Coming of Age:

Digital's Role in Reshaping Canadian Oil and Gas

Foreword

With the new normal for oil prices seeming to be well below US$100 per barrel, companies in the oil and gas sector no longer have the luxury of simply tightening their belts in the downturns and waiting for the good times to roll. The good times may never return in quite the same way again.

But what is a commodity-based industry to do when the price of that commodity declines? The answer, in the case of oil and gas, is to wring cost out of operations, look for unexploited efficiencies and opportunities, and find new ways of doing business and producing revenue, all of which point the way to new digital technologies – technologies that are reshaping entire industries around the world.

To provide insights into this difficult problem, the IT Media Group (ITMG) undertook a research project with sponsorship from Salesforce Canada. The initiative was led by Nasheen Liu, ITMG Managing Partner and SVP CIO Program Strategy. Primary research, content creation, and editing was completed by Dave Carey, ITMG VP Content. John Pickett, ITMG VP Executive Programs, conducted supplementary research, industry polling, and executive interviews. Content review, final edits, and report production was completed by Jeff Ishii, ITMG Chief Technologist and VP Operations.

This report contributes to ITMG's mission of supporting and adding value to the CIO community in Canada. It is our goal to provide a wide range of opportunities for direct engagement between IT vendors and CIOs, enabling them to share knowledge and opinions, provide thought leadership, build relationships, and engage in a dialogue of benefit to both parties.

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Executive Summary

The challenge for CIOs is that IT has long been the neglected child of the Canadian oil and gas industry, not much understood or valued by senior management and left out in the cold with respect to corporate strategy. Now CIOs must find a way of making their voices heard in order to ensure that their companies take the right steps along their digital journey, and they must change the corporate perception of IT from cost centre to cost reducer and revenue generator.

This study aims to equip IT executives with insights that will help them advance their digital transformation agenda, identify barriers that need overcoming, understand how the industry is embracing new technologies, and better prepare themselves for making the case for such technologies with their executive peers.

Methodology

The study taps into the storehouse of knowledge accumulated by The IT Media Group (ITMG) in its seven years of hosting private roundtables and conducting personal interviews with Canadian oil-and-gas sector IT executives. In addition, both global and Canada specific industry research was undertaken to further inform the study. Finally, ITMG polled a cross-section of Canadian oil-and-gas industry IT executives to gauge their interest in and use of many of the key technologies discussed in this report.

Scope

The technologies examined in this study include cloud, business analytics, artificial Intelligence, machine learning, IoT, connected workers, mobile apps, edge computing, smart vehicles, 3D printing, and blockchain. Also discussed is cyber security and the changing digital space, the impact of new technologies on the Canadian workforce, and the role of vendors in digital transformation. A concluding section identifies key areas of business benefits for these technologies, makes recommendations for actions to further CIO digital agendas, identifies the barriers that must overcome, and provides guidance for CIOs to win the support of their organizations.

Selected key findings

Cloud has solidified its position as an important enabler and sometimes a prerequisite for many of the new technologies impacting, or soon to impact, the oil and gas industry, and as such, it is becoming ubiquitous. Of the executives polled for this study, the large majority (81%) are already using cloud, while the rest are planning to use it within the next two years. Cloud offers a cost-effective means of utilizing more of the vast quantities of structured and unstructured data generated by the industry.

Riding on the coattails of cloud is predictive analytics, already adopted by nearly 20% of the polled companies, with more than half of the remaining ones expecting to adopt the technology within two years. Analytics have a big play in the upstream, midstream, and downstream sectors, with effective uses of data becoming table stakes in the Canadian industry. Upstream, they can improve the processing of seismic data, leading to faster decisions and an increase in the

operating time of drilling rigs, wells and facilities; midstream they can provide a more holistic view of pipeline systems, enabling them to be viewed as a single data set; and downstream, they can speed up the decision-making process and help empower managers to make better decisions.

Mobile apps are becoming hugely popular in the industry, a fact that is helping lead the way to the connected worker, a market that is expected to explode over the next few years. By 2025, connected workers – using wearables, along with smart phones and connected devices – could be up to 15% more productive than those not connected. IoT is another technology that is strongly on the upswing in oil and gas, adopted in nearly half of companies polled for this report, with another third planning to adopt IoT within the next two years. With the cost of IoT devices now negligible, equipment, pipelines, wells, refineries, buildings, structures, vehicles and much more are being made smart, in the sense of being able to capture data to make them safer, more efficient, more resilient, more self-diagnostic, and more contributory to the company as a whole.

The remaining technologies examined in the report are at earlier stages of maturity. AI and machine learning are still in the early adoption phase, but they are on the radar of many companies and are expected to ramp up quickly. There is certainly interest in blockchain, but it will be slower out of the gate, with a few companies running up trial balloons in the next couple of years. Edge computing and 3D printing, while promising technologies, are not expected to have wide adoption for several more years.

Conclusions and recommendations

The study determined that there are significant opportunities for Canadian oil and gas companies to make effective use of new digital technologies. The benefits of these technologies promise to improve both the top and bottom lines of the organization. A dozen key recommendations were developed for IT executives to advance the digital agenda within their companies. Among those recommendations are:

- Ensure that cloud computing is the cornerstone of digital transformation. Focus on applications, data quality management, and collaboration
- Predictive analysis technology should be part of the strategic roadmap
- Connect workers to enterprise systems through the use of IoT and mobile technologies

The study concluded with the barriers that put a damper on digital initiatives. Guidance is provided to help CIOs elevate their roles to overcome these barriers to make their digital strategies successful.

# Introduction: The Digital Imperatives for Oil and Gas

Digital technology is fundamentally transforming businesses and industries across the globe, and it is now the responsibility of IT executives everywhere to ensure that their organizations are not left behind on the digital journey. In the Canadian oil and gas sector, the challenges for IT executives are especially great. How do you introduce transformative technologies to an industry that has historically undervalued IT – that has invested in it in lockstep with the price of oil rather than taking a long-term strategic approach? How do you move the needle on IT from cost centre to cost reducer and revenue generator?

