The Ministry of Republic of Azerbaijan

Bachelor's Thesis

Automation in The Oil and Gas Industry

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Abstract

The oil and gas industry will continue increase in the next decades. Acquiring oil and gas from traditional and non-traditional way will become more and harder. This concentrating need will create very significant demands on financial and technology capabilities. Advanced technology will become progressively important to acquire access to more hard traditional and non-traditional resources because of increasing future supplies of oil and gas industry. For this reason, advanced technologies will be costly to run due to unfriendly and unreachable environments. The offshore oil industry will become a complex numerous of advanced technology, workforce, and structures. World's objectives are to identify potential implementation and research aspects of robotics and automation in the oil and gas industry and detect the barriers and challenges of robotic and automation applications to this field.

This study performs required to research and investigation about the automation process in the oil and gas industry. The three segments of oil and gas industry are first investigated. Technology's effect on this field is then explored. In addition, this study investigates current automation technology. The challenges and requirements are detected for automation and robotics in this area. Future research opportunities are explored.

Acknowledgments

I am thankful to my friends, Faiq Karimli, Gurban Gurbanov, Haydar Abdullaev, whose guidance and support from the start to the end enabled me to write this thesis.

Also, I would like to thank Fatima Gurbanova who provided me literature. It was very helpful to developing this thesis.

A special thanks to my family who support me during this thesis development.

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Abbreviations

PIM	Pipeline Integrity Management
SCSSV	Surface Controlled Subsurface Safety Valve
CAGR	Compound Average Growth Rate
ASOA	Azerbaijan State Oil Academy
IIoT	Industrial Internet of Things

HSE	Health, safety and environment
WEF	World Economic Forum
DTI	Digital Transformation Initiative

1 Introduction

In recent years, it is possible to see the importance of automation in transition to technological processes in new highly effective systems. Because of the increased efficiency of modern technological systems with great power depends on the automation of these systems. In order to solve this problem, it is important to introduce new automated management systems in the field of automation and management of production, further development of scientific and technical progress in this area and increase the effectiveness of the scientific works.

Modern refinement and chemical-technological processes combine objects from different classrooms in terms of management facilities. Therefore, when automating technological processes that have a great, powerful, modern science, the latest achievements in this area should be utilized.

The great role was played by the Azerbaijan State Oil Academy and "Neftqazavtomat" Production Association in the preparation of specialists and performs scientific research in the field of automation. In 1995, the Scientific Research Institute of Automation of Management Processes, established under ASOA, obtained scientific results in the field of automation and developed technical means. First turn of Integrated Automated Management System of "Sintezkauçuk" Manufacturing Union (1993), "Automatic control system of Latex production unit" (1994), "SULU-40 measuring instrument determining the amount of water contained in crude oil" (1997), "Oil products quality control system" applied at Baku Oil Processing Plant EO AVQ-6 (2003), "Automatic control system of technological process of organic acid pickling oil products" (2006) established on the orders of the enterprises. Since 2008, mass production of

“SULU-40” measuring instrument and devices which automatically detect the number of dissolved gases in crude oil has been started.

1.1 Background

Automation includes issues such as receiving, transmitting, storing and retrieving information about the status of devices using technology and software tools as well as object management for achieving a predetermined purpose.

As an example of automation is usually the practice of man's experimental activities, designs, communication systems, uninterrupted production, engineering, transport, energy, oil and gas mining industries, petrochemicals, chemistry, metallurgy, etc. can be attributed.

The main demand for automation objects is to ensure full control and management of the processes involved in these facilities. The main purpose of automation is the followings:

1. To ensure that human beings partly and completely are released from information and management processes.
2. To ensure that the processes in the facilities perform in the required direction.
3. To ensure coordination of the complex of objects that performs the function that serves a common purpose.
4. To ensure correction of their dynamic characteristics to improve the operable properties of objects.
5. To ensure compensation of unwanted external and internal exciting effects on processes occurring within the facilities.

1.2 Objectives

The mainstream of this thesis is to show the advantages, opportunities, and challenges of the appliance of Automation in the Oil and Gas Industry. The main objectives are the followings:

1. To demonstrate and analyze the current picture of automation processes in the oil and gas industry.
2. Identify future perspectives of technology.
3. Challenges and requirements in automation.
4. Summarize and suggest future recommendations.

1.3 Methodology

The goal of the thesis was to do a literature commentary on present theory with following analysis on relevant topics for Automation in the Oil and Gas Industry. This method helps to consider the Automation of Processes from different points of view. A major research was started by searching and discussing relevant documents for successful implementation of the method. The goal of the thesis was to do a literature commentary on present theory with following analysis on relevant topics for Automation in the Oil and Gas Industry. This method helps to consider the Automation of Processes from different points of view. A major research was started by searching and discussing relevant documents for successful implementation of the method. Documents were gathered from different sources: literature review, media sources overview, documentary analysis. The result is a theoretical description of Automation in the Oil and Gas Industry with its advantages, disadvantages and future prospects.

1.4 Thesis structure

The thesis contains three chapters. There is a brief description given below.

Chapter One gives main information about automation and technologies used in the oil and gas industry.

Chapter Two describes technology’s possible effect and future prospects on the oil and gas industry.

Chapter Three provides the main challenges and requirements of hardware and software in the oil and gas industry.

2 Chapter One

2.1 Automation process in the upstream segment

In the upstream segment, the aim is a fast return on investment. Participants desire to discover and produce product in the fastest, most secure, most efficient way. The segment is definitely risk-averse, and the uptake of new technology can take several years.

Still, drilling is an upstream segment that has benefited significantly from automation. In the first days of drilling, percussive cable rigs were used to create wells for mineral/hydrocarbon extraction. The rigs raised then dropped a weighted bit to crush rock, and the cuttings were removed through a safeguarding bucket *(Fig. 1.1).* These rigs were risky, labor-intensive, and slow.

Fig. 1.1 Cable drilling rig. (http://www.ritchiewiki.com)

After the cable rig, the rotary drilling rig was presented, which permitted torque to be transmitted to the bit through an electrically or hydraulically motorized rotating desk mechanically attached to drill pipe *(Fig. 1.2)*.

Fig. 1.2 Rotary table. (https://www.reuters.com)

As drillers gained knowledge with this new technique, many additional improvements were formulated. Of particular importance was the addition of control and monitoring of the weight of pipe on the drill bit, as this factor has a critical impact on drilling functioning. As near the beginning of the 1970s, the industry was taking into consideration computer control to more improve the drilling procedure. In any case, it was not until the very delayed 1990s that strong, generally established systems were actualized.

