A new natural resource

Your cognitive future in the oil and gas industry

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Greater competitiveness in oil and gas

Welcome to the age of cognitive computing, where intelligent machines evaluate complex data in new ways to help solve society's most vexing problems. For oil and gas, cognitive computing has arrived, and its potential to transform the industry is momentous. Our research indicates leaders are poised to embrace this groundbreaking technology and invest in cognitive capabilities to spark the digital future in oil and gas.

Executive summary

Cognitive computing is poised to transform organizations and industries. For oil and gas in particular, the timing of a game changer could not be better. Companies are experiencing major disruption: energy price collapse, challenges in reserve replenishment and exploration, high resource development costs and ever-heightening health, safety, security and environment (HSSE) considerations. To meet these challenges, oil and gas companies must improve asset productivity and agility. They need to accelerate discovery of new ideas and improve decision-making capabilities to better navigate rapidly increasing complexity and risk.

In 2015, the IBM Institute for Business Value (IBV) conducted a survey in collaboration with the Economist Intelligence Unit. More than 800 executives participated in this survey, 81 of whom were oil and gas executives across global markets. (For more information on the research, see the "Study approach and methodology" section of this report.)

In this research, a majority of the full sample told us that cognitive computing will play a disruptive role in the industry.[1] And most executives, regardless of industry, plan to increase investment in cognitive technologies.[2]

83%

of oil and gas leaders familiar with **cognitive computing** said it will have a **critical impact on the future of their business**

91%

of surveyed oil and gas executives familiar with **cognitive computing** intend to **invest in cognitive** capabilities

94%

of oil and gas executives familiar with **cognitive computing** expect it to play a **disruptive role** in the industry

To thrive amid the disruptive forces, oil and gas leaders must be smarter in how they approach data. While the digital age has brought a massive amount of industry data brimming with insights, organizations struggle to unlock its full value. Advances in the pioneering area of cognitive computing can help bridge the gap between data access and data insights. Our research reveals that cognitive solutions are already helping oil and gas companies expand capabilities to meet industry challenges and open up fresh opportunities.

In this report, we identify and assess current and future oil and gas applications of cognitive computing, and provide recommendations for those seeking a cognitive journey. We offer insights from executives who understand how cognitive capabilities can help push the current boundaries of innovation and growth, and who recognize the potential for cognitive computing to transform the industry – and are poised to exploit capabilities to do so.

Conquering industry forces

The oil and gas industry is experiencing major disruption:

Price collapse: Oil and gas prices have plummeted since mid-2014, and are dramatically lower than recent peaks of USD 100 and more per barrel.[3] The combination of strong supply and weak demand has reduced crude prices, putting severe pressure on margins.[4]

Reserve replenishment: Proven reserve count is at an all-time high. However, the quantity of oil and gas that is added to these reserves' capacity as a result of discovery and exploration is declining. And so, a declining reserve replenishment ratio – a measure of how much oil and gas is added to reserves relative to production – is negatively impacting stock valuations of oil and gas organizations globally.

Exploration and development costs: Remote exploration and production are driving up costs. Oil companies are experiencing high discovery and extraction costs for new resources.

HSSE considerations: HSSE considerations limit exploration and production options. Governments and citizens are more aware of environmental issues than ever before. And addressing HSSE considerations are adding to higher costs and project delays.

What is cognitive computing?
Cognitive computing is a new computation paradigm. Different types of cognitive computing solutions offer various capabilities, including…

- Learning and building knowledge from various structured and unstructured sources of information

- Understanding natural language and interacting more naturally with humans

- Capturing the expertise of top performers and accelerating the development of expertise in others

- Enhancing the cognitive processes of professionals to help improve decision-making

- Elevating the quality and consistency of decision-making across an organization.

From disruption to direction

It's clear that oil and gas companies are operating amid turmoil. Although the forces challenging the industry appear varied in nature, we identified two major themes running through them – capturing useful insights from vast amounts of data amid complexity, and enabling evidence-based decision making at each level of operations.

To navigate disruption, oil and gas companies need to focus on improving their capabilities to discover key insights and decide best actions faster and better (see Figure 1).

