with internet companies. The first internet companies offered a fairly unidirectional experience, giving their customers news. Now internet companies build their value on what they can enable to happen as a result of their digitally generated understanding.

The power industry has many parallels with oil and gas, including having a business orientated around massive capital investment in infrastructure, and the challenges of keeping it all running, and often weak relationships with its customers. Some power companies traditionally referred to their customers as "meters", he said.

Some oil and gas companies are already moving in this direction. "You can see thought leaders like Shell, with their New Energies Division, looking at how to [do more than] participate in the distribution of gas

and derivative products, [such as] how to engage with end customers, and extend their reach out, providing them with power, [including] renewable power."

"It is really participating in the broader ecosystem," he said.

This virtual layer on top of the physical infrastructure could also be described as a digital twin of the company, he said.

This article is based on discussion at the Engenious session "Plenary 2: Fast track to the future - Learning from other industries" and subsequent phone discussion with Ed Abbo

Carbon emissions and paint – a case study

When the fabric maintenance department of an oil company wanted to explore ways to reduce its carbon footprint, it found the data part of it extremely complicated. Consultant Jeff Diaz explained

A large offshore operator (name undisclosed) was encouraging its various departments to explore ways to reduce their carbon footprint.

The fabric maintenance department – which basically manages repainting equipment to reduce corrosion – wanted to see what it could achieve in terms of carbon, by having paint delivered in larger containers.

It talked to Jeff Diaz, managing director of data engineering with Sullexis, an oil and gas data, IT and business intelligence consultancy in Houston. Mr Diaz told the story at the PIDX Virtual Fall Conference on October 21.

Types of containers

The fabric maintenance department was aware that some paint cans sent offshore were in very small sized containers, typical to the container sizes that would be used for sales to consumers, such as one gallon. Other paints were being sent offshore in 55 gallon plastic drums.

The staff wanted to know whether they could reduce carbon footprint by using different containers.

The only data available was basically supply chain data – what paint the company had ordered, what kind of container it was supplied in, and where it was going.

The options available could be to use larger paint containers, or use re-usable containers.

The fabric maintenance department only had direct influence on the choice of whether to buy paint, and whether it was delivered in a plastic or steel container, and what size to use.

However the department did not actually have any direct control over the sourcing of the paint, the shipping and transport, because the company's supply chain was outsourced to field services companies.

"A single department can sometimes feel a little bit like the little guy, they don't have the ability to have any change."

It started a discussion with the field services companies, who talked to their own paint supplier, who said that this could be an opportunity for them to try out some ideas. But these ideas turned out to be exploring mixing machines installed inside drums for two part paint mixtures.

Who is responsibile

One question to consider was which company was responsible for the various emissions involved in the paint supply chain.

Is it ultimately the company purchasing the paint (the offshore operator), or is it the company making decisions about how much emissions would be made in the supply, such as the choice of transportation vehicle?

If a supplier decides to use a container which involves more emissions, is the supplier responsible for these emissions or its customer?

It was useful to take the standard approach for lifecycle analysis studies, where emissions are classified into "Scope 1" if they are directly controlled by a company, such as where it is doing deliveries with its own vehicles, or "Scope 3", which are indirect emissions, from products it buys but does not control.

When applied here, the fabric maintenance department found it does not have any scope 1 emissions, since it only buys products, it does not own any assets.

All the emissions here would be considered "scope 3", including the manufacturing processes into making the paint.

"I don't want to 'own' emissions that I have no control over, that's someone else's scope 1," he said.

"We realised, we could get really far down in the reeds with this, and bite of more than we can chew," Mr Diaz said. "A full life cycle analysis - would cost hundreds of thousands of dollars."

Calculations

Because not all data you need to make calculations is available, it can help if you limit the scope to the data which you do have available.

Searching the internet, Sullexis found a study from the UK about the kg CO_2 equivalent emitted when manufacturing a 1 gallon steel paint can.

It also found a study from Australia with information about kg CO_2 emitted when recycling steel.

It found a means of calculating the CO_2 equivalent emitted per mass of plastic used to make a container.

"None of this data really exists in a convenient and processable way," he said.

There was "intense data engineering" involved in making the analysis, he said.

Methods like these were used to calculate how much emissions the fabric maintenance department directly owns or controls, based on its decisions about what sort of containers to use.

Once this base had been established, it was possible to see what would change if, for example, all of the paint moved into 55 gallon drums made from recycled steel.

The calculation showed that over 5 years, using 1 gallon paint containers would generate 14 tonnes of CO_2, but 55 gallon containers with recycled steel would use 5 tonnes. But if a recyclable container was used made from stainless steel, that would reduce to 4 tonnes CO_2. There would be a one-time 'cost' of manufacturing the drum, but no more carbon incurred after that.