Digital technologies lay the groundwork for new ways of doing business

There are no simple answers to these questions, but one thing is certain: when it comes to digital, Canadian oil and gas companies can no longer afford to go with the flow – that is to say, the cyclical ebb and flow that undercuts the IT organization's ability to implement a forward-looking strategy. While crude oil prices have rebounded from their 2016 low, the industry's glory days of US$100+ per barrel may well be in the rear-view mirror, especially as alternative energy sources take a larger share of the market. That makes it incumbent on sector firms to cut waste from their operations, find ways of gaining efficiencies, and lay the groundwork for new ways of doing business – all of which point the way to new digital technologies.

10-20%

possible decrease in production costs through widespread use of digitization

5%
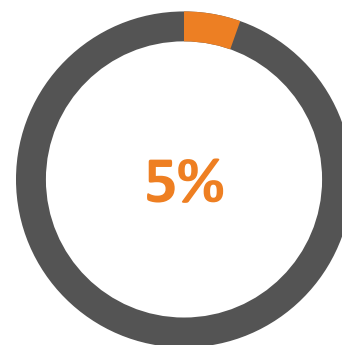
boost in technically recoverable resources by using digital technology

In its report, 'Digitization and Energy 2017'[1] , the International Energy Agency stated, "The widespread use of digitization in the oil and gas sector could decrease production costs by 10% to 20% while also boosting global technically recoverable resources by about 5%." With revenue in the Canadian upstream sector alone averaging $110 billion annually[2], it is plain to see that digital is poised to have a profound financial impact on the industry. For companies to remain competitive, digital can no longer be ignored.

In the Canadian oil patch there is certainly broad awareness of this, but the move to digitization is being hampered by tight budgets. Commented one Calgary-based IT executive for this report, "I wouldn't say that digital transformation is taking off in the oil and gas sector. There's definitely more digital disruption happening in the integrated majors,

especially in the downstream side of things. On the upstream side the focus tends to be on industrial automation. There's certainly more use of IoT and wanting to get a lot more automation at the wellhead, but I wouldn't say it's disrupting. There are efficiencies to be had, but it's not turning the industry on its head."

While digitization has been slow in coming to Canada, many firms have already started on the journey. Stated one of our interview subjects, an IT executive at a large integrated oil and gas company, "We began working towards digital transformation about a year and a half ago. There were two big bodies of work that we needed to start. The first was digital enablement – preparing ourselves as an IT group to be able to respond to a digital strategy. We also needed to modernize certain systems and put certain platforms in place. The second piece of work was to try to define, for our internal business partners, what digital transformation actually means. We did a lot of hard work figuring that piece out. We're now at the point where we've set up the digital transformation council, with senior members of the executive leadership team participating. We've done quite a bit to move all this forward, but the big buckets of work are still very big buckets."

A guide to navigating the digital landscape

This study aims to provide IT executives with insights that will help them advance their digital transformation agendas, understand how the industry is embracing new technologies, and better equip themselves for discussing and making the case for such technologies with their executive peers.

As a long-time content and event producer in the Canadian oil patch, The IT Media Group (ITMG) has captured countless insights on the use and management of technology within the sector through boom, bust, and recovery cycles. This study taps into that storehouse of knowledge, gathered from seven years of hosting private roundtables and conducting personal interviews with oil-and-gas sector IT executives. In addition, we completed both global and Canada specific industry research to identify valuable information with which to further inform the study. We have also consulted with domain experts and the ITMG CIO Advisory Board, composed of IT executives from industry and academia. Finally, in September/October 2018, we polled a cross-section of Canadian oil and gas industry IT executives on their interest in and use of many of the key technologies involved in digital transformation. Follow-up interviews with select respondents were done to further refine and validate the study findings.

The study explores several technologies that play an important role in reshaping the oil and gas industry. It also looks at cyber security and the changing digital space, the impact of new technologies on the Canadian workforce, and the role of vendors in digital transformation. A concluding section summarizes the business opportunities, provides key recommendations for IT executives, identifies the barriers that must be addressed, and provides guidance for CIOs to win support for their digital agendas.

Key Digital Technologies

The study looks at several key technologies that will play an important role in reshaping the oil and gas industry. These include cloud computing, business analytics, artificial Intelligence, machine learning, IoT, connected workers, mobile apps, edge computing, smart vehicles, 3D printing, and blockchain.

Business drivers and solutions

Cost savings tops the list of business drivers that will spur digital adoption. Technologies that promise to significantly reduce costs over the short to medium term will get plenty of love from the industry, especially in Canada, where budgets are tight and the need to impact the bottom line is great. Other short to medium term business drivers, such as increasing productivity and improving efficiency, will punch above their weight in the current climate because of their near-term impact on the bottom line. Drivers that are more strategic in nature and which require a longer time to deliver value may be a harder sell, but they are none the less important. Among them are the need for the business to remain competitive, develop new opportunities, attract and retain skilled workers, provide a safe working environment, and be more operationally nimble.

As pillars that will support much of the oil and gas industry's digital transformation, the study looks first at *cloud computing* and *business analytics*, key technologies for driving value from the industry's huge stores of structured and unstructured data. These technologies pave the way for the implementation of *artificial intelligence* and *machine learning*, both of which depend on examining and analyzing large stores of information. Continuing the focus on data, the study looks at *IoT,* which is becoming a major source of data in the field. Utilization of such data will become increasingly important to *mobile apps* and *connected-worker applications*, both of which are already significantly benefiting field operations. Though still in its infancy, *edge computing* is another important new technology that will impact field operations, though not for some time. Finally, the study looks at three technologies touted by experts as future difference-makers: *smart vehicles, 3D printing,* and *blockchain.*

Cloud computing & business analytics

While Canadian oil and gas companies will eventually employ a variety of technologies in their digital transformation journey, it is certain that cloud computing will be a cornerstone for most of them. The advantages are simply too great to ignore, and as time goes on, the case for cloud will become ever more compelling – so much so that industry research firm MarketsandMarkets estimates the oil and gas cloud applications market will be worth US$5.68 billion by 2022[3].