Figure 1

From disruption, two focus areas have come to light for the oil and gas industry: "Discover" and "Decide"

Price collapse	Reserve replenishment	Exploration and development costs	Health, safety, security and environmental (HSSE) considerations
Find more innovative ways to cut costs and increase revenues	Identify new technological solutions for extraction activities	Apply innovative solutions to exploration and development	Innovate to make better decisions related to operational risks

Discover
Provide ability to digest vast amounts of data to identify new avenues, navigate complexity and implement new ideas

Decide
Provide personalized, contextual, evidence-backed recommendations to support decision-making at all levels

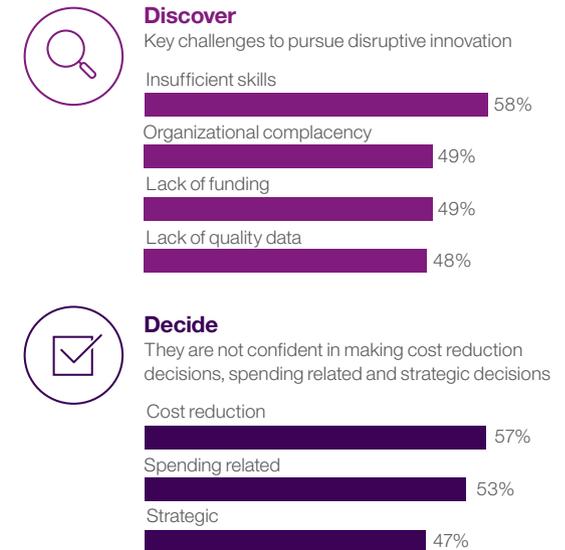*Source: IBM Institute for Business Value.*

Specifically, oil and gas companies need to enhance their abilities to digest vast amounts of structured and unstructured data to identify new avenues, navigate complexity and implement new ideas at higher velocity with quantitative risk levels. And they need tools that can synthesize contextual, evidence-backed recommendations to support decision making at strategic, tactical and operational levels.

Discover: Our survey data revealed that 57 percent of oil and gas companies are actively pursuing industry model innovation (see Figure 2). However, industry executives cite insufficient skills (including data scientists and geologists), organizational complacency, lack of funding and lack of quality data among their greatest challenges in pursuing innovation. To compete with smaller, more agile players, oil and gas companies need to greatly accelerate their ability to turn data into insights – and use those insights for innovation.

Decide: Oil and companies maintain huge volumes of business and technical data – but the constraints of traditional systems, human capabilities and poor quality of data do not allow the value of information to be fully exploited. Our survey revealed that more than half of oil and gas executives are not confident about their organization's cost-reduction, spending and strategic decisions. A potential reason could be that many organizations are forced to make decisions based on incomplete information because they lack the advanced analytical tools and technologies necessary to optimize the vast data at their disposal, as well as to guide them on critical decisions.

Figure 2

Oil and gas company executives face challenges that will require new types of business insights

Discover
Key challenges to pursue disruptive innovation

Insufficient skills
58%

Organizational complacency
49%

Lack of funding
49%

Lack of quality data
48%

Decide
They are not confident in making cost reduction decisions, spending related and strategic decisions

Cost reduction
57%

Spending related
53%

Strategic
47%

Source: IBM Institute for Business Value.

Cognitive opportunity in oil and gas

Figure 3

Oil and gas executives around the world see the value in cognitive and intend to apply it within their companies
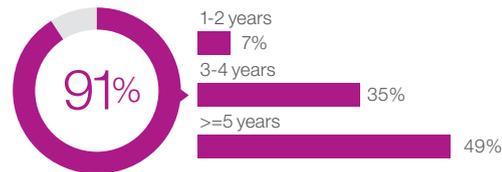

83%

83% of oil and gas executives familiar with cognitive computing believe that it will have a critical impact on the future of their business

94%

94% of oil and gas executives familiar with cognitive computing believe that it will play a disruptive role in the oil and gas industry

91% of oil and gas executives familiar with cognitive computing are likely to invest in cognitive in future

91%

1-2 years
7%
3-4 years
35%
>=5 years
49%

Source: IBM Institute for Business Value.

