

DISRUPTING OIL & GAS

The new technologies that are transforming
the world's energy supplies

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BREAKING TRADITION

The global oil and gas industry is embracing the latest digital advances to drive productivity, efficiency and safety

The oil and gas industry has always been driven by the powerful combination of human endeavour and cutting-edge technology. It is the technology component that has been, increasingly, spiriting the industry forward.

As the oil fields evolve and new energy sources emerge, it becomes more and more critical that the oil industry develops and harnesses new innovations in order to drive efficiency and productivity to support competitiveness.

A recent report by Wood Mackenzie, titled *Digitalisation in Upstream: Show me the Money*, highlights that digitalisation could achieve as much as \$150bn in operations-related cost savings in the energy and natural resources sectors.

The advances in digital technologies represent a new wave of change that is transforming traditional oil companies into technology firms covering new and alternative energy sources beyond just hydrocarbons.

Speaking at the 2018 edition of the Abu Dhabi International Petroleum Exhibition & Conference (Adipec), the UAE Minister of State for Artificial Intelligence, Omar Sultan al-Olama, said: "Technology is going to change the impact of output and return in the energy scene globally. The factors are data, artificial intelligence (AI) and internet of things (IoT), to name a few, as well as blockchain and other emerging technologies." The minister noted that AI's contribution to the oil and gas sector could reach \$2.85bn by 2020.

In an increasingly competitive landscape, making better use of technology also promises reduced costs and improved returns. However, one cannot take a one-size-fits-all approach here. Solutions will have to be customised by the client and provider to exploit the full potential of the technology at hand.

Disrupting Oil & Gas is the second research report in the MEED/Mashreq Energy Partnership series. It looks at how new technologies are being utilised across the oil and gas industry and transforming the sector.

Covering a range of technologies such as drones, 3D printing, AI and IoT, this report aims to provide a detailed glimpse into the future of oil and gas through a series of case studies, each of them focusing on a different technology transforming the industry.

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OIL AND GAS 4.0

Wintershall is reaping the benefits of next-generation industry developments

The world is undergoing a fourth industrial revolution. As our ability to harness and analyse Big Data grows, and technology such as artificial intelligence and augmented reality rapidly improves, whole industries are being transformed. New processes that merge the digital and physical spheres and enhance human decision-making with data-driven insights are fundamentally changing how businesses do things.

This Industry 4.0 revolution is happening not just in the technology sector itself, but everywhere, including in the exploration and production (E&P) industry. Our sector's ethos may be a little more conservative than Silicon Valley's 'move fast and break things' philosophy. But at Wintershall, Germany's largest, internationally active E&P company, digitalisation is not just a buzzword; rather a reality, a necessity and an opportunity that we want to embrace.



Wintershall CEO Mario Mehren

Size of the prize

Digitalisation is a necessity because any business that wishes to remain competitive cannot afford to ignore it. But it is also a great opportunity; a chance to fundamentally transform our processes and our way of working, and to create new value.

The economic benefits are clear. As the World Economic Forum has shown, between 2016 and 2025, digitalisation could unlock \$1.6tn of value for the oil and gas industry, our customers and for society. By 2025, digitalisation has the potential to reduce time to first oil by up to 35 per cent, development costs by 15 per cent, and production costs by 20 per cent. And there are other significant benefits, in addition to these headline numbers. Making greater use of digital in our work can reduce people's exposure to risk and minimise the environmental impact of our operations.

Unlocking this value will be made possible by applying digital technology to industry processes. For example, the industry will increasingly use super-computing and artificial intelligence to enable better, faster interpretation of seismic data during exploration and reservoir modelling at the development stage. Artificial intelligence will also help to model and optimise the design of wells and facilities, while analysing sensor data will inform predictive maintenance and improve production efficiency.

At every point in the value chain, we will see that digitalisation can help us reach better decisions, faster.

Digitalisation

Wintershall is a mid-sized E&P company, and in an industry that often focuses on size, I like to describe our ethos as being 'smart, rather than just big'. And today, being smart means embracing the potential of digitalisation, so we have set out a clear digital transformation strategy.

What does that strategy look like in practice? To inform our future as a digital E&P company, Wintershall has started more than 40 pilot projects. These are exploring the benefits and potential application of a wide variety of technologies, from augmented reality for inspections to platforms for cutting-edge data integration.

But we are very clear that the way to achieve the full benefits of digitalisation in the E&P sector is to focus not just on shiny new tools, but on reshaping the whole process landscape. So, the results from these pilots are being fed into flagship projects that explore the process landscape of the future, such as our digital twin for our Brage production facility in Norway. Using Big Data, in combination with high-performance cloud computing, the digital twin will provide a complete digital replica of

"... Wintershall has started more than 40 pilot projects. These are exploring the benefits and potential application of a wide variety of technologies, from augmented reality for inspections to platforms for cutting-edge data integration"

the platform and its processes. It will provide real-time, 24/7 information on everything that is going on, in the ground, above the ground and in between.

The twin will allow us to optimise all of our processes, from the way the facility is designed to scheduling of predictive maintenance and optimisation of production and energy consumption.

Tactical change

Digitalisation is not just about technology, but about strategic change. This means building an internal culture in which data is no longer kept in silos, but is treated as a strategic asset and is shared openly across our business. It also means developing digital platforms that will simplify the way our colleagues, partners and contractors can work and collaborate with one another, ensuring a smoother and easier way of doing business.

This focus on collaboration is important for us as we take forward a merger with DEA. Our combined company, Wintershall DEA, will be the leading independent E&P company in Europe. But I recognise that achieving our future success is not just about size or geographical footprint, but about how smart we can be in embracing the potential of digital transformation. This will be an exciting change, for Wintershall and for the industry overall.

As the American economist George Westerman put it: "Successful digital transformation is like a caterpillar turning into a butterfly. It's still the same organism, but it now has superpowers."

Mario Mehren is the CEO of Wintershall

PROGRESS THROUGH DIGITILISATION

The oil and gas industry is recognising the benefits of digital investments

Although the oil and gas industry has endured fluctuations in economic cycles, we have continuously innovated. This innovation has happened in all aspects—including exploration, drilling, completion and production—to produce hydrocarbons in the most effective, efficient way.