Fig. 1.3 The two rig hands on left tend to the wellhead while the others prepare the slips (coupling that holds the pipe in place) for the 2 3/8-inch pipe. Image © Chad Ziemendorf. (http://www.intersectionjournal.com)

Implementation of the rotary drilling rig set the new load on the rough working the rigs *(Fig. 1.3)*. This new technique required continual make and break of the notched links that comprise a sequence of drill pipe. Early harshness applied torque to connections by hand with pipe wrenches, and afterward with tongs (hydraulic wrenches). Both methods welcomed hand wounds.

Later progressions included the progress of the top force, an automated tool gets the winch that can make and break connections with little support from the rig group. More newly, some companies have been promoting automated pipe handling systems *(Fig. 1.4)*. These systems are designed to choose up sorted sections of drill pipe from a storage frame, move them into position on top of the borehole, and then relate torque to attach them. The advantages are clear. Far fewer citizens are in harm's way on the rig ground, and the sequence or trip time over an all-human group can be reduced.

Fig. 1.4 Robotic pipe handling system. (https://www.nabors.com)

Within the drilling segment, automation has even established its method into the borehole. In the early 1970s, a communication strategy was formulated that empowered communication of data from the drill bit to the outside through the creation of force beats in the drilling liquid circulated during drilling. Called mud-pulse telemetry, the innovation allows measurements of direction and downhole conditions to be transmitted to the outside so that the driller can respond and regulate drilling parameters as required. Nowadays, downhole steering gatherings and instrumentation have become so trustworthy that drilling directions are easily loaded into memory and the drilling construction holds its direction independently using classic closed-loop control. The mud-pulse telemetry channel can now be used to downlink with the drilling devices to fine-tune the drilling direction in real time.

An even faster communication link – wired-pipe telemetry – is in the first stages of receipt in the drilling section. Considerably than depending on fluid beats for data program, wired-pipe telemetry uses an inserted electrical conductor in particularly made drill pipe to carry signals to and from downhole devices. The electrical method is capable of impressively higher data rates, opening the doors to even further higher and strong closed-loop control.

2.2 Completions

A completion is each the method and instrumentation accustomed change a fresh drilled well to flow hydrocarbons from the formation to the surface. historically, oil wells are drilled and so cased and cemented, a method within which a string of large-diameter pipe is inserted into the well and cemented in place. to achieve access to the oil or gas formations at the target depth, holes are placed within the casing, cement, and rock formation exploitation flight charges, discharged from perforating guns. Typical completion instrumentation for such a well includes a packer, a tool supposed to anchor in and seal off the casing simply on top of the perforations within the casing; and a string of production conduit, that is smaller-diameter pipe connected to the packer. Production of the well then passes through a bore within the packer, through the conduit, and up to the wellhead at the surface.

The first components of the completion to become machine-driven were at the wellhead. A surface valve was edged to the highest of the casing, wherever production may well be started, balanced, or stopped by hydraulic or electrical valves. similarly, completions affected offshore, the necessity emerged for a valve to be placed within the completion below the surface so as to manage the well within the event of loss of the wellhead or stage. the primary of those subterranean valves were inactive devices, primarily rate-dependent check valves that will shut if the rate through them became too high. Inactive valves were effective at anticipating blowouts, however, had deficiencies: They attended plug with rubbish and valve settings couldn't be used to as a result of changes in good pressure.

To address these shortcomings, the initial surface-controlled subsurface safety valve (SCSSV) was presented in the late 1950s. This valve was controlled from the surface using steel hydraulic control lines, which permitted a user to unlock or lock it in response to good conditions. The valve also had a fail-safe characteristic, such that any harm to the wellhead or hydraulic controls would outcome in valve closure. However the adoption stage was nearly 10 years, SCSSVs have become regular equipment in many wells, and are one of the initial examples of an automated usage in a completion.

During the productive life of a completed well, it is often essential to re-enter the well to function therapeutic work. Called interventions, these well re-entries contain a range of tasks such as opening or closing valves, evacuating waste, or even drilling a new wellbore (called a lateral) using a place in the existing wellbore as a departure point. Intervention instruments are carried into the well by a range of resources, including threaded pipe, coiled tubing (a continuous spool of small-diameter steel pipe), slickline (a high-strength steel cable), and electric wireline (a high strength steel cable with one or more embedded conductors) *(Fig. 1.5).*

Fig. 1.5 Slickline unit and coiled tubing unit. (http://prowell-energy.com)

The sort of transportation chosen for an intervention is directed by several factors, including the objectives of the intervention, the well location, the sort of wellhead, the size, downhole conditions, well orientation, and even tools availability and costs.

Threaded pipe such as drillpipe might be chosen for intervention where high masses are expected. An instance would be a casing way out, in which a new part of well is created by processing a hole through existing well casing and cement, thus making a passage to the undrilled formation. In history, a casing way out has been a brute-force service. The spot of the exit is decided by the arrangement of a whipstock (a long anchored slope put in the inside diameter, or ID, of the well, that guides a downhole mill versus the casing). When the whipstock is in place, a cutting mill is brought down into the well and turned by the drillpipe or a mud engine to perform the cut. More recently, technology progressions such as mud beat and wired-pipe telemetry are being considered and even field-trialed for drillpipe interventions. These communication plans offer the possibility of closed-loop control for downhole cutting operations, resulting in enhanced performance and improved decision-making.

Small-diameter coiled tubing might be chosen for intervention for the reason that the intervention targets do not require great pulling, pushing, or rotating forces and the good machinist does not want to pull the production tubing out of the well. Because it is a continuous part of the pipe, coiled tubing can be quickly conveyed. When linked to downhole instruments, it can supply some activation power (pulling or pushing), produce temporary seals, execute milling or cut operations, or even be used for well inspiration medications such as breaking and acidizing.

Coiled tubing is conveyed using an injector, a hydraulic machine comprising a pair of clamps that hold the outside of the tubing and push it into the well. When a well is extremely deviated or straight, this pushing method will only work to a point, after which a machine called a tractor must be used *(Fig. 1.6).* Coiled tubing tractors are linked to a string of coiled tubing devices to help in reaching target depth. A tractor is comprised of hydraulic and motorized wheel segments which provide the extra power required to pull coiled tubing into the well.