Cloud is the prerequisite for enabling digital capabilities

While cloud has been slow to take off in the sector, it is now gaining traction and has met with success at a large number of companies. "As oil and gas companies work toward embracing more digital capabilities, cloud is a requirement – and even a prerequisite – for making the shift… Oil and gas companies around the world are now seeing

cloud as a powerful enabler," wrote Richard Holsman, Managing Director, Accenture Resources, in his 2017 article, *'What's Driving the Oil and Gas Market to Cloud?'* [4].

It's not hard to see why cloud is so appealing. The oil and gas industry is awash in structured and unstructured data, and though it invests heavily in platforms and hardware to deal with it all, the vast majority of it goes unused. Cloud offers a cost-effective way to utilize substantially more of this data and put it to work to increase operational efficiencies, improve health and safety, cut costs, provide predictive analysis, etc.

Said one oil and gas sector IT executive interviewed for this report, "We're already beginning to see that the cloud will help us in terms of ease of deployment, access to quantities of data that we would never be able to afford to store on premise, and better collaboration by giving people one central place where our systems can connect and they can gain access to things."

Said another, "We're moving to the cloud because we need the agility inherent in it. We need the speed to market that it delivers. We need all the new tooling that it makes immediately available to us without having to build it ourselves."

Analytics are the table stakes to unlock potential value

As our survey shows, predictive analytics are growing in importance in the Canadian oil and gas industry, with almost 20% of polled companies already using the technology, and more than half of the remainder expecting to adopt the technology within two years.

>50%

adoption of predictive analytics technology by oil & gas in 2020

Observed another IT executive interviewed for this report, "Pretty much every company in Calgary is using some business analytics stack. Some of them are moving to partial cloud as well. Having some form of analytics seems to be table stakes now."

The International Energy Agency sees great potential for analytics in the processing of seismic data generated by upstream companies, leading to faster decisions and an increase in the operating time of drilling rigs, wells and facilities. "This should also lead to lower costs and the more efficient use of capital. The use of more sophisticated processing algorithms could also assist with the finding of new oil and gas fields, the generation of development plans, and the ranking of exploration portfolio options for upstream operators," stated the IEA in its *Digitization and Energy* 2017 report.

Analytics applied to the upstream, midstream, and downstream sectors

McKinsey & Company reports[5] a concrete example of big upstream benefits from analytics: "A software program did bottom-up analysis, churning through millions of records, normalizing, correlating, and seeking high-probability maximums and minimums, guided by an experienced team of engineers and procurement staff. At the end of this multiweek process, the team could confidently propose critical changes to casing design, procurement, and casing crew selection." The savings came to US$700,000 per well.

US $700,000

savings per well through the use of analytics

Analytics also have a big play in the midstream market. When applied to real-time SCADA data along with historical data, they can help maximize pipeline efficiency, with its many interrelated variables. Analytics can play a role in mitigating risk by interpreting pipeline pressure drops and identifying them as potentially harmful anomalies due to ruptures or leaks. The challenging job of supply-side and demand-side forecasting can be made easier and more accurate with analytics. And midstream companies can use analytics to give them a more holistic view of various pipeline systems, enabling them to be viewed as a single data set.

Downstream analytics can speed up the decision-making process and inform it with more facts and better insights. As a result, analytics can enable companies to empower more managers to make better decisions. "Rather than relying on the instincts of a couple of experienced executives, now middle managers with deep content knowledge or keen analytic skills can contribute to a better outcome," said Accenture, in its 2017 paper *'From Crude to Improved, Digital Disruption in Downstream Energy'* [6].

Effective analytics requires an integrated approach

While analytics hold great promise for oil and gas companies, there are many hurdles to clear before much of the value from them can be realized. While data is abundant in the industry, it resides on different systems and software, comes in varying types and formats, and appears in multiple operational silos and physical locations. And then there is the issue of data quality. As one IT executive stated at an IT Media Group roundtable in Calgary, "We went into BI somewhat naively, thinking we'd have a data warehouse, things would match up, and all would be good. Then we discovered that the hierarchies didn't match and we had a lot of poor-quality data at the source… It was a long slow process to get the culture in line with the expectations of what BI can do."

Another hurdle for IT executives is the fact that the massive amounts of data within their companies are not confined to operations; they're in finance, sales and marketing and many other areas. Optimizing the value of analytics will require an integrated, cross-organizational approach involving the entire value chain.

Artificial Intelligence, Machine Learning & IoT

In an era of lower cost oil, companies are beginning to embrace artificial intelligence and machine learning as tools to optimize performance. The benefits that can be realized by these technologies are enormous, and the good news is that the cost of adopting them is declining.

AI will play a key role in oil and gas digital transformation

Enhanced recovery of oil and gas resources could be a compelling driver for investment in AI. In 2016, recoverable reserves were estimated by the International Energy Agency to be about 1.4 trillion tonnes of oil equivalent (toe). The organization also estimated that this figure could be increased by 5% or more through the use of existing and emerging technologies, an amount equal to more than ten years of world gas consumption at that time. AI would no doubt play a leading role in that recovery.

AI is the digital Swiss army knife of the oil and gas industry. It is an effective tool for forecasting and planning, reserve modelling, facilities management, optimization of field development, surveying and mapping, predictive maintenance and a host of other applications. And we are only at the beginning of AI's life in oil and gas. Over half of the respondents to our survey said they will be adopting some form of AI in the next two years, while almost all respondents are expecting their companies to adopt it in the next 3 to 5 years.