For example, operators in the past have drilled more wells to increase production. Despite recent methods for efficiency gains, such as pad drilling, this approach is no longer economically viable. Our industry has also devised intelligent completions, which largely drove the production renaissance in the US. Now we must explore different methods in other lifecycle segments to increase production and reduce costs.

Industry 4.0

Digitalisation provides a foundation to improve efficiencies and drive operational performance. For decades, digitalisation has been prevalent in oil and gas, but the paradigm of Industry 4.0 has drastically changed our thinking.

Industry 4.0 entails linking technologies to communicate with each other and make decisions without human involvement. This concept has already reshaped many other technology-driven industries and is now transforming the oil field. In fact, it has opened new avenues of exploiting our most valuable asset—our data. It has also introduced efficiencies in accessibility and computing.

Various components make up Industry 4.0. First, IoT, or the Internet of Things, links groups of physical devices for remote monitoring and control. Second, cloud computing reduces technology infrastructure and enables data to be accessed from anywhere. Edge computing, meanwhile, connects intelligent devices to current and historical data for autonomous decisions at a remote site. And finally, advanced analytics brings these four concepts together to an interconnected, intelligent ecosystem that merges the digital and physical worlds.

How does this relate to our work in the oil field? By now, many companies routinely think about their assets beyond a single well. IoT accelerates that level of



Weatherford International
President and CEO Mark McCollum

thinking to the entire field and enterprise levels by using technologies—such as our ForeSite production optimisation platform—to connect and integrate oil field equipment at scale. The resulting network increases access to data, broadens the scope of viewable data, and drives systematic efficiencies for faster drilling, more barrels and less cost.

Cloud computing helps to connect with data in a fast, direct and meaningful way. Our industry generates vast amounts of data, and the cloud lets us access it, from high-resolution logging-while-drilling measurements to years of archived rod-pumping data.

Edge computing helps us to transfer intelligence and lower-level decision-making directly to the wellsite. As a result, your best engineers have the freedom to work on top-priority projects while autonomous computing handles the day-to-day management of processes.

Advanced analytics is the holy grail. With this compo-



Vast amounts of data generated by the industry can be optimised for use through cloud computing

nent, a single user can see an entire enterprise by function, asset, well or any other level. The user can access and match each job or function to the thousands that preceded it. Oil field machinery, largely limited to mechanical function for the past century, acts as an intelligent machine that learns and teaches itself how to increase efficiency, predict failure and manage assets by exception.

Catching up

Our industry is typically slow to adopt next-generation digital technologies. However, surveys today reveal a significant increase in digital investment to improve revenue and reduce costs, as highlighted by Accenture's 2017 Upstream Oil and Gas Digital Trends Survey [i]. A recent announcement revealed that Abu Dhabi National Oil Company (Adnoc) has adopted blockchain technology to reduce the time taken to execute transactions between its operating companies, increase operational efficiencies across its full value chain,

“For decades, digitalisation has been prevalent in oil and gas, but the paradigm of Industry 4.0 has drastically changed our thinking”

and improve the reliability of production data [ii]. Many national and international oil companies have already started exploring data analytics and artificial intelligence to improve their drilling prospects and improve production.

At Weatherford, we apply artificial intelligence (AI) and automation to different well stages. In well construction, we use AI in place of error-prone human judgment for safer, faster connection makeup operations compared to conventional methods. Vero automated connection integrity helps to reduce makeup issues and the associated annual costs, which could be multimillion-dollars. On the production side, we have started adding IoT features to our next-generation automation controllers to provide autonomous optimisation and control.

The shift to automation and digitalisation will help us to not only advance oil field operations, but also fill holes in our workforce. After going through a series of downturns, we have a huge talent gap. Now we have the opportunity to seek out new talent and create a workforce that strikes the right balance between technical and technological brainpower. While traditional oil and gas disciplines such as engineering are critically important, we also need expertise in digital operations, software engineering and data science.

Digital technology will play a significant role in our future. As an industry, we can turn to digitalisation in research and development, manufacturing and operations to safely produce more barrels for less cost. This path forward will help to drive meaningful results for our customers and productivity in the oil field.

Mark McCollum is the president and CEO of Weatherford International

i www.accenture.com/us-en/_acnmedia/PDF-64/Accenture-2017-Upstream-Oil-Gas-Digital-Trends-Survey-Key-Findings.pdf

ii www.worldoil.com/news/2018/12/10/adnoc-has-implemented-ibm-blockchain-technology-to-streamline-daily-transactions

A PLATFORM FOR ALL

Oracle's cloud collaboration solution improves transparency in engineering, procurement, fabrication and construction contracts on oil and gas projects

EPF Corp is a Canadian company created through the integration of two complementary companies, Propipe Group and SAW Engineering. Together, they have developed a client-focused model for the engineering, procurement, fabrication and construction of oil and gas projects.

EPFC identified the need to collaborate across its entire supply chain to drive efficiency and manage scalability. As a result, it looked to the market to find the right cloud-based solution to deliver this goal.

Achieving efficiency

EPFC implemented Oracle's Aconex cloud services in February 2017 across its entire organisation to deal with a number of specific challenges, including tight schedule deadlines; managing the growth of the organisation after outgrowing previous, more manual processes; and ensuring rapid access to the latest design information and documents from all of its locations, including its head office, manufacturing shop and field sites.

EPFC started with a pilot on a small project that took approximately one week to set up. Following the success of the trial, EPFC now uses Aconex across all projects and each project takes between one and three weeks to set up on the cloud, depending on the project size and complexity.

"We see that Aconex is easily configurable to meet EPFC's needs. The user interface is straightforward to operate and allows for easy onboarding of new staff or clients into the system"

– Mladen Trzok, vice-president, engineering and project management, EPFC



Visible results

EPFC has found that Aconex has enabled consistent and predictable results across its projects. The cloud-platform has provided all stakeholders visibility into project documentation and status. This has also helped eradicate issues around work duplication and version control of documents.

To date, EPFC has seen improved efficiencies around processes following the implementation of Aconex,



compared to how they were previously working. Review cycles are 50 per cent faster, close out and data book creation is 75 per cent faster, and the teams using Aconex now have quicker access to the right documents, saving engineering and document control time. Meanwhile, the centralised trackable information transfer keeps the project moving.

