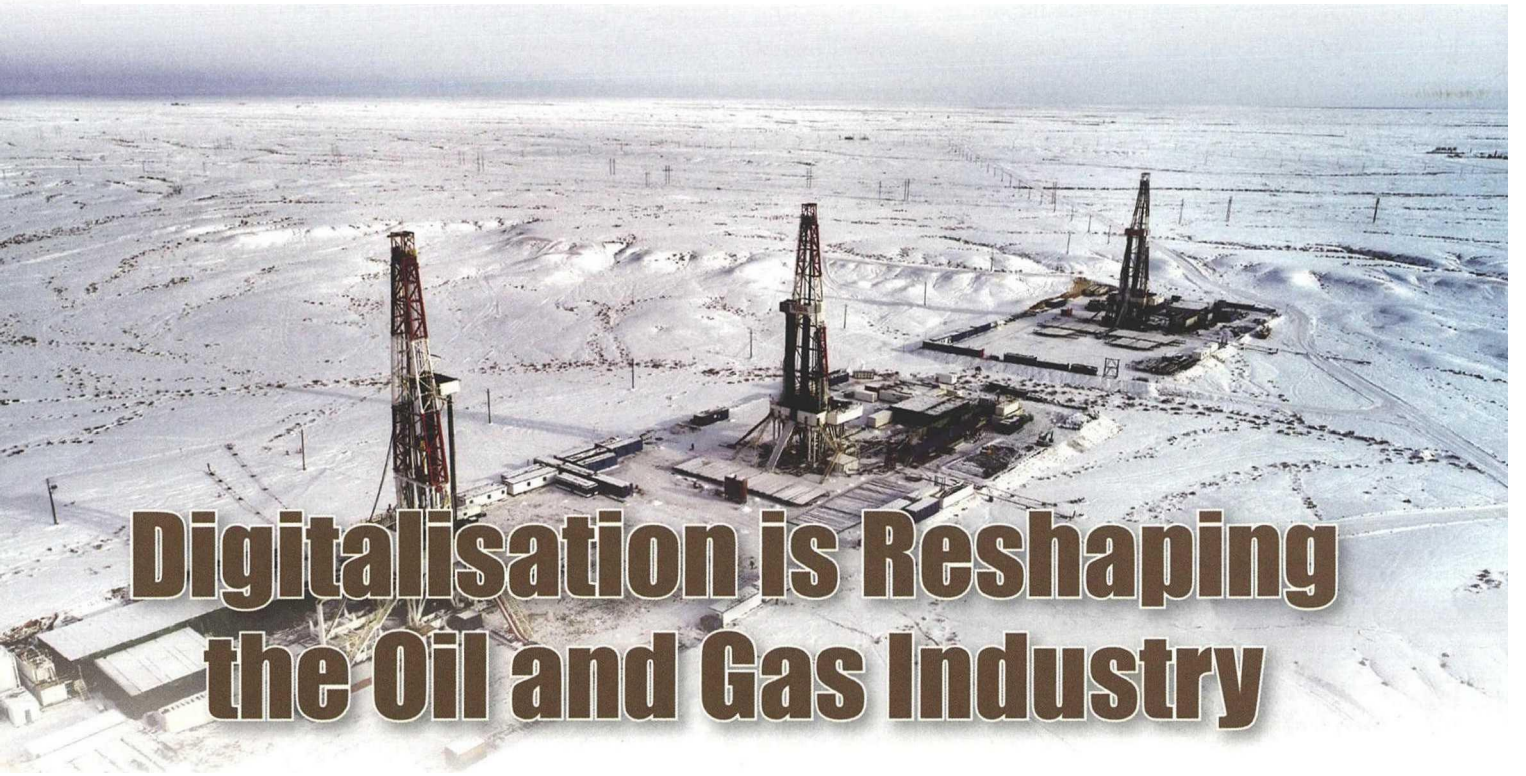

Digitalisation is Reshaping the Oil and Gas Industry

Qing ping
(Nantong University)

The "Industry 4.0" era is characterised by a series of new digital technologies, which affect every link of the vertical value chain and are the important driving force of world change. Digitalisation creates new jobs for people and creates more value for businesses. Capital-intensive industries such as the Aviation and Automotive industries have successfully transformed their business and operating models using digital technologies.The similarly capital-intensive Oil and Gas industry has gradually matured enough to undergo this digital transformation. In the "Industry 4.0" era, which will become highly automated, highly information-oriented, and has a high degree of networking, the Oil and Gas industry has the opportunity to redefine its scope of influence through new digital technologies. These new technologies are accelerating the arrival of the fourth industrial revolution.