Big data has been called the new natural resource.[5] This resource continues to rapidly grow in volume, variety and complexity, particularly in oil and gas. Business data is estimated to double every 1.2 years.[6] Despite the explosive growth of information across industries, less than 1 percent of the world's data is currently analyzed.[7]

While effective for a number of applications, traditional analytics solutions cannot fully exploit the value of big data: They are unable to adapt to new problem domains or handle ambiguity and are only suitable for structured and unstructured data with known, defined semantics (the relation of words and phrases and what they mean). Without new capabilities, the data paradox of having too much data and too little insight will continue (see Figure 3).
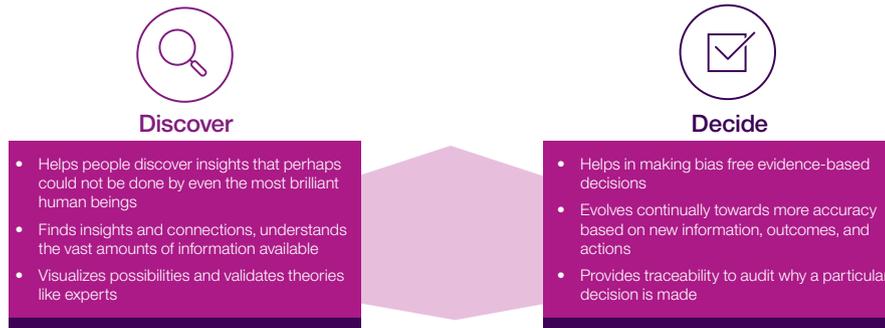
How can the oil and gas industry bridge the gap between untapped opportunities and current capabilities? How can hidden insights that reside in data – structured and unstructured – be fully harnessed for discovery, insight, decision support and dialogue? The answer is cognitive computing. Cognitive-based systems build knowledge and learn, understand natural language, and reason and interact more naturally than traditional programmable systems.

Oil and gas executives agree that cognitive computing has the potential to radically change the industry. Among those leaders familiar with the technology, 94 percent believe it will play a disruptive role in the industry, 83 percent believe it will critically impact the future of their business, and 91 percent intend to invest in cognitive capabilities.

So, how specifically can oil and gas organizations leverage cognitive computing to address issues currently plaguing the industry? This new computing paradigm has two capability areas that align with and specifically address the two industry focus areas previously identified: Discover and Decide (see Figure 4).[8]

Figure 4

Two capability areas – Discover and Decide – illustrate how industry executives can leverage cognitive computing

Discover

- Helps people discover insights that perhaps could not be done by even the most brilliant human beings
- Finds insights and connections, understands the vast amounts of information available
- Visualizes possibilities and validates theories like experts

Decide

- Helps in making bias free evidence-based decisions
- Evolves continually towards more accuracy based on new information, outcomes, and actions
- Provides traceability to audit why a particular decision is made

Source: IBM Institute for Business Value.

Discovery capabilities

Cognitive systems can help users discover insights that perhaps might not be found by even the most brilliant human beings. Discovery involves finding insights and connections and understanding the vast amounts of information available around the world.

Some discovery capabilities have already emerged through cognitive systems that use predictive data solutions that can scale engineers' knowledge while supporting faster analysis of large volumes of data (see example, "Case 1: Turning to predictive data science"). Another example of applied cognitive technologies is rapid prototyping that enables collaboration with humans (see example, "Case 2: Prototyping cognitive technologies to mitigate uncertainty and risk").

Discover

Case 1: Turning to predictive data science

A large oil and gas company is based in Australia and operates globally. It wanted to improve its decision-making processes to increase efficiency and better design, fabricate and construct future oil and gas facilities. To do so, it implemented a cognitive advisory service that scales the knowledge of engineers to deliver insights and information to wider groups.

The solution, which employs predictive data science, can field complex questions in natural language and quickly analyze large volumes of unstructured and historical data. The resulting insights can support faster resolutions, improved process flow and better operational outcomes. The company also sees a potential to bring down costs and increase efficiencies across the organization.