90%
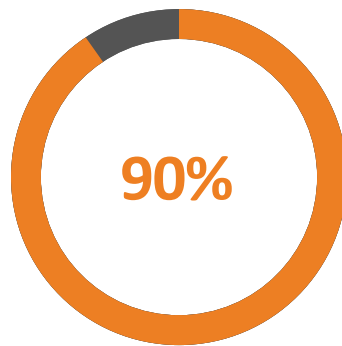
of oil & gas companies are expected to adopt AI
over the next 3 to 5 years

"AI may race ahead of the geologists. The future of geologic interpretation may belong to a cloud service," wrote Calgary-based energy expert Geoffrey Cann in a 2017 blog post[7]. "Cloud computing doesn't stop at geologic interpretation. Imagine smart drill bits with sensors behind the cutting wheel that shoot real time data to the cloud for comparison and interpretation against enormous seismic datasets, and against all prior drilling jobs, to help direct drilling operations."

Machine learning will broaden the benefits of AI

Machine learning is one of AI's most promising offspring. Through the use of algorithms, patterns can be extracted from the vast amounts of data produced by the industry, and through statistical analysis of this data companies are better

able to make their operations run more efficiently, enhance production, improve workflows, predict equipment failure, avoid downtime, optimize maintenance schedules, and lower costs. And the kicker: machine learning can significantly outperform humans doing statistical analysis and model building, and can do so autonomously. Although still in its infancy, machine learning is here and new products are coming onto the market rapidly.

**IoT provides the backbone for pro-active and prescriptive operations**

Much of the data now flooding the industry is produced by proliferating Internet of Things (IoT) devices. With the cost of these devices now negligible; equipment, pipelines, wells, refineries, buildings, structures, vehicles and much more are being made smart. This is because organizations are able to capture data to make them safer, more efficient, more resilient, more self-diagnostic, and more contributory to the company as a whole.

IoT is transforming service engagement from reactive to prescriptive, opening the door to new operating models for manufacturers. And the pace of this change is rapid. In IDC's 2017 InfoBrief, *'Omni-Experience Customer Engagement for Manufacturers'* [8], sponsored by cloud provider Salesforce, companies were asked what best characterized their service operational approach with customers. It was found that between 2015 and 2017, the number of companies taking a break/fix approach declined from 39% to 22%, the number taking a preventative maintenance approach declined from 38% to 36%, the number moving to a proactive, product monitoring approach increased from 23% to 28%, and the number taking a prescriptive approach went from zero to 15%.

Connected Workers, Mobility & the Edge

Even employees are being equipped with IoT devices. "Wearables can carry out a lot of external sensing that doesn't happen at the moment, providing real-time feedback about the environment to the control room and giving feedback to associated workers rather than just the individual," said BP's technology principal Blaine Tooke in an article[9] on the digital platform I - Global Intelligence for the CIO. Tooke noted that as much as US$5 billion a year could be available for the oil and gas sector if the right smart-wearable technology were to be rolled out.

Connected workers are more productive than their non-connected counterparts

15%
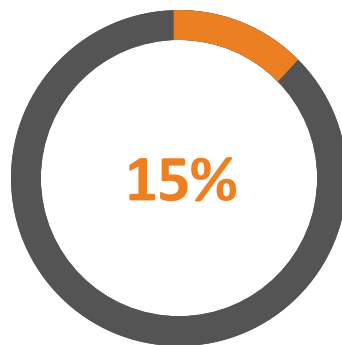
employee productivity improvement for connected workers

The World Economic Forum goes even further, saying that between 2016 and 2025, connected workers – using wearables along with smart phones and connected devices – could add US$100 billion to the industry, while reducing accidents and injuries by 13%[10]. It adds that by 2025, connected workers in upstream operations could be up to 15% more productive than their non-connected counterparts, while downstream could see a 15% improvement in employee productivity.

Mobile technologies and solutions are plentiful

The availability of powerful, explosion-proof smart phones and tablets is creating a big appetite for mobile apps in oil and gas, and demand is shifting from standalone solutions to ones that are integrated into enterprise platforms and systems. Companies are deploying or planning to deploy a long list of mobile apps for things like asset management (e.g. drill rig maintenance, pipeline construction, vehicle maintenance), workflow management (e.g. approvals for training and leave, travel expense reporting), health and safety improvements, and real-time dashboard and KPI reporting. And by putting real-time analysis in the field, mobile apps are empowering field employees to make timely decisions on their own.

As an IT exec at one of Canada's largest oil companies noted at a recent IT Media Group roundtable, "We won't build any mobile applications, but we will buy off the shelf. There is a big push in our field offices for mobile apps. We recently added 300 mobile apps back in the mix." Said another exec at the same roundtable, "Our field organizations want to handle all their activity by mobile components. We see that as a strong requirement when we try to generate requirements for new systems and new applications that impact our core operations."

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Buy off the shelf mobile applications where possible to accelerate time to results

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Implementing oil and gas IoT solutions will be challenging for a number of reasons. Internet access is not ubiquitous throughout the industry, especially in remote locations, so there are connectivity issues to be dealt with. And with widespread use of the Internet comes the concern for security, much on the minds of all corporate executives these days, not least in the energy sector. Then there are mountainous amounts of data that must somehow be sifted through, and myriad data standards that must be considered.

Edge computing has enormous potential for upstream and midstream operations

Edge computing may help alleviate communications problems by performing analytics and taking actions remotely, reducing the huge communication demands associated with far-flung field operations. "Edge servers are embedded in IoT gateway devices so that data can be collected and analyzed locally – close to sensors – instead of being sent to the remote SCADA system…This setup also enables decisions to be made about the importance of data – not constantly pushing data every set time interval if nothing has changed, for example," explained Automation World's Aaron Hand in his article *'Oil and Gas at the Edge'* [11].