Digital application areas in the oil and gas industry

Based on information technology, digitalisation refers to the application of digital technologies to change corporate strategy, business models, and customer ecosystems, so as to create commercial value for businesses. The digitalisation of the Oil and Gas industry is to apply digital technologies to drilling, oil field development, and production in order to automate the process and analyse the advanced data, thereby facilitating the upgrade and transformation of the traditional Oil and Gas industry. Currently, the digitalisation of the Oil and Gas industry mainly exists in the upstream and mid-stream areas; while digitisation in the downstream area is limited. Major oil companies around the world have partnered with technology service companies such as ABB, GE and IBM to create digital oil fields and smart pipelines using a series of new, digital technologies. However, compared to other industries, the Oil and Gas industry has taken many digital actions, which are generally considered conservative with limited impact on existing operations or business models. The digitalisation of the Oil and Gas industry is a gradual development, rather than a revolutionary change.

Upstream-digital oilfield

The digital oil field is a spatialized, digitalised, network-oriented, intelligent, and visualised technological system of the physical oil field. It relies on Digital Earth multimedia and virtual technology, which is based on geospatial coordinates, and integrates multi-resolution and massive data, to express multi-dimensional oil fields., Thereby

comprehensively informatizing the oilfield entities. During geological exploration, the information system and digital platform are used for data management. During, oil and gas exploitation, visual technology and dynamic simulations are used for efficient supervision and decision-making. During oil and gas production, real-time data collection and the IoT are used to manage the whole process.

Mid-stream-smart pipelines

The Smart pipeline is based on pipelines and the related lifecycle data. Using modern information technologies such as the IoT, cloud computing and big data, it collects, counts, and analyses the pipelines' properties and data in order to support pipeline construction and operation, integrity management, emergency pipeline and intelligent decision-making. As early as 2004, CNPC began to build digital pipelines along the Ji-Ning section of the West-to-East gas transmission project. To achieve centralised monitoring and scheduling of the Second Line of the West-to-East gas transmission project and the Sino-Burma oil and gas pipeline project, real-time data collection and pipeline network operation monitoring were used Sinopec began the construction of digital pipelines in 2007, starting with the Yu-Ji Pipeline. Then, in the Eastward gas transmission project of Sichuan, it used digitalisation to build a professional pipeline geographic information system, with the data covering the entire pipeline and ancillary facilities.

Downstream - refining and sales

Digitalisation of downstream business in the oil and gas industry has gained importance in recent years. In refining, Sinopec has supported digital development since 2013. It has piloted digitalisation in four refining enterprises: Jiujiang Petrochemical Company, Zhenhai Petrochemical Company, Yanshan Petrochemical Company and Maoming Petrochemical Company. The new retail idea in sales began to attract attention in 2017. New retail refers to a data-driven pan-retail style centred on consumer experience, using the Internet to achieve online and offline integration, full channel and reconstruction of people, goods and places. Influenced by the new retail idea, the Oil and Gas industry made changes in sales by promoting innovative oil products such as self-service tankers; and also in non-oil business with products such as Easy Joy online shopping.

Advantages of digital transformation in the oil and gas industry

According to Accenture 2016 Upstream Oil and Gas Digital Trends Survey, in the next three to five years, data and analysis tools, the industrial IoT, and mobile devices will be the most important areas in the digitalisation process of the Oil and Gas industry. Robots and UAV, AI and wearable technology will be the three fastest growing areas. These digital technologies play an integral role in promoting economic benefits, work efficiency, personnel safety, and environmental benefits.

Economic benefits

The digitalisation of the Oil and Gas industry helps companies to reduce their costs and expenditure and potentially bring in additional value. According to the Digital Energy Report 2017 issued by the International Energy Agency (IEA), digital technology can reduce production cost in the Oil and Gas industry by 10% to 20%. According to the Digital Transition Initiative - Oil and Gas Industry jointly presented by the World Economic Forum and Accenture, digitalisation can add an additional $1.58 trillion to the Oil and Gas industry, customers and society,of which $580-$600 billion is estimated to go to upstream enterprises; about $100 billion to mid-stream enterprises; and $260-$275 billion to downstream enterprises. BP, a British Oil and Gas company, has worked with Microgravity, a company from Silicon Valley, to develop a super-specific sensor that can be placed in deep boreholes to distinguish oil from water, thereby improving oil field storage monitoring. The technology is expected to save 5% of exploration and development costs, 20% of maintenance costs, 20% of overtime costs, and 10% of materials costs. Using digital technology in gas stations can better capture consumer preferences and their purchase patterns. Full-channel retail and experiential services can generate an additional $6 billion for the Oil and Gas retailers.