The calculations indicate that the fabric maintenance department does have the capacity to make reasonable changes to carbon emissions, contrary to what was believed at the outset.

This article is based on a presentation at the PIDX 2020 Virtual Fall Conference. It can be viewed online at **https://pidx.org/calendar/event_recordings/**

See Day 1, from 16.08

Open Footprint – standards for storing emissions data

The Open Footprint Forum, which counts BP, Chevron, Equinor and Shell among its members, is developing standard ways to store emissions data. *Johan Krebbers from Shell explained*

Open Footprint Forum is a new organisation, formally created on August 24, 2020, developing standard ways to store carbon emissions data, so it is easy to pass from one company to another.

Johan Krebbers, general manager of digital emerging technologies, and VP IT innovation with Shell, explained what is going on, speaking at the PIDX Autumn Virtual Forum.

The basic idea is that when a company manufactures a product with inputs from a number of suppliers, it will need to be able to compile the carbon footprint data from each of the suppliers, to provide carbon footprint of its manufactured product.

Open Footprint differs to the many other carbon footprint standards projects happening around the world, because it is focussing on the storage format for the data, rather than the calculation of it.

Consider that there may be standard ways for electronic component manufacturers to calculate the carbon footprint of an electronic component. So a company which manufactures a device made up of multiple electronic components should then find it easy to combine the numbers.

A manufacturer will probably want to provide its customers and investors with separate data for its Scope 1 emissions (controlled by the company), Scope 2 (emissions from generation of purchased energy) and Scope 3 (emissions from products purchased).

But it is usual for manufacturers to use products from a number of different industries, so it will need more than a calculation method specific to one industry.

"Whoever has a supply chain will go into this problem sooner or later," Mr Krebbers said.

Measurement vs calculation

Currently, many companies are calculating their emission data using various estimation formulas, Mr Krebbers says.

If you don't know how much GHG was actually emitted by your steel supplier, you can try to work it out from a formula.

But in the future, more of it can be measured directly, and then this measured data can be used.

It is easy to measure emissions if you are the company which is directly making them, such as burning gas to heat up a furnace to make the steel.

But working with measurements, rather than formulas, can only work if the measured data is being gathered and is in a standard format, so it can easily be loaded into various computer systems, he said.

About Open Footprint

Members of Open Footprint include Accenture, BP, Chevron, Cognite, DNV GL, Emisoft, Equinor, Halliburton, Infosys, Intel, Microsoft, SAP, Salesforce, Schlumberger, Shell, University of Oslo, and Wipro.

The Open Group organisation operates a legal framework behind the standard, but does not have any involvement in the standard itself.

There are 20 people working on the project part time.

It is also looking at the data requirements of different industries, including shipping and airlines, as well as oil.

Deliverables from the project will be available free of charge to everyone – although companies are encouraged to become members so that they can have deeper involvement in the standard.

Companies could then implement this on their own services, for example Microsoft could offer an implementation of it on Azure.

SAP has already announced plans to put Open Footprint inside software it is developing to help companies manage their carbon footprints, in an initiative it calls Climate 21.

There is no competitive situation, in terms of competing with other companies or standards on the best way for how data should be stored or loaded. "Innovation happens in how you exploit the data", Mr Krebbers said.

Development plan

The first project is to make a "minimum viable product" of an emissions data storage standard for the first release. It will include data definitions, data types, and metadata.

Projects are ongoing to work out what the 'scope' of the metadata should be.

For example, for each piece of emission data, you might want to provide data about when it was measured, what the temperature was, and any calculations that were made. "There's an increasing number of [pieces of] information about that data you need to keep track of," he said.

The work will start with scope 1 (controlled emissions) and scope 2 (purchased energy) and later move to scope 3 (purchases).

There is an aim to develop a reference architecture (a template for how it could all fit together) in the first quarter of 2021.

It would be useful if there was a standard API, so that software systems which work with the emissions data could talk directly, on a software-to-software level, rather than at the level of exchanging data. This would also encourage the companies of all sizes to develop software tools which work with emissions data, sharing data with other software tools using the API. "We can create a market and ecosystem out there," he said.

A future challenge to address is finding ways to store information about any calculations which have been made in making the data.

There could be opportunities to standardise some of the calculation methods.

It may also look at ways to include environmental issues which are not about greenhouse gas emissions, such as waste going to landfill.

"We are really at the beginning of this world. The flexibility of the set-up is very important, and scalability."

Many people have asked about whether there should be a blockchain component to it. But Mr Krebbers does not think this makes a sensible starting point, because it would add a lot of complexity.

There could be a value to using blockchain if you will need to prove that data has not been tampered with, but this is something that could be considered later. "The business value is first to collect the data," he said. "If we look at how we collect the data today it is very immature."