This technology has enormous potential for upstream and midstream operations in particular. Edge computers can gather and process data in unmanned locations such as wells, pipelines and subsea structures, and communicate the information via satellites; they can convert analog data from countless gauges and meters into immediately usable digital data; and they can inform a variety of disparate processes across the organization with real-time information.

Smart Vehicles, 3D Printing & Blockchain

Smart vehicles hold the promise of big savings for energy-sector companies. This technology opens the door to remote vehicle diagnostics, maintenance alerts, reduced operational expenses, enhanced communications, better security and a variety of location-based services.

Smart vehicles are an emerging technology that will impact productivity and safety

Practical applications such as vehicle platooning are now beginning to emerge. Platooning refers to a system in which two or more trucks drive in a tight convoy, supported by control systems. All of the vehicles in the platoon are linked to each other by vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications technology. The truck in front sets the speed and direction, and the others follow. The technology enables the vehicles to safely travel in close proximity, reducing drag and providing significant cost savings. Eventually, this technology will pave the way to autonomous driving for large vehicles.

### 3D printing is poised to become a key technology for oil and gas

3D printing, or additive manufacturing (AM), is already taking hold in the industry, and growth is expected to be buoyant, with market research firm SmarTech Publishing predicting that AM will be a US$2 billion market in the sector by 2027[12]. The oil and gas industry is poised to become one of the most important generators of revenue – both near- and long-term — for additive system manufacturers and service providers worldwide, according to the research firm.

The allure of this technology for the oil and gas industry is not hard to understand. With its complex infrastructure spanning the globe, often in remote locations, the provision of spare parts can be an enormous challenge, especially with the extremely high cost of downtime for critical pieces of equipment like pumps. One way to address this issue is by maintaining very large inventories of spare parts, but this is costly and creates a growing problem of parts obsolescence. Printing parts on demand is an elegant solution to the problem. And in some cases, 3D printing will enable the production of spare parts that are superior to the originals. Single-part fabrication enables the manufacturing of parts that in a traditional manufacturing process would have to be welded together. 3D printing also enables the rapid prototyping and quick testing of new concepts. And by speeding up the design process, companies can move more rapidly into full production.

Challenges remain with this technology. With its rigorous regulatory framework, there will be numerous health and safety hurdles to clear for 3D printed parts before they can be incorporated into operational equipment. And of course, there are manufacturers' rights to be considered when reproducing parts of a company's equipment. But these issues will be worked out over time, as additive manufacturing becomes more entrenched.

Blockchain is at an early stage, but trials have already begun

In their book *'The Truth Machine: The Blockchain and the Future of Everything'* [13], authors Michael Casey and Paul Vigna state, "Blockchains point the entire digital economy toward something people are calling the Internet of Value… Think of how disintermediation has already transformed the global economy in the earlier Internet era and you get a sense of how sweeping this next phase could be."

30%
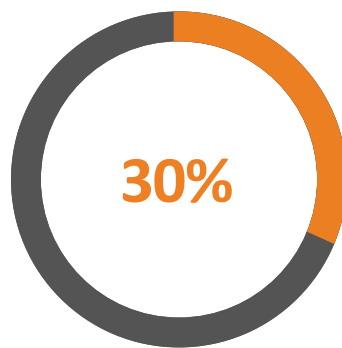
oil and gas market transaction cost reduction through
the use of blockchain

The next phase has already begun in the oil and gas sector. In 2017, Mercuria, one of the world's largest commodity traders, announced the first large oil trade based on blockchain. "Thanks to blockchain technology, we are able to bring more efficiency into a typical commodity chain," said the company's CEO, Marco Dunand. "If you take a crude oil cargo loading in West Africa and going to Asia, it typically takes about forty days for the documents – the bills of lading and so forth – to circulate before they come to the end user. We've run these tests on a parallel basis and we did it in seven days."[14] Dunand said he could see blockchains reducing transactional costs in some oil and gas markets by as much as 30 percent.

In essence, blockchain is a distributed ledger that records and compares encrypted transactions on many different machines, none of which holds all of the information. The data cannot be altered retroactively, making transactions highly secure and verifiable – not to mention nearly instantaneous – and particularly suited to the oil and gas industry's complex supply chains, where large infrastructure developments can involve hundreds of suppliers. Notes The World Economic Forum[15], "This complexity can make it hard to track risks and responsibilities, leading to complications in exchanging proprietary data. It can also be difficult to track the money flowing through this huge framework of contracts and suppliers, increasing the risk of corruption and resources being siphoned off."

Currently, many blockchain trials are being undertaken throughout the industry, but this is a technology that is still in the very early stages of development. Groups of like-minded businesses – producers, suppliers, carriers, financial institutions, etc. – will have to come together and sort through many issues to make blockchain a reality.

Cyber Security and the Changing Digital Space

As new technologies are taken up by the oil and gas industry at an accelerating pace, the issue of cyber security is looming ever larger. Smart handhelds and IoT devices are proliferating, connected SCADA systems are vulnerable to attack, users are exhibiting lax security habits and storing data on poorly secured sites, vulnerabilities are arising with the growth of shadow IT, and the list goes on. Meanwhile, the bad guys are becoming more aggressive and growing ever more sophisticated. These are dangerous times for all companies, and by the very nature of their business, oil and gas companies are particularly in the crosshairs. Security breaches can have catastrophic consequences for sector companies, ranging from plant shutdowns, to damaged equipment, to environmental destruction, to employee death or injury.

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*It's critical to understand the impacts of cyber security
attacks to your organization*

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In its Jan/Feb 2018 article *'Cyber risks in oil and gas'* [16], Canadian Insurance Top Broker magazine got a take on this issue from Lance Mortlock, oil and gas leader for Ernst & Young in Canada. "Part of the challenge is that, even as they're rapidly acquiring these technologies to improve efficiency, the impact of cyber security attacks is not fully understood by the [oil and gas] industry. Given the level of investment we're seeing in operational technology and automation… these companies need to be upping their game."

