The intelligent oilfield: meeting the challenges of today’s oil and gas exploration and production industry

Executive Brief
Executive summary

To succeed in the competitive upstream oil and gas marketplace, companies must leverage a diverse set of capabilities involving people, process and technology. In addition, competition for natural resources has driven companies to explore for and produce oil and gas in remote and hostile locations. And as the environment grows more diverse, the locations more unforgiving, and the business challenges more complex, skilled technical personnel are aging and becoming scarce.

To attract and retain available skilled professionals, companies need to change their corporate cultures. This requires implementing innovative business processes to help people take full advantage of near-real-time oilfield data and turn it into actionable information that can help to increase recovery and production, reduce operating costs and ultimately increase profitability. To accomplish this, companies must understand and embrace new ways of working. This involves establishing new roles and responsibilities—along with rewards and recognition programs—and new work processes to help create an environment that facilitates more informed decision making and efficient execution.

The ability to enhance decision making is crucial to overcoming many challenges. Increasing energy demand and geopolitical forces are creating a volatile commodity marketplace. Global competition for natural resources continues to drive the need to improve oil and gas reservoir performance. Shareholders and Wall Street analysts are pressuring companies for a return on their investments commensurate with other long-term investments. There is increasing public scrutiny concerning the environment and global warming, and recently the world has seen adverse publicity regarding alleged price gouging at the gas pump. And although new technologies have shown promise for meeting industry needs, it can be arduous to integrate new technology with existing processes, systems, organizations and global networks of diverse business collaborators.

The convergence of forces, threats and technologies creates a ripe environment for the intelligent oilfield—a solution that integrates people, process and technology to improve oilfield performance by leveraging frequently captured data that is delivered, converted to usable knowledge and acted upon in real time. Successfully implementing the intelligent oilfield to take full advantage of all available data requires a sophisticated program of projects designed to integrate key human and technology resources.
Creating a collaborative environment for decision making

The intelligent oilfield encompasses a collaborative environment for communication; data collection, reporting and monitoring; knowledge and information sharing. This environment helps people make informed decisions and take appropriate actions across the enterprise. In addition, it enables alignment, focus and common understanding to help prioritize operations.

According to a Cambridge Energy Research Associates (CERA) study, the benefits of the intelligent oilfield can include lower operational costs, earlier and increased production, lower capital investment, increased recovery of oil and gas, and lower abandonment costs. What's more, a significant increase in asset value can be achieved if oil and gas reservoirs are managed on demand and in real time. The CERA study also notes that field operator productivity can increase between 100 and 400 percent, operating costs can decline by 10 to 20 percent and average production rates can increase by 1 to 3 percent. Depending on the oil and gas field size, savings can be generated in the hundreds of millions of dollars. This could result in value creation in the billions of dollars each year.

Innovations in various technologies are helping people make the intelligent oilfield a reality. For example, massive amounts of sensor data are being delivered to skilled people who then remotely search the data, convert it to usable knowledge and use it via advanced visualization technology—avoiding cumbersome data stores and transmission by allowing raw data to remain at the source. This helps analysts automatically detect complex data patterns/problems—such as sand production in wells—so the right person can be alerted to initiate a response before a problem occurs. Visualization, modeling and analytics make it easier for decision makers to understand a wealth of complex information, which can lead to improved oil and gas reservoir management.

The IBM approach: successfully integrating people, process and technology

IBM’s intelligent oilfield solution has five key performance-oriented implementation components (see chart below). These interdependent components can be essential to achieving significant return on investment from an intelligent oilfield. Implementing them facilitates real-time global asset awareness—or access to data from all of the appropriate assets—by enabling proactive asset management using frequently captured data that can be distributed, converted into relevant knowledge, evaluated and acted upon in real time.
With such a program in place, oil and gas companies can use the wealth of information generated from their assets more effectively to make more informed and predictive business decisions. Companies can also remotely and collaboratively manage wells and fields; this helps to save time and money and extends the reach of skilled resources, while also increasing recovery and reducing risks.

The chart above illustrates how IBM integrates the five components of an intelligent oilfield program. The intelligent oilfield is designed to help people (the highest-valued component) work together more effectively, in order to reap the greatest value from the highest-cost component (data gathering and control) and its midlevel byproducts. Raw data (bottom right) migrates up through each component until it is converted into knowledge (upper right), which people use for improved decision making. Ultimately, all the technology components support the workflow of skilled personnel. Depending on circumstances, a company may engage with IBM to accomplish any of the five components first. But a successful initiative depends on fully integrating all five.