Work efficiency

The digitalisation of the Oil and Gas industry helps enterprises to improve work efficiency. According to the Digital Oil and Gas Chemical Industry - Safe, Efficient and Profitable published by ABB, oil and gas chemical companies can increase productivity by 30% by adopting digital management processes. Shell's Ormen Lange gas field is equipped with ABB's digital automation system in order tooptimise the control process and stabilise the production process. Robot Drilling Systems, in collaboration with Energid Technologies and Norway's Odfjell Drilling, has developed and deployed a robot drilling system, which has the potential to save 40 drilling days per derrick per year. Schlumberger, in collaboration with Parsable, has experimented with a

wearable technology based on Google Glasses, that helps staff save time on routine tasks such as on-site checklists and improves staff efficiency by about 15%. ING and Mercuria have used blockchain technology for the trading of crude oil and other commodities. Blockchain can improve the efficiency of the traditional commodity trading sector and create more efficient and transparent downstream business activities.

Personnel safety

The digitalisation of the Oil and Gas industry can reduce accidents. Before the emergence of digitalisation, Oil and Gas companies could only perform maintenance after abnormalities. Accidental collapses of critical assets, or disastrous accidents which negatively impacts on production targets had occurred from time to time. With the introduction of digital technology, equipment life is extendedand operational failure is reduced, which protect the safety of field workers. The UAVs and robots of Robot Drilling Systems can replace staff, preventing their presence at dangerous sites. The smart glasses developed by Schlumberger and Parsable provide real-time measurements, monitoring and safety checklists to improve the safety of field staff. Norwegian National Oil launched a completely unmanned platform on the Norwegian continental shelf, advocating the use of data, analysis and robotics technology to improve safety.

Economical benefits

The digitalisation of the Oil and Gas industry helps to reduce carbon emissions and polluted gases. 3D printing creates 3D objects by continuously adding multiple layers of material. The application of this technology in the oil and gas industry can reduce the need to transport parts to and from remote areas. This will reduce carbon dioxide emissions by 2 million tons. Columbia Pipeline Group, in collaboration with Accenture and General Electric (GE), has developed smart pipelines to transport natural gas. The technology integrates data from different sources, including geographic information, work management systems, control centres, call systems, and external data sources. Users can check data in different ways, quickly identify areas of concern, assess threats, and respond. This predictive analysis technology can reduce about 350 million tons of carbon dioxide emissions, as well as 150,000 tons of sulfur dioxide and 200,000 tons of nitrogen oxides. In addition, its environmental value includes a reduction in oil spill of 54,000 barrels in production and 65,000 barrels in transportation processes.

Opportunities and challenges for the digitalisation of the oil and gas industry

An emergence of new digital technologies will be developed rapidly in the Industry 4.0 era. The digital transformation of the traditional Oil and Gas industry will face both opportunities and challenges.

(1)Opportunities for the digitalisation of the Oil and Gas industry.

First, the Oil and Gas industry has a low-level of digitalisation, with much room for development. The Oil and Gas industry has played a key role in the transformation of the world economy, yet its degree of digitalisation is far lower than that of other industries. According to Digital China: Powering the Economy to Global Competitiveness published by McKinsey & Company, the three most digitalised industries in China, the United States, and the EU are information and communication technology (ICT), media and finance. The proportion of digitalisation in the Oil and Gas industry is only 40%, lower than the average 49% in other industries. The digitalisation of the Oil and Gas industry has been backward, suggesting vast room for development. Digital technologies which have been used and proven successful in Aviation and other industries can serve as a reference for the digitalisation of the Oil and Gas industry. Driven by disintermediation, disaggregation, and dematerialization, there is huge potential for the digitalisation of the Oil and Gas.

Second, periodic change in oil prices will promote the digital transformation of the oil and gas companies. Oil prices are influenced by supply and demand, geopolitical, financial, and other factors. Particularly, since 2014, the low oil prices have made it very difficult for Oil and Gas companies to keep shareholders satisfied. Oil and gas products are homogeneous, so it is difficult for companies to create a competitive advantage in product variety and quality. The Oil and Gas industry has to reduce costs and increase efficiency under the innovative operation model, and digital technology is the impetus for such innovation. Therefore, the use of digital technology to cut costs by oil and gas companies is an important step to enhance their competitiveness, and also an inevitable choice to survive and develop through periods of low oil prices.