The user-friendly platform minimises administrative overhead and human error, allowing a reduction in

personnel hours with higher work output. The increased efficiency and productivity also benefit external service providers and vendors, who can easily share and receive up-to-the-minute information.

Cloud stakeholders

As the Aconex cloud platform is hosted by Oracle, EPFC can provide access for the entire cross organisational project teams. Unlimited access supports complete adoption and a common data environment across the entire project.

The structure of Aconex is 'neutral', meaning that each organisation has its own secure space to collaborate internally and also to easily collaborate across the project with external organisations. Since Aconex is an open system, data can be tied into other systems via import/export or application programming interface (API), supporting one comprehensive view across the project.

In-house training and onboarding are provided by the EPFC document management team. Aconex provides a 24/7 helpdesk accessible to all users on the projects, restricted not just to EPFC employees. There are also extensive online training and support materials and videos available to all users.

EYES IN THE SKY

Drone technology has improved project reporting on Malaysia-based Petronas' \$27bn-worth Rapid petrochemicals project

Aerodyne, a global drone-based end-to-end managed solutions provider, has completed more than 45,000 total drone flight operations and inspected more than 201,500 critical assets and major projects with a gross development value of \$80bn.

Aerodyne's core competencies lie in the use of autonomous artificial intelligence-driven drones that can perform critical assets inspection, geospatial and aerial mapping surveys, security and surveillance and progress monitoring.

One particular project that Aerodyne is working on is Petronas' refinery and petrochemical integrated development (Rapid), the largest refinery and petrochemical complex in Southeast Asia. The \$27bn project has a construction area of 2,000 hectares and will produce 9 million tonnes (MT) of petroleum products and 4.5MT of petrochemicals a year. Aerodyne is involved in aerial monitoring and reporting of the project progress.

Some of the issues that Aerodyne is addressing in this project include health, safety and environment, costly delays and mistakes from development and planning for project management and corporate communication.

Turnkey solution

Compared to traditional methods, drones can provide automation to accelerate the data acquisition process, with additional speed and accuracy during routine risky industrial inspections.

Drones can be equipped with a multitude of payload and sensors, depending on mission requirements or intended purposes. High-quality and complex inspection data can be obtained from critical and operational assets with the use of visual, thermal and Lidar sensors, among others, and further analysed and optimised to deliver data intelligence and prescriptive data to its stakeholders.

An on-site team of 30 engineers provides progress monitoring services on a 24/7 basis for Rapid. Through myPRISM, Aerodyne's project reporting and surveillance solution, Aerodyne provides all stakeholders access to an enterprise collaboration dashboard for accurate progress reporting and monitoring. This greatly improves the project situational awareness to promote compliance and elimination of costly delays and mistakes, where stake-



holders will always be aware of the project status.

Drones can also provide pre-construction surveys by capturing images and data of a section of land. For aerial exploration, for instance, drones produce vital topographical information and accurate surveys of the targeted area. Oil and gas companies use this data to enable better planning and development of the potential areas, as well as to analyse the perfect spot to install the facilities. Drones record images to allow engineers to determine the right area to start building temporary passageways for facilities.

It is a common practice for facility owners to shut down their operations temporarily, especially for in-



Critical assets inspection

“Drones can be anywhere at the same time and provide real-time monitoring, resulting in the elevation of onsite security and safety”

– Jeffery Lau, business development and operations director, Aerodyne Middle East

spection. This usually causes companies to lose revenue during the shutdown. However, with drones, onshore and offshore vent stacks and exhausts can be inspected while they are live and not rely on scaffolding or cranes to enable technicians to complete the work efficiently and economically. Through efficient pinpointing of problem areas and improved ability to locate faults, drones enable companies to focus on the areas that need maintenance.

Upward progress

Captured visual data from the drones is used for better visualisation of assets. The 2D orthomosaic data is survey grade and can be extracted and combined with any computer-aided design (CAD) files. Many clients require 3D accurate reality models too. Imagine it like a digital copy of assets rather than in papers like the traditional way. The clients will have live data in the computer for enhanced collaboration and a digital record of the process.

Drones can be anywhere at the same time and provide real-time monitoring, resulting in the elevation of onsite security and safety. The application of drones in this field has already mitigated safety risks by removing the need for technicians to inspect the assets manually.

The real disruption comes from making sense of the data while removing human risk. Using the available data,

Aerodyne is able to perform health analysis, comparing previous inspections to newer ones to give situational awareness of the components' health. This allows for prioritised maintenance and mitigation plans to be put in place to achieve seamless process optimisation and asset management across the lifecycle of the project.

Drone utilisation and analytics will continue to be integrated into workflows of multiple industries, together with other technologies such as enterprise cloud applications, 5G/LTE connectivity, robotics, artificial intelligence and 3D printing. Virtual reality technology has the potential to change the entire industry by offering access to pre-construction surveys and virtual project site tours.

Overall, Aerodyne's clients benefit from the improved project management and situational awareness, geospatial intelligence and optimised management of critical assets. There is a significant improvement in reporting time and a reduction in inspection turnaround time, resulting from faster data collation and report generation.

PRINTING PLANS

3D printing facilitated an architectural model of Emirates National Oil Company's current and future facilities, displaying the energy firm's future vision in one integrated hybrid model

Two primary reasons were behind Emirates National Oil Company's (Enoc) decision to commission Dubai-based Generation 3D to create a 6 metre architectural hybrid model for its current and future refinery facilities.

Firstly, Enoc higher management wanted a physical representation of their ambitious expansion plan. Secondly, the model showcased the final outcome of the entire 900 square-metre site to the Enoc board, partners and customers at the Water, Energy, Technology & Environment Exhibition (Wetex) 2017 held in Dubai, and is now on display at Enoc's company headquarters.

The challenge

For Generation 3D, the challenge began with a highly technical reverse engineering plan to rework data gathered from the existing site, to create fully 3D manufacturable files. This data was collected using the 3D laser scanning or light detection and ranging (Lidar) technology. This process alone took two months.