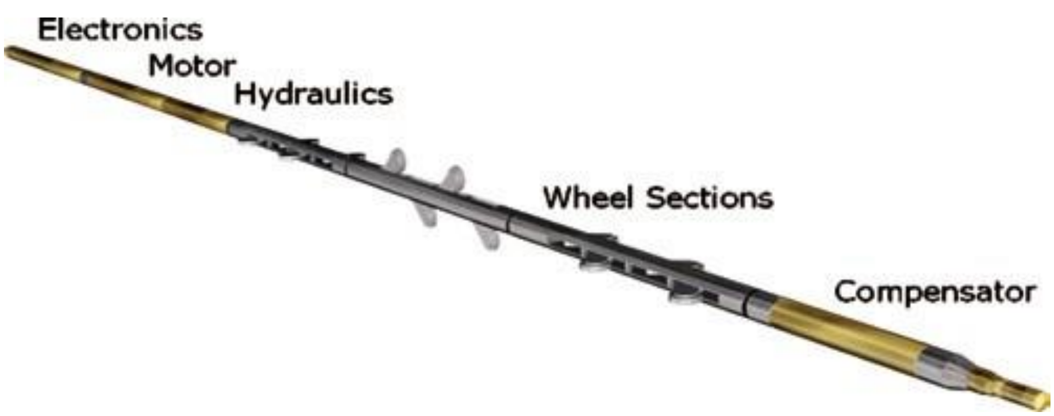

Fig. 1.6 Welltec Well Tractor.

Electric wireline is utilized once tools that require power square measure needed. Historically, wireline has been utilized in good work (where characterization instruments are lowered into a just-drilled well to assess formations) or perforating applications, but additional recently it's been accustomed convey intervention tools like downhole electrical cutters and mills. These devices accommodate motors and cutting structures and might build exactitude cuts to pipe downhole, or take away deposits of scale or paraffin. The tools typically incorporate extra actuators for positioning and securing the system whereas playing a cut.

Similar to coiled tubing, wireline deployments sometimes require the use of tractors when the well is extremely deviated or straight. Wireline tractors are analogous to coiled tubing tractors in both design and role, only the methods of power spread vary.

All of these intervention methods have costs, such as the cost of stopping production or giving service tools or charges connected with the service provider (mobilization, equipment rental, staff). The importance of the charges will change based on location, market conditions, and equipment accessibility, but in general, strung pipe interventions requiring a winch to convey are the costliest, followed in order of declining cost by coiled tubing, wireline, and slickline.

Stimulated by the view of saving money on intervention transportation as well as by a rising interest in mechanical technology during the 1990s, a joint industry group financed the Micro Rig project in collaboration with robotics huge iRobot. Micro Rig is an intelligent, unbound well tractor *(Fig. 1.7)*. The machine is battery powered and can lower itself to and return from a wanted aim depth in a well without the use of a rig or reel. However not strong enough to substitute threaded-pipe intervention, Micro Rig can be used in place of wireline and some coiled tubing interventions for tasks such as sleeve shifts or gauge retrieval. The machine is also small enough to be moved by helicopter, making it appealing for remote areas. Micro Rig has seen many field trials but has yet to see extensive acceptance as a viable intervention method.

Fig. 1.7 MicroRig robotic intervention tool by iRobot.

Intervention costs make many progressions in oilfield technology. As oil and gas wells progress into deeper and deeper water, the framework required to produce and approach the wells is moving from the sea surface to the seafloor. People were first used for setting up and service of subsea equipment, at enormous cost and risk *(Fig. 1.8)*. Fastened distantly operated vehicles are now the favored method of installation, examination, and modification of equipment on the seafloor. These gadgets offer extremely skillful controllers as well as high quality, real-time imagery, and can be conveyed from relatively small service vessels.

Fig. 1.8 Panther XTP by SAAB SEAEYE. (https://subseaworldnews.com)

Need to repair water pipelines, pushed the international oil and gas companies such as StatOil and Cheron to develop pipeline repair robotic systems. Robots can work in the water down to 1000 meters *(Fig. 1.9).*

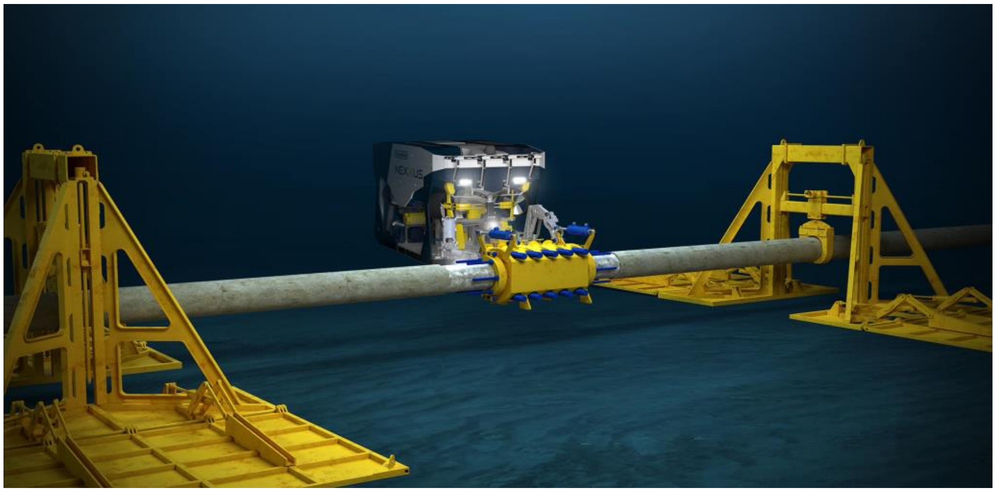

Fig. 1.9 Deepwater Pipeline Repair System. (https://www.oceaneering.com)

It is obvious to access subsea installations is difficult. So unmanned automated topside platforms may be a good alternative to increased accessibility for large operations *(Fig. 1.10)*. Furthermore, these platforms can recover up to 22 percent more of the oil or gas than a normal subsea alternative.

Fig. 1.10 SINTEF Topside Remote Platform. (https://www.sintef.no)

The Fraunhofer robot was developed for inspection *(Fig. 1.11)*. There are pipes, poles, and stripes of reflective tape applied to the environment for localization that help the robot for the inspection process. The inspection robot can work under 35+˚C ambient temperature, up to 90% relative humidity and direct sunlight for 12 hours per day. Furthermore, the robot has a laser scanner which used to perceive its environment. For perform visual inspections, the robot has a six-axis arm camera. The robot has wireless LAN and Bluetooth to communicate with the main control operator.