That view is validated by a survey of oil and gas industry players done by The Boston Consulting Group, which found that none of the surveyed companies had undergone a comprehensive security audit (spanning corporate, upstream, midstream, and downstream operations) of its value chain.[17]

Canadian IT executives from the oil patch have weighed in on cyber security issues at a number of IT Media Group roundtables. Here's what they had to say:

CIO Security Challenges	Advice for CIOs
"The business units welcomed security as long as it wasn't overly intrusive. The resistance came from IT because people feared that it was going to interfere with their approach to things they were trying to implement."	Formalize the security governance framework by naming a Security Officer and creating an organization whose mandate is to make data security a priority of both IT and lines of business.
"What keeps me up at night are the cloud and mobility services. It's so tempting for users to use Dropbox. The temptation is to just start storing [company information] out there. Then they can get it at home and in the field and on mobile. It seems easy and cheap, but the risks aggregate to be very large."	Define and implement security standards for mobile and cloud-based applications. Ensure that standards are adhered to.
"For me, the biggest risk is denial of service on our critical infrastructure. It's taking down our PCI environment. It's taking down our SCADA and industrial control systems."	• Instrument the environment to detect and manage security breaches. • Monitor types, frequency, and impacts of incidents and build a framework that can take rapid corrective active. • Probing and testing of the environment can also be performed to identify security vulnerabilities and lapses.
"When we get out to the SCADA world, they are very good at setting up control systems, but now they're trying to integrate them and they need to get the management cheaper. We're selling the fact that security standards for your SCADA environment make your operations cheaper. You don't have to have as many people and it doesn't cost you as much."	Attempt to regain limited governance of shadow IT to ensure that standards are adhered to. Assess new applications to determine what controls need to be layered on top of them.

Impact Of New Technologies on the Canadian Workforce

There is no doubt that the influx of new technologies will have a significant impact on the workforce at Canadian oil and gas companies. Many jobs will disappear as a result, but there is some good news on the labour front as well.

Plan to hire data scientists, analytics specialists, instrumentation technologists, and software engineers

A 2018 report from The Petroleum Labour Market Information (PetroLMI) Division of Energy Safety Canada, entitled *'A Workforce in Transition: Oil and Gas Skills of the Future'* [18], notes that occupations such as data management and analytics specialists, instrumentation technologists and software engineers will be more in demand. While data scientists are not new to the oil and gas industry, their role will increase as analytics are applied to more data streams across the industry. Some have even predicted that in the next decade, oil and gas companies could employ more PhD-level data scientists than geologists.[19]

"Many of the new or emerging opportunities will be appealing to workers who are seeking challenging, technology-driven occupations, such as directing automated rig equipment, mapping paths for autonomous trucks or managing large amounts of technical data," said Carol Howes, VP of Communications and PetroLMI, Energy Safety Canada.

Field workers in general, however, will be more challenged. They will be expected to have both mechanical and digital skills as they use increasing amounts of data analytics for decision-making. As a greater number of tasks are automated, more of the workforce will need to be digitally literate as well as more innovative and creative in looking for productivity improvements, according to the PetroLMI report.

As oil prices rise and job growth picks up in the oil patch, one of the challenges for Canadian firms will be preparing employees for the future. As one Calgary-based IT exec at an IT Media Group roundtable put it, "Just cycling through employees is expensive and disruptive to the organization. Once you've hired somebody, you want to make sure you are getting the full value out of them for as long as possible. Throughout their career you've got to help and develop them as technologies change. We try to spot what these employees will be ready for and what it will take to get them there."

Attract and retain employees with domain expertise and the required technical skill sets

Said another, "There is a growing space where you want to find more individuals that are closer to the business. They have those soft skills. They have domain expertise in key areas. One of the challenges with energy is there's a lot of uniqueness with the groups and business units. Finding individuals with the right technical set and the data science set married with domain concepts is still a challenge."

As with every other industry, there are special challenges when it comes to the millennial workforce. Canadian oil patch executives weighed in with their views:

CIO Millennial Challenges	Advice for CIOs
"There is a level of entitlement with millennials that hasn't been earned. How do you balance that with their passion and thirst? It's trying to find that balance where they feel like they are getting what they want with the corresponding level of work, accountability, responsibility and results. We're spending a lot more energy on that, but if you get the right level of energy and the right attitude you can get some pretty good things."	• Focus on results instead of fixed work schedules. • Structure the team so that there is a balance of veterans and younger employees. • Assign roles that take advantage of the strengths and skills of the individuals on the team so that they can work together to solve problems.
"Putting a millennial in a conservative business unit just creates a ton of noise and dissatisfaction. Whereas if we put a millennial in a place that's looking at new technology, that's where we have the most success. They get the most satisfaction out of it and the business sees more value out of it."	• Place millennials in groups that are looking at new technologies. That's where they will have success and produce business value. • Avoid placing millennials in a conservative business unit. There is a higher probability that they will be dissatisfied

The Role Of Vendors In Digital Transformation

One way of addressing IT workforce issues is by partnering with vendors who have access to talent that wouldn't otherwise be available to many energy sector firms. And of course, vendors bring much more to the table than simply smart people. They have highly sophisticated technologies, knowledge of myriad use cases, highly scalable resources, robust security, a vested interest in making technology work for their clients, and they spend massive amounts on R&D. With digital transformation starting to take hold in the industry, venders will become ever more important partners on this critical journey.