Following this, designers at Generation 3D began reverse engineering the Enoc oil refinery site using specialist computer-aided design (CAD) software and techniques. This was carried out in synchronisation with the site scanning team and the 3D printing to minimise lead time and drive efficiency.

Simultaneously, Enoc's building contractor sent its proposed plans for the future development to Generation 3D in AutoCAD format. Generation 3D's designers



"The project required our team to become adept in new CAD systems and practices overnight, while managing large-scope changes throughout the project"

– Max Reynard, director, Generation 3D



Generation 3D's designers harmonised multiple CAD platforms to improve file management



harmonised multiple CAD platforms such as 3DS Max, Magics, Bentley MicroStation and Pixologic ZBrush to improve file management. The team then painstakingly converted all the construction plans into 3D printable files, a process that requires time and skill.

Over the course of the project, Enoc's engineers were regularly invited to analyse the work in progress, discuss updates and provide feedback to ensure complete transparency. Once approved, the 3D designs were exported to Generation 3D's in-house 3D print-room to be manufactured overnight.

The technology

The designers at Generation 3D used selective laser sintering 3D-printing technology for this project. This was due to the durability of the nylon material used, the high accuracy and tolerance threshold (accurate to 50 microns) and flexible printing methods.

The designs were organised into batches and 3D-printed alongside the manual fabrication of the model base and podium. This combination of manual and digital manufacturing helped streamline the project and greatly reduced lead-time.

Updates and flexibility

The design of the model allows for sections to be easily altered and updated zone by zone, should there be any revisions in the site plan.

DELIVERING EXCELLENCE

Wireless sensors reduce risks across plant lifecycles by preventing machine breakdowns, improving monitoring and enabling remote site access

Emerson's digitisation strategy is built around helping its customers reach top quartile performance. The US-based company's technologies help lower costs, reduce complexity and accommodate change through its project certainty approach, innovative technologies, tools and proven service capabilities.

During the operational phase of the plant, Emerson collaborates with end-users to understand the root cause of lost opportunities in safety, reliability, production, energy and emissions.

In this article, Emerson focuses on the operational life-cycle of the plants at which the firm's operational certainty programmatic approach is helping to target those inefficiencies in a structured way using its Plantweb Digital Ecosystem, a collaboration software platform.

Real-world examples

Customers who benefitted the most have leveraged the scalability of the Plantweb platform to prioritise their issues and have invested in digital technologies in a systematic way to realise return on investment at every step.

Corrosion monitoring

A large refinery in the region had to use opportunity crude with a higher total acid number to improve profitability. This involved a potentially higher rate of corrosion of its assets and associated risk. By using Emerson's real-time corrosion monitoring sensors and analytics, the refinery now has full visibility of the health of its process equipment. This helps to optimise mitigation measures without compromising safety and yield.



Reduced maintenance costs is one of the biggest benefits of Emerson's Plantweb platform



Non-intrusive wireless corrosion sensors were deployed in a matter of weeks with little infrastructure costs.

Machine health

A major international oil company in the Middle East was experiencing production losses in its downstream plant due to the unexpected breakdown of essential machines, and has now deployed Emerson's machinery health monitoring system. By implementing the wireless vibration and temperature sensors, the challenge was tackled at a very low cost. Predictive diagnostics provide accurate and early information on the health of equipment, enabling timely corrective actions and significantly reduced downtime.

Another problem area was manual rounds to hazardous areas of the same plant to monitor process parameters from local mechanical gauges, which were prone to frequent failures. Over the past two years, hundreds of mechanical gauges have been replaced with robust wireless sensors that send real-time data to the control room, thus addressing safety concerns. The company plans to use Emerson technologies to monitor leaking pressure-relieving devices and steam traps, as well as to monitor corrosion in important assets.

Monitoring production

A large national oil company automated the production monitoring of more than 500 oil wells, spread over hundreds of square kilometres, using Emerson's wireless sensors, remote terminal units and Scada system. It now has easy visualisation, analysis of the data and actionable information to take corrective actions with minimal field intervention. Using Emerson technologies helped reduce capital costs by 40 per cent compared with traditional methods.

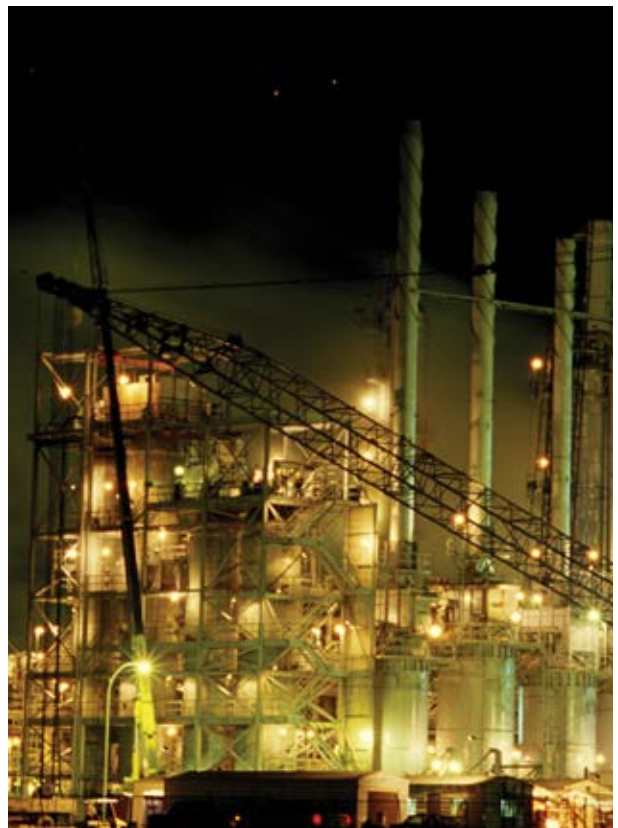
Handling remote sites

Another very large oil and gas company resorted to Emerson digital technologies to monitor toxic gas in four of its remote unmanned sites, where there was no power and signal infrastructure to deploy conventional detectors. The same company is now using Emerson's technologies in the water management system at one of its sites. Wireless sensors for monitoring flow, steam traps and pressure-relieving devices are networked over widely spread-out areas of the plant, giving real-time information. The analytics from the system provide actionable information to improve efficiency of water management and enhance asset reliability.