Discover

Case 2: Prototyping cognitive technologies to mitigate uncertainty and risk

A leading global energy company headquartered in Europe faces growing energy demands around the world and a need to maintain supplies for years to come. It found itself making high-stakes decisions amid uncertainty and risk. At the same time, the volume of complex data the company needed to process was growing exponentially. To address these challenges, the company worked with a partner to prototype and pilot cognitive technologies with practical, real-world uses within the oil and gas industry.

These technologies collaborate with human experts in more natural ways, learn through interaction and help employees apply big data to make better decisions. The company is using the new applications to bolster strategic decision making as it seeks to optimize oil reservoir production and acquire new oil fields.

Decision capabilities

Cognitive systems aid in decision making and reduce human bias by offering evidence-based options. They continually evolve based on new information, results and actions. Current cognitive systems perform more as advisors by suggesting a set of options to human users, who ultimately make the final decisions.

These systems are helping oil and gas professionals make more informed and timely decisions. For example, applying natural language processing (see "Case 3: Applying natural language processing to optimize prospecting"). Another company enhances its analysis of crude processing by adding vast amounts of unstructured data (see "Case 4: Adding unstructured data to cost analysis"). And yet another multinational company harnesses both internal and external data to act more efficiently (see "Case 5: Strengthening management of HSSE risks").

Decide

Case 3: Applying natural language processing to optimize prospecting

An energy company based in Europe has operations in more than 30 countries around the world. When making critical exploration decisions, it used evaluation processes that often lacked access to relevant information. Its new cognitive computing capabilities now supply researchers with information about existing developments and projects, as well as information from external data providers in the oil and gas industry.

The solution unifies data that is structured and unstructured, both internal and external, presenting the company with confidence-weighted options and recommendations. Such analysis helps it assess potential acquisitions – whether companies, oil fields or technology solutions – by reducing uncertainty.

Decide

Case 4: Adding unstructured data to cost analysis

A large global oil and gas companies based in North America wanted to cut crude oil processing costs to improve margins. Low-cost crude includes contaminants which require more complex and expensive processing. So, the company sought a solution to help analyze vast amounts of information from the global crude marketplace in order to anticipate conditions and improve trading decisions, and thus reduce refining costs.

Using a cognitive computing solution, it can now take relevant data and apply pattern recognition and natural language processing to find multidimensional relationships across several unstructured sources. The solution reveals insights from external news sources, for example, and enables data-driven tradeoff analysis of key crude characteristics, thus expediting purchase decisions. And the company can now also more effectively analyze run histories and operations to better assess its crude-refinery run experiences.

Decide

Case 5: Strengthening management of HSSE risks

To sustain performance, energy companies must be able to react quickly and effectively to any number of environmental issues that may arise. A large oil and gas company based in North America, wanted to improve its HSSE responsiveness by making better use of the internal and external data it accessed.

It deployed a cognitive computing solution that harnesses knowledge from across the organization and applies it efficiently. Today, it analyzes information from global reports and provides insights into the most effective and efficient ways to derive best-in-class capabilities. As a result, the company can better monitor and mitigate environmental risk and respond more proactively to abnormal operations.

The way forward

As with any material change to an environment, there is a learning curve to be scaled. In terms of system implementation and user interaction, cognitive systems are fundamentally different than traditional programmatic systems.15 Oil and gas organizations can learn from pioneering organizations that have already implemented cognitive by following three key sets of recommendations (see Figure 5).

Figure 5
Organizations with cognitive computing experience have identified three critical action areas for success

1 Define the value	**2** Lay the foundation	**3** Manage the change
• Find the right opportunities for cognitive	• Invest in specialist human talent	• Ensure executive involvement along the cognitive journey
• Define the value proposition and chart a course for cognitive	• Build and help ensure a quality data corpus	• Communicate the cognitive vision at all levels
• Be realistic about value realization	• Consider impacts, business processes, and policy requirements	• Continue to raise the cognitive IQ level of the organization

Source: IBM Institute for Business Value.