A successful intelligent oilfield initiative relies on all components, fully integrated for optimum results.
Limitations of traditional information analysis

The approach to the intelligent oilfield outlined in the chart above addresses the difficulty of turning raw data captured around the clock in real time into useful, relevant information—and, in turn, knowledge. Having this critical knowledge helps people make business-critical decisions, and finding a way to get it is a key challenge for the upstream oil and gas industry. What’s more, determining the appropriate action to take from raw data generated by an individual well is a challenge, given the uniqueness of reservoirs and wells worldwide. Projects are also becoming more complex as companies explore in diverse and unforgiving environments—placing a greater burden on the aging, increasingly scarce population of skilled technical personnel.

For these reasons, much potentially useful raw data is not stored and rarely analyzed. Nor is it distributed to the people who need it most. Common and complex production problems—such as sanding, water encroachment, skin damage that limits productivity, corrosion and scaling—adversely affect production and/or equipment. To prevent and solve these problems, skilled personnel need to understand the issues and processes and be able to critically analyze information and take appropriate action.
All of this is changing how upstream oil companies address data collection, interpretation and analysis in the oilfield. The need for a new approach is illustrated by the following examples:

- Today’s data volumes are 100 to 1,000 times greater than volumes gathered by conventional technology—making data management difficult.
- With fewer skilled staff members, demand has increased for more global collaboration to leverage available skills, facilitate work in appropriate physical environments and support the use of common applications and IT infrastructures. Staff members need secure Web access—anytime, anywhere and from multiple devices—and more electronic documents (for example, the electronic-well file).
- Nontechnical (back-office) activities must be reduced to maximize limited technical (engineering and geosciences) resources; this includes functions such as linking payment transactions for complex services to real-time payment.
- External threats to security are increasing; these factors are being addressed by data-gathering and analysis technologies such as intelligent supervisory control and data acquisition (SCADA), early event warning, smart alarming and automated controls.

The following sections outline how the IBM approach to the intelligent oilfield helps to overcome these challenges, examining each of its five components in order of importance.

**People and collaboration: the human factor matters**

The most critical success factor in any intelligent oilfield program is the degree to which people can leverage the latest tools and technologies for improving analysis, alarm capabilities and process management to help them make better-informed, more proactive decisions. New skills and ways of working (including collaboration, knowledge sharing and assistance to those who work in remote locations), change management and new organizational models are at the heart of realizing the intelligent oilfield.
In an intelligent oilfield environment, people must collaborate in innovative ways to enhance their productivity and improve the performance of the organization's oilfield assets. And effective collaboration demands clear and straightforward communication within a simple organizational structure. This mutual effort—among all those responsible for monitoring and maintaining the oilfield assets—gives people more dedicated time for innovation, creativity and continuous improvement. Collaboration can occur at a single location, or it can occur virtually, across many locations. And it can include access to knowledge and expertise outside of a physical asset or business unit.

Working together in new ways requires people to practice acute listening skills. The company must also develop and implement clearly defined roles, responsibilities, accountabilities, measures and key performance indicators for the processes and participants in the intelligent oilfield environment. Training, coaching and mentoring are vital to interpreting real-time information, making real-time decisions and achieving rapid, effective execution. All of this may require a mind-set shift from a pure "react" mode of operation to an "anticipate and preempt" mode.

Think of the intelligent oilfield as a catalyst for change. It drives maximum efficiency from an oil company’s people, processes and technologies. It may also force some reevaluation and consolidation of IT systems and integration with other organizations and their IT systems. And its success depends not only on seamless implementation of the right processes and technical solutions, but also on adoption of the right approach to managing change and ensuring continuity.

**Workflow optimization: process as a catalyst for change**

Many of today’s oilfield-related workflows and processes are based on raw data collection and delivery frequency. The intelligent oilfield takes full advantage of the fact that data from the oilfield can be collected and delivered in real time, by streamlining numerous oilfield-related processes and their sequence. This in turn helps people increase their productivity and efficiency.
Real-time collection and delivery of oilfield data dramatically changes the way people process and use information. In an intelligent oilfield, integrated business processes (end-to-end across the company and with key partners, distributors and suppliers) are designed to help the company respond more quickly to change. Change can mean an increase or decrease in customer demand, a new marketplace opportunity or an external threat. Optimizing the value net, or the set of customers and vendors that a company uses, can reduce complexity via improved collaboration, reduced cycle times and lower operational costs. By increasing the flexibility of information analysis, a company can extract more value from information through an increased ability to manage volatility and unpredictability. This flexibility helps companies define, assimilate, standardize and manage core business processes while evaluating key performance indicators—all of which are critical for sharing knowledge and implementing improved practices across the enterprise.

**Integrated systems and applications: connecting the dots**

With the capabilities of today’s monitoring technologies, a single oil or gas field can generate more than a terabyte (1,024 gigabytes) of raw data per day. Moving such massive amounts of data across unconnected, disparate IT architectures can slow down interdepartmental communication. In an intelligent oilfield environment, applications need to interact with each other more effectively and efficiently and use the same data. That way, a global workforce possibly working in remote centers has a standard set of tools to convert data into actionable information. Without such tools, people in different groups could create confusion by making contradictory or incompatible analyses and, in turn, adversely impact decisions and timing.