Business results without compromising safety is the end goal, not digitisation itself. It is often mistakenly

"Business results without compromising safety is the end goal, not digitisation itself"

– Ganesh Pattabhiraman, Plantweb sales director—Middle East and Africa, Emerson Automation Solutions



thought that Big Data analytics alone will solve every problem. Without high-quality, relevant data, analytics cannot deliver the desired results. The common refrain is "we have tonnes of data, but no actionable information", the truth is vital data needed for meaningful analytics is missing.

With a range of more than 40 non-intrusive and wireless sensors, missing information can be fetched and added very easily and cost-effectively with Emerson's Plantweb Digital Ecosystem. Emerson has more than 10 years and 10 billion operating hours of experience on these sensors.

NEW POSSIBILITIES

Industries such as construction, marine engineering, and oil and gas increasingly understand the benefits of additive manufacturing

Immensa Technology Labs, a regional additive manufacturing (AM) company, has been working closely with numerous UAE and regional organisations on projects related to AM and utilisation of the technology in their respective operations.

Outside the oil and gas sector, Consolidated Contractors Company began working with Immensa in 2017 and, by the third quarter of 2018, had implemented AM across various functions within its organisation. Other companies, including Victory Team in the marine sector, Dubai Health Authority in the healthcare sector and Etihad Group in aviation, have all embraced the technology and are leveraging the value of AM.

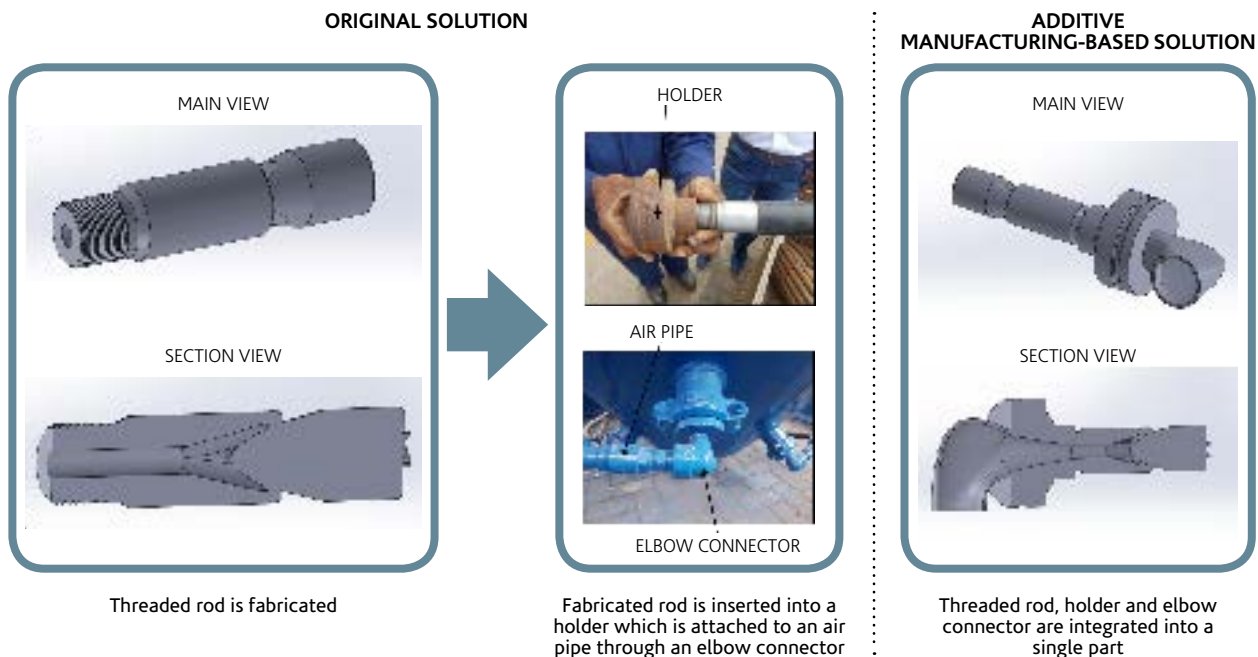
Industry specific

In oil and gas, several companies in the region have started exploring AM. Arabian Oasis Industries (AOI), a division of Dubai-based Al-Shirawi group, has engaged Immensa to identify how it can leverage AM in its busi-

ness. Today AOI and Immensa are working on multiple projects falling into three categories: custom replacement parts, optimising existing parts and certification of industry-specific parts.

With regards to custom replacement parts, Immensa is reverse engineering and reproducing spare parts and components that are no longer supported by the original equipment manufacturer. This project has proven to be technically viable and is currently undergoing onsite testing.

Immensa and AOI are also exploring parts and components that are being produced using conventional fabrication processes, but can be optimised to take advantage of the AM process—for instance by combining multiple parts into one component. One part that is being evaluated for viability by Immensa for AOI is oilfield manifolds. To conclude whether a part is viable, it has to undergo a six-step process from design for AM, to operating conditions simulation testing, technology selection, material qualification, economic viability,





Additive manufacturing helps Immensa and its clients improve the traditional fabrication process by combining multiple parts into one simplified component // Image via Shutterstock

physical testing, and, if required, third-party certification. For the manifold project, the team is at stage five, during which it will be determined if it is economically viable to use AM for this part.

AOI is also working on a specific part for the oil and gas industry that requires American Society of Mechanical Engineers (ASME) certification. Since ASME is still in the process of developing standards for powder material usage, the company will work with Immensa and a certification organisation such as Lloyds Register over the coming months to determine if AM is the way forward.

Companies servicing the oil and gas sector, such as Kuwait-based Canar Trading & Contracting Company,



Traditional versus 3D-printed Air Jets

“With regards to custom replacement parts, Immensa is reverse engineering and reproducing spare parts and components [for AOI] that are no longer supported by the original equipment manufacturer”

– Fahmi al-Shawwa, CEO, Immensa Technology Labs

which services Kuwait Oil Company among others, are moving forward and working with AM providers to better serve the requirements of clients.

Abu Dhabi-headquartered NSCC International, an engineering and marine works company, is also working with Immensa to identify parts within its drilling equipment that can be redeveloped and optimised for specific functions.