Fig. 1.11 The Fraunhofer Inspection Robot. (https://www.researchgate.net)

Intervention in subsea completions remains a hard and costly process. It was basically these costs that impelled the industry into considering automation inside the well itself to extend the time until intervention, or even eliminate the need for it. Called intelligent completions or smart wells, these downhole systems contain the regular completion equipment but add valves, chokes, sensors, and actuators that are distantly observed by both people and software.

By building in the capacity to change well performance in reply to good conditions, outside conditions, or even tools failures, operators enlarge the productive life of the well. The first clever completion was conveyed in the North Sea in 1997. For the next 7 years, engineers and marketers of intelligent good technology centered their efforts on matters of reliability *(Fig. 1.9)*. Accelerated life testing, breakdown mode analyses, and diversity in engineering devices more often seen in aviation found their way into hardware plan and preparation and, by 2004, frameworks were seeing broad use.

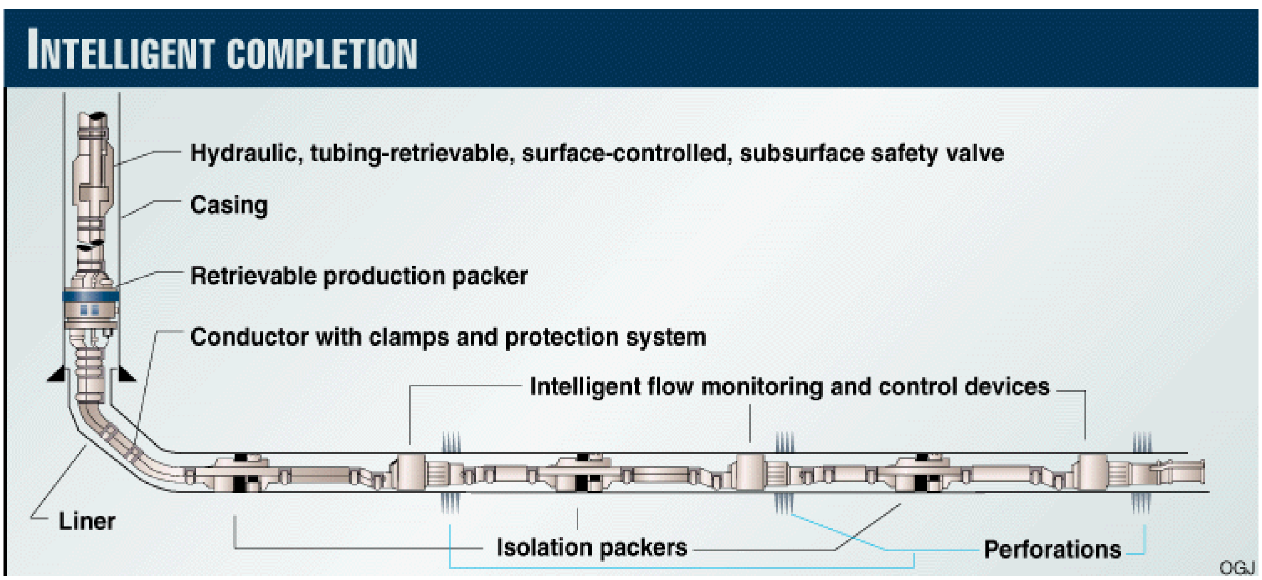

Fig. 1.12 Intelligent completion system. (https://www.ogj.com)

Modern intelligent well systems employ electrical, hydraulic, or visual umbilicals to broadcast data and commands to and from the configuration and the surface. These umbilicals are clamped to the outer of the completion hardware as it is run into the well, which makes their sending quite complex. Upcoming intelligent wells will help from more compact or even integrated umbilicals, and perhaps even remote telemetry. Uphole, data from downhole sensors will run from inspection by human specialists to prescient algorithms that propose optimization recommendations not just for special wells, but for whole fields.

Further, into the future, wells will change depth or structural design in answer to changes in data. Qahtani and Dialdin guess that upcoming wells will automatically abandon exhausted zones and re-deploy items into new segments of wells. Many guess that nanotechnology will be utilized in the progress of microscopic devices that can be pumped through geological formations for exploration, assessment, and performance observing *(Fig. 1.10)*.

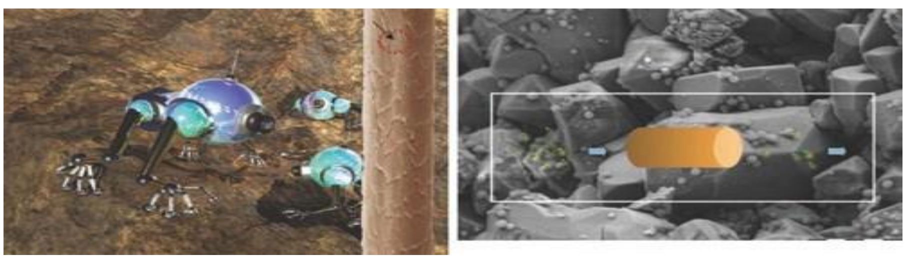

Fig. 1.13 Technology for future wells.

2.3 Automation process in the midstream segment

In midstream oil and gas operations, the framework is often more reachable, and the situations can be less harsh. Because of this, automation solutions have made great advances.

Beginning at the wellhead, many companies suggest independent data securing and transmission systems that interpret input from well gauges and broadcast data distantly for analysis. These transmissions systems may be part of a whole field network that can permit limited alterations to be made to the field act distantly.

Pipelines also advantage from their relative convenience and comparatively less threatening environments, since it is now achievable to convey tethered or independent inspection tools called smart pigs within pipelines to carry out inspections. These tools can calculate and record wall width and ID profile, and permit operators to make forecasts about corrosion or erosion rate, and conclude when to perform protection. Programmed smart pigs along with logical software are the important devices of PIM programs. These PIM programs plan to substitute reactive seepage repairs and other failures with practical, predictive maintenance that, for instance, repairs issues that can guide to spills before the spills occur.

The images portrayed under are pipeline inspection robots presented by Baker Hughes *(Fig. 1.11)*.

Fig. 1.14 Pipeline Inspection Robots. (http://www.imeche.org)

Oil transport and storage equipment like tankers conjointly create use of robotic devices for examination. bound robots are used both among the holds of oil tanks and on the outside hulls of the vessels to appear for injury or leaks. Offered by many makers, these devices can execute a pre-set examination path or be guided distantly *(Fig. 1.12)*.