Third, technology service companies have helped the digital transformation of the oil and gas industry. At home, Huawei is committed to becoming the leader and preferred partner of the ICT market in the petrochemical industry, actively building a good production chain to help the innovative development of petrochemical companies. Internationally, ABB is a well-known leader

in developing solutions and services for the petroleum, natural gas and chemical industries, with achievements such as Norway's national oil communication system project, the electrification of Troll oil field, and Valhall's secondary development project. At present, the Oil and Gas and Technology partnerships include CNPC and Huawei, Sinopec and JD, Chevron and Microsoft, BP and GE, Shell and HP, Schlumberger and Google. These world-renowned technology service companies can help the digital transformation of the Oil and Gas industry.

(2)Challenges facing the digitalisation of the Oil and Gas industry.

First, early-stage digitalisation cannot contribute to economic efficiency. For the traditional Oil and Gas industry, this early-stage of digital transformation will require vast financial support for technological research and development, as well as the acquisition and use of infrastructure. This will increase cost, thus bringing financial pressure to the companies, worsening the situation for those already in a period of low oil prices. Therefore, oil and gas companies will be concerned about whether they can survive this early-stage of digital transformation.

Second, oil and gas companies have not reached consensus in terms ofdigitalisation. The Oil and Gas leaders at all levels hold different opinions about digitalisation and how it can drive business transformation. Furthermore, the backward organisational culture and institutional, procedural, and cultural restrictions in traditional oil and gas companies hinder the process of digitalisation. Because the companies'organisational management system does not have a unified concept of digital transformation, decisions to use digital technologies are always put on hold.

Third, many digital technologies still lack commercial support. For example, some globally integrated oil companies have implemented the IoT, Cloud Computing, AI, Wearable Technology, and 3D Printing on a small scale, but there is a lack of successful experience in large-scale commercialisation. An American senior manager of an oil and gas company once quoted the proverb: "the consumer industry and IT companies in regards to digital transformation are that the 'early bird catches the worm', while that for the Oil and Gas industry is only 'the second mouse gets the cheese'". Many oil companies are taking a "wait-and-see" approach towards digital technologies, none of them daring to be the first to try new technologies. This results in slow progress in the digitalisation of the traditional Oil and Gas industry.

Fourth, ensuring data security is a great challenge. Cyber attacks from hackers and criminals will continue to increase as digital technology develops. The Oil and Gas industry's network environment is increasingly growing with networked computer equipment, personnel, equipment infrastructure, applications, services, telecommunication systems, and important information for transmission and storage. As the digitalisation of the Oil and Gas industry increases, the risk of their information being attacked also increases. Data security regulations can no longer meet the actual needs, and the speed of updating the relevant laws and regulations has fallen far behind the speed of digital technologies.

Suggestions for the digitalisation of Oil and Gas industry

The non-systematic application of new technologies cannot meet the needs of the Oil and Gas industry. Only by comprehensive promotion of digital transformation can the industry create significant value. Incremental changes are no not enough to unleash the full potential of digitalisation, nor can it address relevant challenges. Several suggestions to better carry out digital transformation for the Oil and Gas industry are as follows:

First, the development of a digital strategy should be the key prerequisite. Digitalisation must be included in the highest-level strategic agenda of Oil and Gas companies. Management needs to change its traditional way of thinking, and instead, should understand the necessity of transformation and the numerous benefits brought by digital technologies. As with any other significant transformation, management needs to develop a precise strategy, including a clear vision, investment and resources. The function of digital technologies in improving management and business model transformation also needs to be developed. The process of developing a strategy is one, which requires management of companies to reach consensus. The development of a unified digital plan to serve the ultimate business goals is the key premise for successful digital transformation in the Oil and Gas industry.

Second, reasonable investment and evaluation of returns should be guiding principles. The Oil and Gas industry should evaluate the returns on investment before digital technologies are introducedin order to develop a multi-year budget, which can help balance short-term and long-term economic benefits and financial pressures on cash flow. At the present stage, most oil and gas companies choose to cooperate with technology services companies. However, there are also other investment options to consider, including acquiring companies with the digital capability or establishing their digital platforms, etc. In conclusion, prudent selection of appropriate digital