ALL IN ONE PLACE

Blockchain technology enables Abu Dhabi National Oil Company to manage complex transactions between operating companies with room for growth

After recognising blockchain's potential across its businesses, Abu Dhabi National Oil Company (Adnoc) met with IBM in 2018 to discuss possible uses. In these early discussions, they together realised that there was immense potential to drive efficiencies in the accounting of the flow of hydrocarbons and associate transactions between Adnoc's various operating companies throughout the oil and gas value chain. Blockchain, as a distributed technology with specific technical characteristics, was well suited to the task.

Group-wide view


As a complex organisation, Adnoc has multiple operating companies responsible for different parts of its hydrocarbon value chain. Each company has its own structure, systems, shareholders and role in the hydrocarbon journey, as crude oil, gas or refined products and petrochemicals flow through these entities en route to their final destination, whether for export or domestic use.

By creating a blockchain spanning these different companies, Adnoc receives a group-wide view of the flow of these hydrocarbon quantities and the associate large financial transactions, enabling efficiencies in accounting. Furthermore, the individual operating companies, as well as others with a share or interest in them, can base decisions on an immutable record that they can trust.

At present, the application is focused on a specific subset of Adnoc's supply chain, which given its daily production of about 3.1 million barrels a day, is large. IBM tracks the onshore production operations through to the refineries or gas processing, and then on to the export terminal. Each participant in the supply chain provides data on quantities exchanged and this is recorded to the ledger.

Tracking, managing and executing these transactions and exchanges used to be a long, labour-intensive process with phone calls, emails, verification and approvals. Not only is the process now much more efficient and



 Adnoc's digitalisation strategy unites cutting-edge technology and its people, integrating operations across the entire value chain

streamlined, but the blockchain can be visualised in such a way that the group receives a holistic view of the interrelationships. The individual operating companies gain their own perspective—for example, seeing the quantities entering and leaving their company en route to the next stage of the process.

Since the blockchain application is being installed within the Adnoc group, it is running within the context of its existing robust cybersecurity policies and IT infrastructure. It did not require anything different to be done from an IT or cybersecurity perspective.

Troubleshooting

IBM worked closely with Adnoc's digital and IT teams throughout the process of designing and building the application. Adnoc helped co-create the solution with IBM and was involved from the beginning. The actual end-users or sponsor users were also involved and had the opportunity to shape the development of the system. This ensured that the application caters to their needs and they are comfortable with the way data is being collected and visualised. In doing so, there has been no need to train people on the specifics of the application.

The blockchain application will be managed and further developed by an internal team at Adnoc.

Future growth

Blockchain is a proof of concept that covers three large,

“By creating a blockchain spanning these different companies, Adnoc receives a group-wide view of the flow of these hydrocarbon quantities and the associate large financial transactions, enabling efficiencies in accounting”

– Anthony Butler, chief technology officer, IBM blockchain services, Middle East and Africa

core areas of the value chain. Adnoc had a hypothesis that this could deliver value and IBM worked with the company to help prove it. As the blockchain application is expanded, it will eventually be linked to customers and investors, providing seamless integration among stakeholders. This enhanced clarity and transparency will reduce inherent business risks and consequently enhance the attractiveness of Adnoc Group as an investment partner.



The Panorama Digital Command Centre is built around a 50 metre video wall that visualises data across Adnoc Group at every stage of the oil and gas value chain



AUTONOMOUS EXPLORATION

Saudi Aramco's in-house software uses 3D photographic data from unmanned aerial vehicles to explore hard-to-reach areas

The search for hydrocarbon deposits beneath the Earth's surface can literally hit a wall during field trips to gather and interpret descriptive data that is then used to build quantitative, 3D models of the subsurface, or workflows for geological assessment. Rock outcrops could be treasure troves of information—until a high cliff or steep slope makes the site unreachable.

The advent of unmanned aerial vehicles (UAVs) for exploration is changing all that. The addition of remote sensing technologies to capture the required information allows drones to serve a dual function: not only do they overcome the safety hazards posed by high outcrops, but they contribute to an integrated workflow via a geographic information system that plans the drone's flight. This new technology holds tremendous promise for continuing to change oil and gas exploration.

Saudi Aramco first tested UAVs for photogrammetry, or aerial surveying using a digital camera. The company hired a local vendor after securing necessary government approvals to test-trial, and despite some minor difficul-

ties, the successful trial yielded knowledge on how to deal with the enormous data gathered, as well as how to process the photos for a digital elevation model.

A technology-driven company, Saudi Aramco has built its own software in-house. Called Geological Toolbox, it was enhanced specifically for outcrops. Users can enhance 3D models with many applications from this toolbox. For example, a virtual core can be made from the outcrop; then, the explorationist can compare it against his or her geological log sheet using the software.

Trial journey

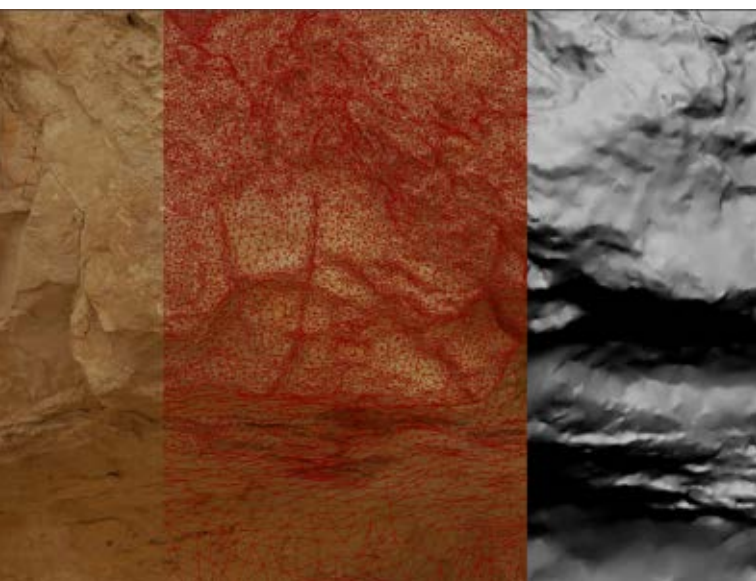
Recently, Saudi Aramco's EXPEC Advanced Research Centre (EXPEC ARC) Geology Technology/UAV Project managed a 3D capture of the western slope of an escarpment in central Arabia with an elevation of more than 150 metres, and many dangerous cliffs. The area is relatively large, with an approximately 6 kilometre top-down view of the terrain surrounding the escarpment (at 2 cm resolution) and a medium resolution (1.5 cm), oblique 3D photorealistic data capture of an entire length of the