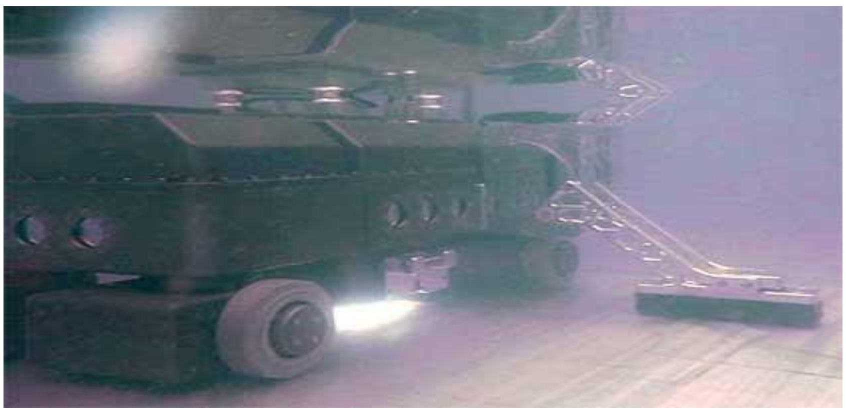

Fig. 1.15 In-Tank Inspection Robot. (http://www.newtonlabs.com)

2.4 Automation process in the downstream segment

The downstream segment of the oil industry is responsible for last processing, product distribution, and marketing. The downstream segment turns crude oil into usable finished products such as heating oil, asphalt, lubricants, synthetic rubber, plastics, fertilizers, pesticides, and pharmaceuticals. The downstream segment contains all retail outlets like gas stations. Marketing, customer service and strategic planning for the sale and distribution of finished products also are included in downstream.

3 Chapter Two

3.1 Technology's effect on oil and gas industry

Industry forces and digital innovations are remodeling the Oil and Gas industry. A disorganized adoption of latest technology may no longer enough, a holistic attainment to digitalization could create important value.

I will focus on how digitalization will allow the Oil and Gas industry's present and future revolution. This chapter also points to understand the influence that the digital transformation of adjoining industries, such as automotive and electricity, will have on the Oil and Gas sector. Digitalization's influence on Oil and Gas was considered over the value chain, from exploration and production to midstream, downstream and retail. The value analysis avoided market operations and trading, which were noted qualitatively.

Some dominant supply and demand forces are forming the Oil and Gas industry and the broader energy value chain *(Fig. 2.1)*. These include technological progress like horizontal drilling and hydraulic breaking, which are opening shale resources and playing a significant role in making the oversupply chargeable for permanent low crude prices. Other factors, like the growing interest in electric vehicles, are affecting demand. The impact of these forces, combined with the potential breakdown of digitalization, can be felt within Oil and Gas and adjoining industries.

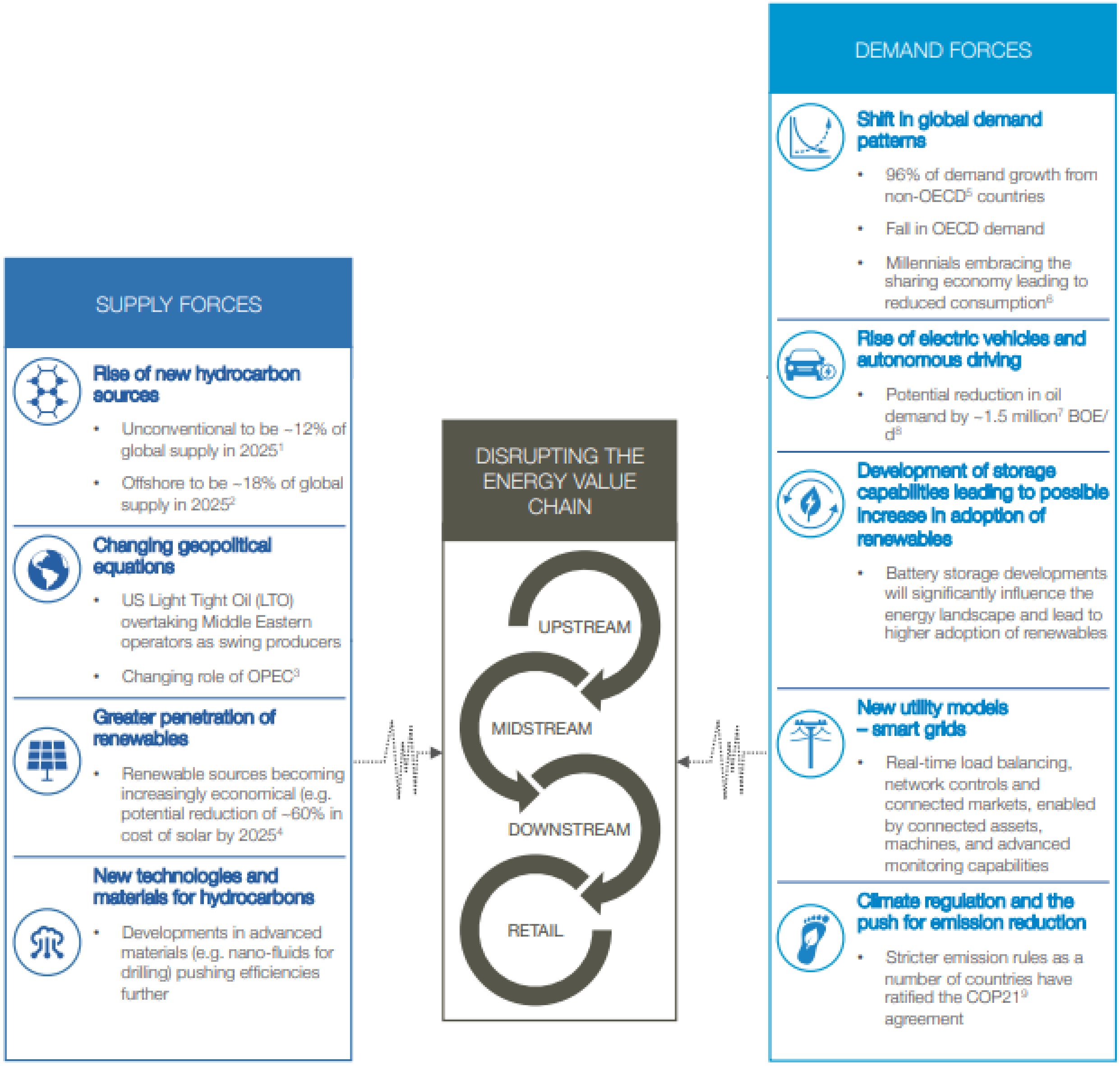

Fig. 2.1 Shifting trends in supply and demand are remodeling oil and gas industry. (World Economic Forum)