PIDX / Open Footprint MOU

Open Footprint signed a memorandum of understanding with PIDX in November 2020, in order to avoid duplication of efforts.

Under the agreement, PIDX will focus on defining packages of data, and types of data, which are suitable for transmission between producers of emissions data and receivers of emissions data.

PIDX will also focus on creating or adopting standards for secure and encrypted transmission of the data, and defining how the emissions data is transmitted between computing platforms, for Scope 1, Scope 2 and Scope 3 emission reporting, from suppliers to customers.

Open Footprint will focus on establishing the emission data elements which need to be reported for any industry, including for scope 1, scope 2 and scope 3. It will define the standard storage, naming and access structures for emission data at rest (ie not being communicated).

Novosound – ultrasonic testing with thin film

Scottish company Novosound has developed innovative thin-film ultrasonic sensors which carry out wall thickness measurements in pipelines and perhaps also tanks

Novosound, based outside Glasgow, Scotland, has developed ground-breaking, thin-film, ultrasonic sensors.

The company is initially developing them for pipeline inspections, but they could be used on any metal which needs to be regularly assessed for corrosion, such as tank walls.

They have big advantages over standard ceramic ultrasonic testing devices because the thin film material allows a much better connection with the metal.

Ultrasonic testing devices require a solid (or liquid) contact with the surface they are testing because ultrasonic sound cannot pass through air, only solid or liquid.

For an example of this, you (or your partner) may have had an ultrasound examination in a hospital, where you saw a gel being rubbed on the body. The purpose of this was to create a solid connection between the device and the body.

In oil and gas installations, some sort of gel needs to be applied when carrying out ultrasonic testing with standard ceramic devices. It can get very messy, particularly when testing pipelines above your head. Sometimes wallpaper paste is used. After a day of ultrasonic testing, people can end up covered head to toe in it, says Dr Dave Hughes, founding director and chief technology officer of Novosound.

Mr Hughes' background is 12 years of research into thin film technology, at the University of West of Scotland Institute of Thin Films, Sensors and Imaging.

His research team developed a way to produce a piezo transducer with a patented, core thin-film material.

The thin-film material can then be easily wrapped around the pipeline. Very little or no gel is needed.

This closer connection between device and metal also means a higher accuracy measurement – Novosound estimates that its device can measure pipeline metal thickness to 0.1mm accuracy.

A further advantage of this technology is that it is much cheaper to manufacture than standard ceramic ultrasonics.

The lower cost of the thin film device makes it viable to leave it permanently installed, leading to another big advantage – repeatability of measurements.

It is very hard to make accurate ultrasonic measurements using a handheld device, particularly when the item being tested is curved or some other shape. You would need to direct the ultrasonic beam through the metal at exactly the same angle at the same point to get a thickness measurement which can be compared with the last one.

When the goal is to assess how much the pipeline has corroded over the past year, from the change in metal thickness, repeatability is essential.

A common way to get repeatable measurements from ultrasonic is to take hundreds of measurements and average them, because a single ultrasonic measurement does not have a high enough accuracy level.

Typical ultrasonics have an accuracy of 2mm, when an accuracy of 0.1mm is required, if this is a typical corrosion seen by a pipeline per year.

If the thin film sensor is cheap enough to be permanently installed, companies can leave it permanently fixed to a pipeline or tank. They do not even need to send someone into the pipeline or tank to take the measurements, the data can be delivered by cable to a remote location.

Dr Dave Hughes, founding director and chief technology officer of Novosound

Three new products

Novosound is launching three new products, all named after legendary Celtic stories – Kelpie, Belenus and Nebula.

The Kelpie is a flexible inspection tool , named after a shape-shifting water spirit inhabiting the lochs and pools of Scotland.

The Belenus is a sensor designed to be permanently installed without cabling. There is a matchbox device containing data storage and a battery, where the data can be later downloaded. The device is designed to withstand high temperatures (up to 400 degrees C), so can be used on a hot pipeline or tank. Belenus is a Sun God in Celtic mythology. It is waterproof.

The Nebula is a cloud service – the data from the Belenus can be uploaded to this service, where there are tools to analyse it and spot trends, and also connect to the operator's own software.

The company

Novosound does not anticipate doing inspections itself, just manufacturing sensors and managing data.

Novosound is backed by private equity investors. The chairman is Dr Derek Mathieson, former chief marketing and technology officer with Baker Hughes.

It has its own thin film manufacturing plant near Glasgow, UK, and can assemble the sensors in-house.

Although the products are new, the company has been researching and developing thin film sensors for over 2 years, and has customers in North America and Europe, including corrosion monitoring installations in power generation plants, aerospace, and a German pipeline inspection company active in oil and gas.

novosound.net

Novosound's "Kelpie" pipeline ultrasonic thickness sensor

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