3D digital reconstruction of the outcrop compiling all UAV photos: half of the image is with a mesh detail and the other half without



Drone exploration has enabled survey teams to map larger areas in less time



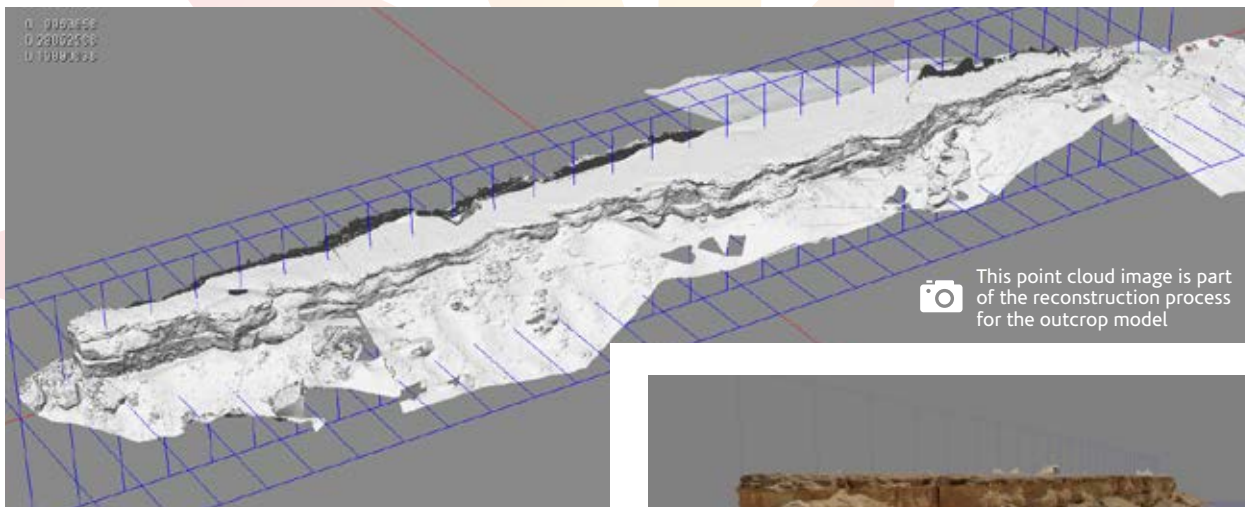
escarpment connecting various measured sections.

A high-resolution (sub-millimetre) 3D photorealistic data capture head-on to various measured section focus areas was an excellent result, with digital data and a 3D model depicted in the network.

Overall, the benefits can be measured in efficiencies and enhanced safety. For instance, mapping and measuring a large outcrop that extends for kilometres requires many measured sections to understand the heterogeneity of the bed sets and lateral changes of the facies—and thus create a model of the depositional setting.

The process requires many teams, each with at least three people, in order to cover the area, with numerous field trips to the remote locality over many days.

With drone technology, a single team of four people can do the job in far less time and with no exposure to a potentially harsh environment. From the comfort of their



offices, explorationists can check the data in a ‘virtual’ fly on their desktops, zoom in and out, follow each facies and make their own interpretations.

In this case alone, drones demonstrate a step-change in risk management, along with significant cost savings and greater efficiency.

Untapped potential

With the industry increasingly using UAVs for surveying and mapping, facility inspection and surveillance, refinements will add to their value. As with any type of aircraft, factors such as heat, precipitation and turbulence can diminish performance. Consistent performance in all types of weather would be an improvement.



“Saudi Aramco’s drone wish-list includes the capability to conduct a “virtual geological field scout” and more accurately document different geological features and trace each facies laterally—which would prove a boon to geoscientists”

– Salem Shammari, senior geological consultant, Surface Geology Division, Saudi Aramco

Saudi Aramco’s drone wish-list includes the capability to conduct a “virtual geological field scout” and more accurately document different geological features and trace each facies laterally—which would prove a boon to geoscientists.

Also missing in drone-related field work is the ability to obtain a rock sample (or hand specimen) from high cliffs for further geological analysis—for example to check the texture of grains and clay types, or analyse rock porosity and permeability.

Longer battery life and greater payload, as well as enhancements in data collection are also eagerly awaited.

RISING TO THE 3D CHALLENGE

A 3D-printed model of a complex oil and gas production component allowed engineers to bridge the gap between design and fabrication

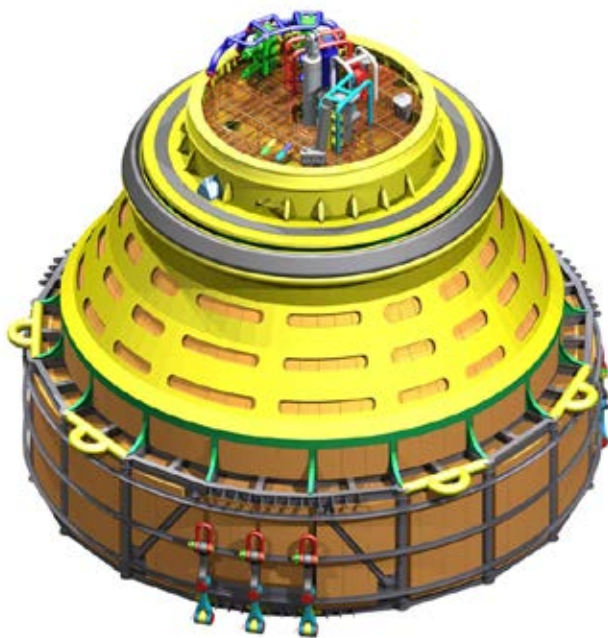
Shell employs 3D-printing technology to make the design and construction of equipment used in oil and gas production faster and more efficient. Printing technology allows the company to create accurate-scale prototypes in materials such as plastic, which it tests and uses to improve designs and construction processes. In the off-shore environment, teams in North and South America have experimented with 3D printing in situations where they face high installation costs.