The breakdown in supply, demand and commodity prices, united with permanent market volatility, have made investors attentive of the industry, which has an inferior total return to shareholders compared to other businesses *(Fig. 2.2).*

10-Yr TRS CAGR (09/2006 – 09/2016)		5-Yr TRS CAGR (09/2011 – 09/2016)		3-Yr TRS CAGR (09/2013 – 09/2016)		1-Yr TRS CAGR (09/2015 – 09/2016)		MARKET CAP (09/2016; USD Bn)	
Technology	9.0%	Healthcare	17.1%	Technology	13.6%	Mining	32.0%	Bank	5,351
Healthcare	8.8%	Technology	14.4%	Healthcare	11.1%	Technology	19.8%	Healthcare	4,506
Retail	8.2%	Machinery	11.6%	Machinery	6.9%	Chemicals	15.5%	Technology	4,241
Machinery	7.1%	Retail	11.5%	Utilities	4.8%	Oil and Gas	14.9%	Oil and Gas	2,567
Chemicals	6.8%	Bank	9.2%	Retail	4.3%	Machinery	11.6%	Telecom	2,523
Telecom	6.8%	Auto	8.5%	Telecom	3.6%	Telecom	11.0%	Retail	2,421
Mining	4.3%	Chemicals	8.0%	Chemicals	2.9%	Utilities	7.4%	Utilities	1,831
Auto	2.7%	Telecom	7.5%	Bank	0.6%	Healthcare	5.9%	Chemicals	1,608
Utilities	2.3%	Utilities	5.2%	Auto	-1.7%	Auto	4.3%	Auto	910
Oil and Gas	0.0%	Oil and Gas	0.2%	Oil and Gas	-5.3%	Retail	0.6%	Mining	823
Bank	-0.3%	Mining	-7.8%	Mining	-6.3%	Bank	0.4%	Machinery	557

(Note: CAGR = compound average growth rate)

Fig. 2.2 Total return to shareholders.

3.1.1 Digital trends

In comparison to other sectors, the industry's approach to digital transformation is anticipated to be evolutionary instead of revolutionary. However, developments in technologies like the cloud, social media, and big data and analytics are driving trends that have huge potential for Oil and Gas. Cloud computing can improve business nimbleness by breaking down silos of company business functions. Big data and analytics will facilitate innovation by supporting corporations in analyzing massive quantities of structured and unstructured data from different sources, and generate real-time insights. Mobile technology allows new business situations, whereas social channels improve relationships with customers by probably creating these connections fast, direct and low cost. The falling cost of sensors and the emergence of the industrial internet of things (IIoT) will immensely increase the volumes of data that corporations can access.

Combining these technologies in innovative ways that could enlarge their capabilities exponentially, way on the far side their effectiveness if deployed individually. This combined impact will presently add a new level of connected intelligence to oil and gas operations. Beyond rising efficiency, digitalization could permit corporations to higher reach out to customers. Big data and analytics, IIoT and mobile devices are rising as prime digital topics for oil and gas companies *(Fig. 2.3)*.

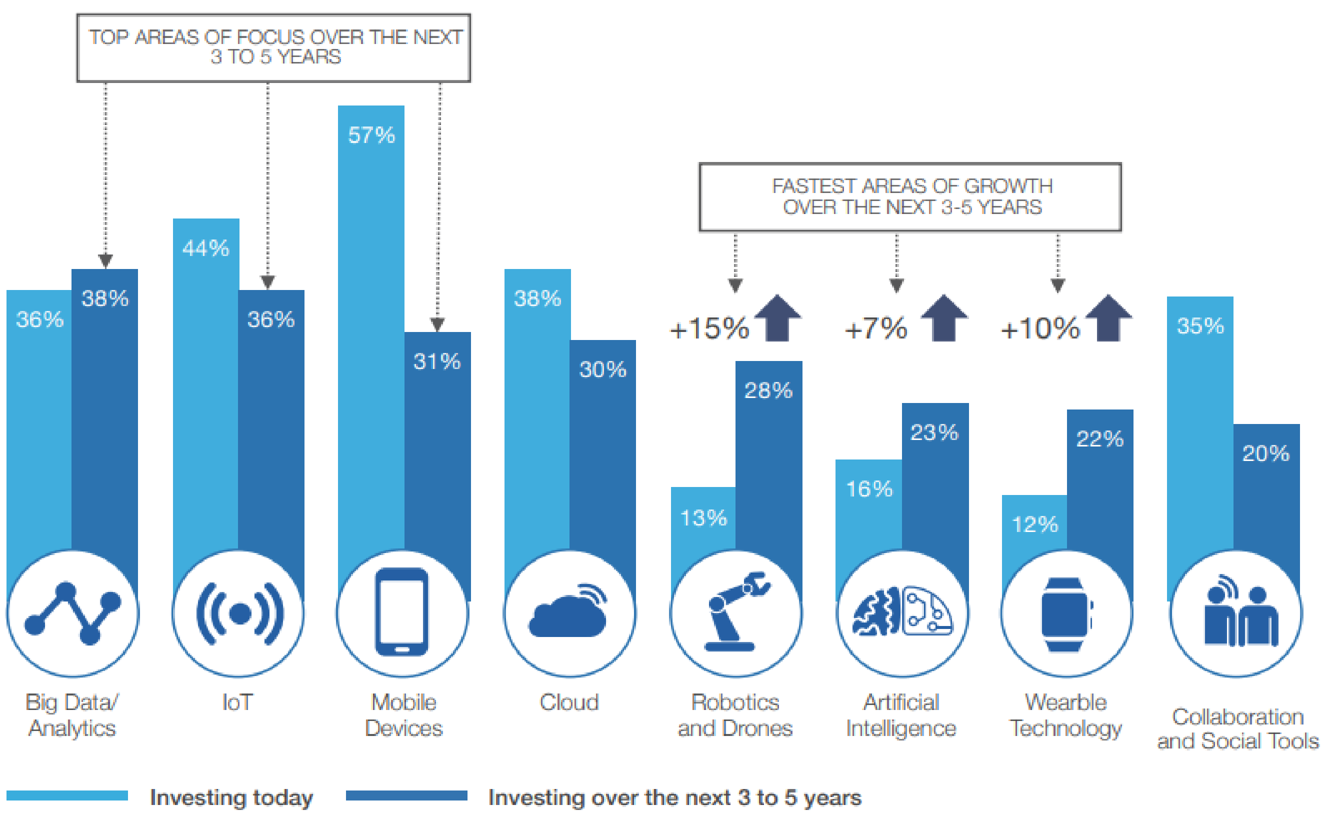

Fig. 2.3 Investment in digital technologies. (Accenture, The 2016 Upstream Oil, and Gas Digital Trends Survey)