After many years of hosting discussions with energy sector IT executives, The IT Media Group has gained many insights on vendor relationships within the oil patch. Several vendor-relationship best practices were also discussed at these roundtables. Here are a few that should resonate with all IT executives:

CIO Vendor Challenges	Advice for CIOs
"We've started to really lean on strategic partnerships, and it took us a while to get our head around the difference between an ordinary partner and a strategic one. In the end, we realized that strategic partners were the ones we brought to the table at our dreaming stage, our 'We're not sure what the solution is yet' stage. Everyone else was called in when we said, 'We want to buy one of those.'"	• Ask vendors to investigate leading-edge technologies that could impact your industry. • Spend time with vendors to understand their strategic product roadmap and participate in customer forums.
"We'll go through a few vendors as we look for the one that can act as a strategic partner. Once we find that organization, we tend to build a very strong relationship with them. When you get to the point where you really know each other and trust each other there is an element of risk mitigation. As long as you have that trust then you leverage it and you change the conversation from being, 'prove to me that you know what you're doing,' to being, 'help me understand how this technology can help me align with what you know about our company.' That's a valuable conversation to be able to have and it really changes the framework."	Implement formal service management training programs to reskill managers from team/people management to service management.

CIO Vendor Challenges	Advice for CIOs
"We've moved to a largely outsourced model and we hit our dollar number, but our ability to innovate was hampered because vendors are not motivated to bring innovation. We tried to come up with a model of pushing the vendor to do it, but it's not naturally part of that relationship. So we've now added a layer of IT business analysts that have the architecture skill set. They're the superstars in a couple of key disciplines that are bringing that innovation back."	• Hold formal innovation sessions with vendors to develop ideas that can be brought to the business. Work with vendors to learn how to brainstorm, collaborate, and share ideas. • Ensure that knowledge transfer is a key deliverable of any professional services agreement.
"We're trying to incent vendors to talk about an index-based pricing model. It sounds easy, but it's difficult. It's WTI-based, and there are some riverbanks, and things would adjust as the market adjusts, without all this negotiation and talk about revenues and cost-cutting. It would help guide things a lot easier. Some vendors are looking at it and saying, "Okay, interesting. We'll think about it. Others just aren't interested."	Develop SLAs and metrics with your vendor that are reflective of what is going on in the business. Otherwise they may show green but the relationship is actually red.

Canadian Oil & Gas Industry Poll

To help us determine the interest in, and level of commitment to, some of the key transformational technologies that will impact the oil and gas sector over the next few years, we asked a number of Canadian IT executives from the sector to weigh in on various questions related to these technologies. The companies represented in this poll generally reflect the make-up of the industry as a whole: over half are upstream, about a quarter are in services, with the rest midstream or large integrated. The poll and subsequent interviews provided us with general cross-industry data points and provided an opportunity to validate our findings and conclusions.

At what stage are your digital transformation activities?

25%
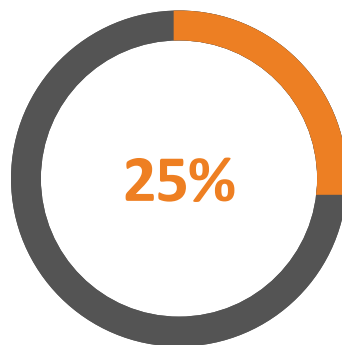
are actively investing in digital transformation

So how ready are Canadian oil and gas companies for digital transformation? The good news is that it's on all of our respondents' radar. Over a quarter of the executives polled are already investing in such initiatives, while another quarter are researching their options. Just under half said they are interested in and aware of the value digital transformation can bring, but indicated that it is not a current priority.

What technologies are important for digital transformation?

When rating the importance of various technologies to the company's digital strategy, cloud and predictive analytics ranked highest, with both deemed of high importance to more than half of respondents; cloud, in fact, was considered of either high or medium importance to all respondents. Mobile apps, IoT and machine learning were cited by over two thirds of respondents as being of either high or medium importance.

Over what time frame do you expect to adopt the technologies?

81%

have adopted cloud technologies

45%

have deployed mobile applications

0-90%

acceleration of AI adoption over the next 3 to 5 years

With respect to adoption of the specific technologies described in this report, cloud leads the way, with the vast majority of respondents (81%) having already adopted it, and the rest planning to adopt it within the next two years.

Mobile apps are also getting lots of love from the represented companies, with almost half already adopting them and over a third planning to adopt them within the next two years. **IoT** is very much in play, already adopted in over a third of represented companies, and slated for adoption in the next two years at another third. **Predictive analytics** have already been adopted at almost 20% of polled companies, and more than half of the remaining ones are expecting to adopt them within two years. **AI and machine learning** have little adoption at present but over half of respondents said they will be adopting them in the next two years, while long term – 3 to 5 years – almost all respondents are expecting their companies to adopt them. There's certainly an awareness of the potential benefits of **blockchain**, but they are still down the road; a quarter of respondents are expecting to implement some form of blockchain within the next couple of years, while another third are looking to implement it within 3 to 5 years. Just under half of respondents are expecting to make use of **smart connected vehicles** within the next couple of years, but the remainder of our respondents are not considering using them. **Edge computing** is still a long way off for most respondents, with fewer than half expecting to adopt the technology within the next five years. And **3D printing**, despite its promise, is not under consideration by the large majority of respondents.

What are the barriers to digital transformation?

There was broad agreement among participating executives that the greatest barrier to digital transformation in oil and gas is corporate culture. Internal readiness, competing priorities, lack of budget, and legacy systems were also cited as major obstacles. Skills, security, senior management support and lack of vendor products and services were all widely cited as minor obstacles.

What are the key drivers behind your digital initiatives?

Not surprisingly, key drivers for digital transformation were cost reduction (which all participants cited), followed by increasing productivity, streamlining processes and improving competitiveness.

IT and Business are collaborating on making digital investments

A promising trend is in the decision-making process for investments in digital technologies. Most of the executives polled report that such decisions are jointly made between IT and either the affected line of business or an executive committee representing the broader corporate interests.