Stepping stones

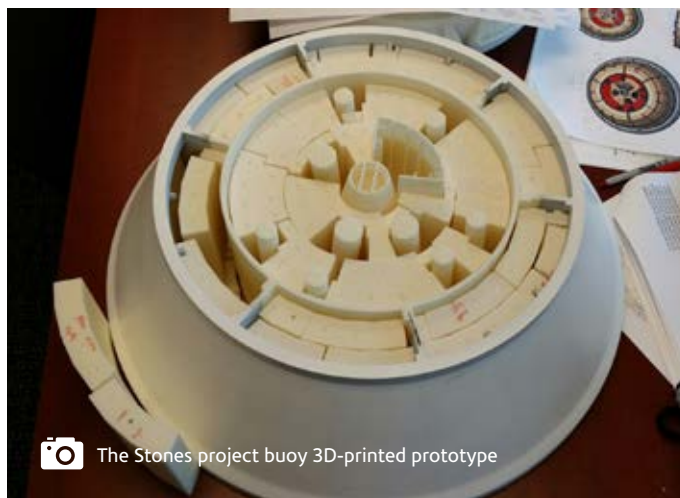
Due to being self-contained, versatile and efficient, floating production, storage and offloading (FPSO) facilities are commonly used by Shell and others throughout the world to produce oil in regions where there is a relative lack of infrastructure.


The Turrutella is the first FPSO facility that Shell has deployed in the Gulf of Mexico, but not globally. Shell also uses them elsewhere, including the Parque das Conchas (BC-10) project off Brazil with co-owners Oil and Natural Gas Corporation and Qatar Petroleum International.

The Turrutella, with a deadweight of nearly 160,000 tonnes, is 274 metres long and 48 metres wide. The vessel has a daily capacity of 60,000 barrels of oil and 1.4 billion cubic feet of natural gas. Up to 800,000 barrels of oil can be stored onboard.



 3D render of the Stones project buoy



 The Stones project buoy 3D-printed prototype



 Shell's Stones buoy



A 19 metre-tall buoy moored at the surface receives oil and gas from the seabed

Viewed from above, the FPSO has a huge circular hole in its bow. To moor itself in the field, the Turritella manoeuvres directly above the submerged turret buoy, then pulls the buoy up into the hole, like putting a cork in a bottle.

As many FPSOs are designed to do, the Turritella weathervanes freely around the buoy as winds change. But unlike most other systems, the buoy itself is part of the ship. That is a major safety feature, since it eliminates the possibility of the FPSO or other vessels colliding with the buoy and risers. Both the FPSO and the turret buoy were provided by SBM Offshore.

Testing the waters

The Stones project boasts a series of firsts for Shell, including an in-line connector that provides adjustable mooring tension for the FPSO and its internal turret buoy. Shell engineers began developing the technology in 2010, but since the concept is new to the Gulf of Mexico, the US Bureau of Safety & Environmental Enforcement wanted to see a working model first.

Under normal circumstances, building an accurate, working demonstration model would take months. To avoid delaying the project, Shell employed 3D-printing technology to produce the complex model in just four weeks.

The challenge was to design, fabricate and assemble large blocks of syntactic foam that would nest inside the turret buoy. Syntactic foam is high-strength cellular material made of tiny spheres of glass, ceramic, polymer or metal bound together with polymer. The material is widely used for floatation, but never before on this scale. The buoy is roughly the height of a four-story office building. Manufacturing limitations meant that each piece of foam had to be relatively small. To fit inside the turret, nearly 1,000 blocks in a variety of complex, interlocking shapes were made, and had to be installed in a specific sequence.

“As 3D-printing technology develops and the cost comes down, it will become an even more viable tool, with the capability to make spare parts and to make new, different shapes and products. We’re just at the start of new possibilities with 3D printing and what it can mean for Shell”

– Yuri Sebregts, executive vice-president technology and chief technology officer, Shell

The team realised that the construction sequence of putting together hundreds of syntactic foam blocks was complex. They needed to find the right sequence to put the blocks into a very complex geometry.

Usually, project teams have nothing more than paper drawings to try to describe how best to do the installation work. However, in the case of the Stones buoy, the team used a 3D printer and created a model of the structure, and then a model of all 222 components of the foam blocks. That way, the team could plan the project’s construction and ensure the right installation sequence, so that it was done safely.

Having a model like this in the design process helped the team to bridge the gap between design and fabrication. 3D printing provides a great tool to be able to plan, execute and anticipate any problems and come up with solutions before the process even starts.



ABOUT MEED

MEED has been integral to delivering business information, news, intelligence and analysis on the Middle East economies and activities for over 60 years. Attracting a key senior management audience through its content and activities, MEED is a media brand, publication and data business that covers a spectrum of services which inform, engage, connect and ultimately support our subscribers and partners in their business development and strategic growth.

Recently acquired by GlobalData Plc, MEED is now part of one of the largest data and insights solution providers in the world with the capacity to build global communities for our clients.

Our purpose is to support the region's companies make better and more timely decisions through our innovative data solutions and grow through our comprehensive and world-class marketing solutions.

To find out more email: info@meed.com

ABOUT MASHREQ

Established in 1967, Mashreq is the oldest bank in the UAE, with award-winning financial solutions and services. Throughout its 50 years' history, Mashreq has differentiated itself through innovative financial solutions, making it possible for its customers to achieve their aspirations.

Today, Mashreq has a significant presence in 11 countries outside the UAE, with 21 overseas branches and offices across Europe, the US, Asia and Africa.

Mashreq launched its new Vision and Mission recently, outlining its commitment towards its clients, colleagues and the community. In line with its vision to be the region's most progressive bank, Mashreq leverages its leadership position in the banking industry to enable innovative possibilities and solutions for its customers across corporate, retail, international, treasury and Islamic banking.

Mashreq is proud to be the first financial institution in the UAE to be awarded the Gallup Great Workplace Award for four consecutive years from 2014-17. Mashreq also continues to invest in recruiting, training and developing future generations of UAE national bankers.