3.1.2 Big data and analytics

Cheap sensors, extending network, and ever-greater computing power are driving the rise in data collected by oil and gas companies. Modern offshore drilling platforms have roughly 80,000 sensors, which are predicted to generate roughly 15 petabytes of data during an asset's era. Big data and analytics will aid firms to explore this massive sum of data. Approximately 36% of Oil and Gas companies are already investing in big data and analytics. Though, just 13% use the experiences from this technology to force their approach on the way to the market and their competitors. This divergence highlights how these companies have not always inserted big data and analytics completely in their frameworks, but are only applying the technology little by little. Full-scale sending could have extensive impacts on output and operations.

3.1.3 The Industrial Internet of Things

"The IIoT is a system of interrelated computing devices, mechanical and digital machines, objects, or people that are provided with unique identifiers and the ability to transfer data over a network without human-to-human or human-to-computer interaction" (World Economic Forum: Digital Transformation Initiative). In developing from a merging of separate technologies, the IIoT has broken down the walls between operational technology and information technology. This means unstructured, machine-generated data can be analyzed for experiences that force enhancements in plan and execution, and guide to smarter, faster decision-making. IIoT, in addition, enables machine-to-machine communications.

Some problems that IIoT can solve are followings:

a) To resolve unproductive and unplanned downtime happening in oil and gas exploration by monitoring the critical assets.
b) To ensure better utilization rate of critical assets
c) To increase the efficiency, productivity, and lifetime of the assets.
d) To reduce the losses that occur during processing, transportation of oil.
e) To reduce the accidents and catastrophic events happening at rigs.

3.1.4 Mobile devices

Oil and gas companies have invested heavily in fully integrating mobile devices into everyday operations. The major benefits of this integration include workflow improvements from better group communication, increased worker productivity and better recording of field data. Mobile technology also allows for real-time data monitoring via specialized software on smartphones and can have a positive impact on health, safety and the environment (HSE). Companies have improved employee safety by using smartphone GPS coordinates to track workers in hazardous situations. Deploying mobile applications in combination with radio-frequency identification tags is making assets smart and their movements visible.

4 Chapter Three

In this chapter, I focused on the environments that automation will be applied. It also emphasizes hardware and software requirements.

4.1 Challenges in oil and gas industry

Today’s oil and gas industry is facing geographic challenges such as the deep waters of Mexican Gulf, the frosty regions of Russia and the hot, unimproved deserts of Middle East. The initial thing to consider when analyzing the environments, the work conditions on offshore establishments. The most significant ones are as followings:

a. Atmosphere – The atmospheric conditions on offshore platforms are very threatening. Because of the materials used and generated during the processing of hydrocarbon resources, three types of gases occur. These gases can occur separately and mixture.
b. Unprotected maritime environment – Offshore platforms are partly protected and unprotected apart from living spaces and a few technical rooms. In this case, direct sunlight and saltwater can harm the safety of people.
c. Heavy weather – High-speed wind, rain and snow, all these weather conditions happen more frequently and more intensively to offshore.
d. Extreme temperature – There can be excessively high and low temperatures according to the region the platform is established.

e. Restriction area or walking paths – The width of the characteristic walking path is approximately 0.70 - 0.75 meters.

There are main two logistical issues that offshore rigs have:

a. Firstly, personnel must be protected and working in safe condition. However, it is very expensive.
b. Secondly, it must be possible to discharge personnel quickly in the case of emergency.

As oil and gas exploration drive into more unfriendly and remote regions, these hassles become serious barriers to the financial viability of an offshore setup.

There are some disasters that created hesitations against using robotics and automation in oil and gas industry. One of these disasters is called Deepwater Horizon oil spill which occurred at the Macondo Prospect. Deepwater Horizon has created a great agreement and legislation. The main part of the legislation requires a rise in investigation and repair at offshore rigs where robotics and automation will find a role in make possible those in the industry to satisfy these new norms.

The operations realized on these types of platforms must be accepted to create application scripts for mobile robots. Operations might be scheduled and occasional. The scheduled operations are duties planned on the daily basis. The occasional operations are tasks triggered by exterior influence on a more or less random base.

The most significant scheduled operations are the followings:

a. Inspection – gauge readings and valve and lever position readings.

b. Monitoring – gas level, check for leakage, acoustic anomalies, surface condition and check for intruders.
c. Maintenance – gas and fire detector test, sampling, pigging, cleaning, refilling and pipelines.

The most frequent occasional operations are:

a. Valve and lever operation – change pressure, change flow rate and start or stop equipment operation.
b. Gas leakage – identify and locate, stop dangerous operations (welding, cutting, …) and secure area and stop leakage and monitor concentration drop.
C. Fire – identify and locate the fire.

The robot can operate at different levels of automation. It might be fully automatic, semi-automatic and manual. Fully automatic operations don't require human intervention. Semi-automatic operations might be requiring varying degrees of human intervention. This is a bit different from the traditional robotic applications because decision makers must be into the control loop to cooperate with the robots and the control system. The successful implementation of robotics and automation will trust in the excellent integration of human, technology, and organization.

The inspection robots may need continuous human involvement compared to the fully automated robots. This makes them the simplest. The manipulation robots have to make decisions while performing several tasks. That’s why this makes them more complex than the inspection robots. Considering in the short term, the inspection robots make a better result in the oil and gas industry.