Advice for Canadian Oil and Gas IT Executives

While it will take time for the full impact of digital to be felt, it will undoubtedly play a strong role in reshaping the oil and gas industry in Canada. Companies are already undertaking digital projects that are transformational, and the trend will only accelerate.

Game changing opportunities are available by using digital technologies

While true digital disruption – the kind that changes business models – will be harder for companies to achieve in this sector compared to most others, there will still be game-changing opportunities. For example, even though upstream producers all make the same product and use similar methods to find and extract it, significant advantage could be gained by firms that use new technologies to achieve breakthroughs in exploration and extraction. And companies in the services sector, which have a wider scope of activities and the right size and nimbleness to respond quickly to changing market conditions, will have many opportunities to be disruptors in their market segment, leapfrogging competitors when opportunity knocks.

For most companies in the oil and gas sector in Canada, however, the main benefits of digital transformation over the next three to five years are likely to come from improvements to all aspects of their operations.

Areas in which the biggest impacts will be felt

• Optimizing costs • Reducing production downtime • Connecting workers • Streamlining processes • Enhancing exploration and extraction • Improving employee health and safety	• Enabling proactive and prescriptive maintenance • Accelerating projects • Shrinking the workforce • Stimulating innovation • Developing new sources of revenue

How CIOs can move digital forward

In order to move digital transformation forward, it will be incumbent on Canadian IT executives to shed the service mentality, demonstrate the IT organization's ability to work successfully with the business, and educate senior management on how these new technologies can bring value to the company.

Here are some suggestions that will help IT executives achieve success with their digital agenda:

Capitalize on cloud: Ensure that cloud computing is the cornerstone of digital transformation. Focus on applications, data quality/management, and collaboration.

Invest in analytics: Make predictive analytics part of the strategic roadmap. More than half of O&G firms will be using predictive analysis tools by 2020.

Connect workers: Connect employees to enterprise systems through the use of IoT and mobile technologies. This will provide opportunities to increase revenues, improve productivity, and reduce accidents.

Consider AI and machine learning: Be aware that artificial intelligence and machine learning tools offer sizeable opportunities. Almost all O&G companies will adopt AI by 2023.

Put IoT in place: Deploy IoT throughout the production chain and link to AI to improve operating models.

Be proactive on blockchain: Participate in blockchain initiatives targeted at the supply chain to reduce transactional costs in O&G markets.

Evaluate edge computing: Consider adding edge technologies to upstream and midstream operations to alleviate remote communication constraints.

Consider smart-vehicle technology: Look at investment in smart vehicle technologies to improve operational efficiency and lead the way for autonomous driving.

Investigate 3D manufacturing: Explore the use of additive manufacturing to provision spare parts and reduce the cost of downtime for critical pieces of equipment.

Make security a priority: Embed cyber security rigour into the digital technologies being deployed. The risks of catastrophic consequences related to security breaches increase as the number of devices and technologies increase.

Build a strong, lasting team: Work with HR to implement a talent management program for IT. Hire people that are a cultural fit and that have the flexibility to adapt to digital transformation. Look for ways to keep millennials motivated and engaged. Provide assistance for older team members to upgrade their skills and transition to new types of work.

Maximize vendor value: Leverage technology vendors and develop strategic partnerships to help navigate the digital transformation journey.

Overcoming obstacles to digital transformation

Finally, it needs to be said that while digital transformation offers significant benefits, the actual adoption of the technology is not without its barriers. IT executives provided their opinions on the obstacles that put a damper on their digital initiatives.

Major Obstacles	Minor Obstacles
• Corporate culture • Internal readiness • Competing priorities • Lack of budget • Legacy systems	• Skills • Security • Senior management support • Lack of vendor products and support

CIOs need to be prepared to allocate time and resources to overcome these obstacles to increase the likelihood of a successful digital transformation in Canadian oil and gas. Here is some tried and true advice to win the support from fellow executives, line-of-business leaders, and the rank and file:

Become a business leader: Set your sights on becoming a business leader, not simply an IT leader. Take every opportunity to learn the details of the business. Spend as much time as possible, formally or informally, with executive peers and LOB leaders. Understand their needs and pain points. When talking with them, speak the language of business.

Make a case for the business of IT: As CIO, you are the de facto leader of the company's digital transformation journey. It is incumbent on you to educate your peers on the many business opportunities that will be enabled by the burgeoning power of technology. When touting those opportunities, always be cognizant of the fact that the Board and the CEO will be strongly influenced by the bottom line.

Prove your value: You need to demonstrate the contribution of IT to the business. Use some form of formal KPI scorecarding to measure IT performance. Use KPIs that closely align with the business's goals and values, such as revenue/market growth, customer satisfaction and operational efficiency.

Communicate, communicate, communicate: There are countless ways for IT to get its message out and engage with all levels of the organization. Make sure your messaging is well crafted and well targeted. Get advice from your marketing executive. Establish a regular cadence in communicating with the business. Publicize your successes.

Get creative: Establish a process for bringing innovative ideas forward from the business. Pass along the best ideas to an incubator team for analysis and possible implementation.

Build a support ecosystem: Build an ecosystem of partners to share risk and reward, tapping into resources from industry, academia and the vendor community to augment skills and knowledge, conduct research and access use cases.

Get help from outside: Cultivate collaborative opportunities with vendors. Gain insights from peers by attending conferences, roundtables, seminars and other events. Interact directly through face-to-face and online peer groups. Create your own network of trusted advisors, meeting informally to share knowledge and validate ideas. Experiment with formats like lunch-and-learns and peer presentations.

Digital transformation presents an excellent opportunity for CIOs to elevate their status and reinvigorate their careers. This is especially true in the oil and gas industry, which has historically undervalued IT and paid little heed to its leaders. While there will be many challenges on the journey ahead, CIOs that embrace and meet those challenges will prove themselves as strategic leaders and take their rightful place as equal and valued members of the C-suite.

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