1. Define the value

Early planning helps ensure the greatest return on investment. Defining the value of cognitive to your oil and gas organization is critical and includes several steps:

Find the right opportunity – A cognitive solution is not a fit for every business issue and use case. Evaluate opportunities based upon unique capabilities of cognitive, with potential combination of stream analytics, in the light of pressing needs in oil and gas sector. For example:

Are there processes or functions that today require humans to spend an inordinate amount of time seeking timely answers and insights from various information sources (such as extracting insights from the huge amount of sensor data and operational data available in written logs)? Is there a need for users to interact with the system in natural language, such as helping employees to interact and seek expert advice?

Define the value proposition and chart a course for cognitive – Identify both the differentiated value provided by cognitive computing and the business value up front – enabling improved decision making in production, trade and handling non-technical tasks, reduced operational risk and cost savings by executive sponsors and stakeholders at all levels.. In addition, establish a cognitive computing vision and roadmap with executive-level support. Continuously communicate roadmap progress with appropriate executives and stakeholders.

Be realistic about value realization – The benefits of cognitive computing systems are not realized in a single "big bang" at the time of initial deployment. Rather, these systems are evolutionary and benefits can accrue over time. Communicate this reality to stakeholders and specify benefits and realization plans for the top management, field engineers and technicians, for example.

2. Lay the foundation
Lay the foundation for a successful cognitive computing solution implementation by focusing on the following:

Invest in human talent – Training for cognitive systems is knowledge -intensive and requires specialist support. Implementing cognitive computing solutions require unique expertise and skill sets. It also requires fresh thinking and commitment to acquire such skills from engineers, scientists and other employees, including: natural language processing experts, machine learning experts, process experts and strategists.

Build and help ensure a quality data corpus – Cognitive systems are only as good as their data. Invest adequate time in building a quality corpus of internal and external data that includes structured (for example, operational data, sensor data) and unstructured data (for example, community perceptions about a certain project) from multiple databases and other data sources – even real-time data feeds and social media. In addition, invest in records digitization to secure the future of your organization's corpus, focusing on both historical and current documentation.

Consider impacts, business processes and policy requirements – Assess likely impacts cognitive solutions might have on business processes, organization and culture – how people work. Because users interact with cognitive systems in entirely different ways than traditional input/output systems, processes and job roles could be impacted. Consider if any data policy changes are necessary.

3. Manage the change
Compared to traditional programmable systems, cognitive systems are a whole new ball game. As such, change management is more critical than ever.

Ensure executive involvement in the cognitive journey – Executive involvement should begin with active participation in defining the cognitive vision and roadmap and continue throughout the journey. To maintain momentum, this should include executive participation in regular reviews of: incremental progress at the strategic and operational levels, and value realization.

Communicate the cognitive vision at all levels – Because cognitive computing is new and not completely understood by most, regular communication at all levels is critical. Address any fears, uncertainties and doubts head on, and leverage executive sponsors to reinforce the value of cognitive to the oil and gas organization's mission.

Continue to raise the cognitive IQ of the organization – Education is critical to assuring cognitive is understood and adopted. Of particular importance is managing expectations related to system-generated recommendations. Cognitive systems are probabilistic and not deterministic. Accuracy rates will improve as a system learns over time. Educate stakeholders early on about accuracy rates, and conduct regular reviews on incremental improvements, focusing on the benefits.

Ready or not? Ask yourself these questions

Study approach and methodology
As a follow up to the initial IBM "*Your cognitive future"* research study, we conducted additional research in early 2015 to dive deeper into select industries and explore opportunities for cognitive computing. Through a survey conducted by the Economist Intelligence Unit, IBM gained insights from more than 800 executives from around the world representing a variety of industries, including healthcare, banking, insurance, retail, government, telecommunications, life sciences, consumer products, and oil and gas. The study also included interviews with subject matter experts across IBM divisions, as well as supplemental desk research.

- Despite industry strengths in analyzing and using numeric data, what other data – including unstructured elements – are you not leveraging? If converted to knowledge, how could you better meet key objectives and business requirements?

- What is the associated cost to your organization and the wider oil and gas ecosystem of not having the full array of possible options to consider when decisions and actions are being taken?

- What benefit would you gain in being able to detect hidden patterns locked away in your unstructured data by combining it with structured elements? How would this accelerate innovation, production or performance?

- What would change if you could equip every employee to be as effective as the leading expert in that position or field?

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Related publications

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