4.2 Requirements for hardware development

The hardware of the mobile inspection and robots must be suitable for reliable and useful offshore operations. There are some requirements must be applied:

a. The device must be certified.
b. The device must be explosive-proof, weather-proof and water-proof.
c. The devices must be fit for hard situations.
d. The drive systems of the device must be qualified for the unfriendly environments and the additional floor conditions.
e. The device has to maneuver in limited areas. For this reason, its size must be fitted to already described reference passage.
f. The device must be equipped with extremely dependable sensors to comprehend its surroundings, particularly to detect barriers.
g. The device must be able to move in the perpendicular on basic ladder-type steel areas.
h. The device must be equipped with sensors to trace its position for movement.
i. The device must be equipped with an operator to commit objects and position sensors.
j. The device must have relevant sensors and tools to realize inspection and operation tasks automatically, semi-automatically or manually.
k. The device must be able to get in touch with the main control station.

4.3 Requirements for communication

Distant nature of offshore installations is a great challenge for teleoperation in the oil and gas industry. The offshore rigs might be located far away from land, for example, hundreds of miles, managing complicated and dynamic operations in tough environments.

Operation setbacks in this kind of installations may ensue poor outcomes for human operators, the environment and process devices. Safe and effective teleoperation is significant for such facilities, providing an advantage and optimal efficiency at remote locations.

4.4 Requirements for software development

A mobile robot can be used without professional experience more like easily and intuitively as a daily-used tool. This means that:

a. The device can be controlled automatically, semi-automatically and manually.
b. New examination and manipulation duties can be programmed fast and without the help of specialists.
c. Interact with robot must be safe.

For this reason, the software for a mobile robot should provide following important functions:

a. To navigate without collision both in remote mode and in automatic mode.
b. To easily program ordinary inspection and manipulation tasks.

c. To realize pre-programmed tasks automatically.
d. To execute surveillance and control of the robot from a distant location.
e. To display data such as the actual gas concentration, camera images or other information on the remote screen.
f. To warn the remote operators when anomalous sensor values are defined.
g. To look at recordings of former autonomous inspection tasks at the screen.

4.5 Requirements for robotic systems

Due to the unprotected marine environment, bad weather condition and hostile, explosive, poisonous and corrosive atmosphere, offshore platforms pose a tough environment for operators. Mobile robots must accomplish some challenges that do not endure in any other application in order to apply mobile robots in offshore platforms. These challenges are the followings:

a. Complex environments – There are complex structures like pipes, tanks, stairways, steel frames in offshore platforms. It can be hard to mobile robotics detect these structures by sensor systems. The sensor system must be able to differ appropriate structures like barriers and free transitions.
b. Floors – Offshore platforms mostly composed of plain steel floor and grilles.
c. Explosive atmospheres.
d. Humidity – Relative humidity can increase up to 100 percent.

e. Temperature – Depending on the platform's location the environmental temperature demonstrates important variations. The mobile robot must be workable in temperature between -30˚C and +50˚C.
f. Corrosive Environments.
g. Other conditions – Extremely radiant heat.

Conclusion

There is no doubt that oil and gas companies will benefit not only by increasing the use of more intelligent technologies but also by reducing the human risk factors present in challenging environments at the same time. There is a clear incentive from oil and gas companies to isolated operations, such as the tasks related to pipe processing and drilling and equipment operations to automate oil and gas facilities. These examples represent high-risk operations for humans and therefore offer opportunities to improve HSE performance. In addition to increased productivity and productivity, robots used for high-risk tasks will also lead to improvements in HSE performance. Such tasks are not always predictable and represent unusual robot activities. For this reason, the robot will require features that extend human decision-makers' "eyes, ears and hands" and perform control and maintenance operations on the process infrastructure. Reduced commissioning and operating costs are some of the potential benefits of having normal unmanned top oil platforms, along with improved HSE. However, such oil and gas platforms require advanced methods and tools for monitoring remote control and control and maintenance operations.

In this study, an introduction to the automation in the oil and gas industry has been made. The challenges and requirements of robotic and automation equipment are being investigated. Future research opportunities such as robot manipulator, mobile platform, teleoperation and submarine robots are being discussed. In general, we think there are many opportunities in the oil and gas industry and that some research is being done to improve robotic and automation applications. For this reason, it is the best time to develop robotic and automation systems that can meet oil and gas requirements.

References

Afandiev I.R., Karimov C.K., Maharramova T.M., Automation of field technological processes, 2016.

“Drilling rig”, Wikipedia. <http://en.wikipedia.org>

Eustes Alfred W., The evolution of automation in drilling, 2007.

Hovda S., Wolter H., Glenn-Ole K., Olberg, Potential of ultra-high-speed drill string telemetry in future improvements of the drilling process control, 2008.

Lurie P., Head P., Smith J., Smart drilling with electric drilling, 2003.

Oubre H.J., Thurman R., Vallee J.C., Emergency shutdown systems – evolution and status, 1977.

Omari M., Plessing H., Innovation in coiled tubing tractor technology extends the accessibility of coiled tubing in horizontal wells, allowing better possibilities for well intervention, 2007.

Schwanitz B., Henriques K., Interventions with reliable execution in hostile environments, 2009.

Moritis G., SPE: industry slow to adopt downhole robotics, 2002.

Rudakevych P., Fuel cells for robots., Fuel cells for portable power workshop, US Department of Energy, 2002.

Mathieson D., Intelligent completions technology has come a long way since ’97, but the road ahead is long., Drilling Contractor, 2007.

Robinson M., Intelligent well completions. Technology Today Series: J Petrol Technol, 2003.

Qahtani A., Diadin H., Future advanced completion technologies to maximize recovery, 2009.

Bhat P., Bhat S., Use of nanorobots for logging, 2006.

Bradley H.B., The petroleum engineering handbook. Society of Petroleum Engineers, 1987.

Thomas J.P., Anderson C.E., Armstrong R.A., Guinn D.C., Design of a subsea petroleum production system, 1968.

Trice A., “The Future of Cognitive Computing”, IBM Bluemix Blog, 2015. <https://www.ibm.com>

Accenture, The 2016 Upstream Oil, and Gas Digital Trends Survey. <https://www.accenture.com>

TechTarget, “Definition: Internet of Things (IoT)”, IoT Agenda, July 2016. <http://internetofthingsagenda.techtarget.com>

Upstream Oil and Gas, 2014. <http://www.upstreamoilandgas.com/>

Gary, J.H., and Handwerk, G.E., Petroleum Refining Technology, and Economics. 2nd Edition, 1984.

GE Energy, 2011. <http://www.ge-energy.com/solutions/index.jsp#tabs-industries>

Meeting the Challenges of Today’s Oil and Gas Exploration and Production Industry. <http://www-935.ibm.com>

The Robotized Field Operator. <http://www.isa.org>