IBM uses an approach to the intelligent oilfield that integrates Web services and a supporting service-oriented architecture (SOA). This proven set of technologies enables a plug-and-play environment that can help to streamline work processes and enhance business efficiencies. It can help companies turn raw data into information that can be directed to the right person, in the right format and at the right time, to facilitate the right decisions.
Data management and infrastructure: managing data better

Most of today’s upstream oil and gas companies struggle with data management. This struggle will grow acute as companies establish operations centers in more remote locations and increase their demands for quality information, timely decisions and response from these locations. To decrease the cycle time from an adverse occurrence in the field to a decision and its proper execution, companies (and specifically the right people) need accurate, real-time, remote access to all data and information related to wells, reservoirs and the associated equipment.

Once gathered, intelligent oilfield data must be transmitted, sometimes over vast distances, to enable more resources (people and computers) to assist in evaluation and decision making. Increased collection frequency leads to greatly increased data volumes. Currently, as much as a third of a skilled oil and gas engineer’s time is spent on data mining. With more raw data constantly arriving, more data-mining time is required. This, in turn, demands a high-bandwidth communications infrastructure and more robust data management. By combining analytics and business intelligence tools with this high-bandwidth infrastructure that helps to turn raw data into useful information, upstream oil and gas companies can increase business benefits from productivity and efficiency gains.

The intelligent oilfield can effectively address these data management challenges. Hierarchical analysis of the wealth of data that a field generates can help to create knowledge that helps analysts predict adverse and beneficial occurrences more accurately. Analysts can intervene based on historical data already captured, analyzed and archived. Furthermore, they can conduct reservoir analysis at any time, based on the data stream, rather than having to wait for major milestones.

And finally, the intelligent oilfield can facilitate integration of existing internal and external systems, such as asset management, workflow and finance. And it can provide analysts with an enterprisewide view of data that dramatically enhances longer-term strategic planning and performance.
Data gathering and control: collecting the right stuff

Data and the information derived from it sustain the entire oilfield effort. Rates, cuts, pressures, acoustics and temperatures are the most basic data points, and companies deal with many other significant data points as well. But many companies today collect data with uncertain frequency and deliver it for conversion into actionable knowledge with similar uncertainty.

In the intelligent oilfield, however, data is not just collected and stored. It is scrubbed, normalized and calibrated. Raw data remains at the source; metadata is transmitted across the entire IT infrastructure. Information is fused and analyzed with multiple data streams around the clock, in near real time, helping companies to prevent costly occurrences such as pump failures.

By analyzing the information derived from data against multiple historical references, oil and gas companies can more accurately predict future performance and proactively solve problems. Anomalous patterns can be detected and sent to the appropriate person for investigation; and the analyst can then reprogram the appropriate software, if necessary, to help improve future accuracy. Autonomic data analysis (i.e., self-configured, self-adaptive analysis) runs unaided, providing early warning of critical issues such as sand and water breakthrough and fluid composition changes.
Why an IBM intelligent oilfield solution?

IBM's end-to-end business consulting and technology capabilities make IBM highly qualified to deliver solutions designed to help upstream oil and gas companies achieve sustainable profits from producing assets. These capabilities extend from onshore to deepwater oil and from shallow-water to onshore gas. IBM capabilities also help upstream companies better leverage their workforces today and into the future.

IBM's distinctive offerings for the intelligent oilfield are built around service solutions focused on people, process and technology areas. Although these three core components have been recognized for some time, innovation, integration, R&D and industry expertise are what differentiate IBM.

People

- Change management—IBM has considerable experience and expertise in facilitating business innovation by helping organizations manage organizational change and the dynamics of people and process to bring about business transformation. This is a key competency in an intelligent oilfield program, where the company must change its work processes, including its rewards and recognition system, to foster a corporate culture geared to proactive prevention of oilfield problems and failures—as opposed to a traditional, reactive culture focused on addressing problems and repairing failures after the fact. IBM helps to establish a blueprint for the implementation of such productive change. Successful readiness planning helps to identify risk areas over the life of the project. And by understanding the implementation environment—including related processes, oilfield technology and IT projects—IBM can help to mitigate risks in these areas. IBM can also identify integration points, dependencies and synergies between the intelligent oilfield and other company initiatives.

- Executive sponsorship and stakeholder alignment—To achieve intelligent oilfield implementation and its associated business benefits, key leaders from disparate internal organizations must share a common vision. These leaders must be willing to translate this vision into visible, tangible program support. Large numbers of potentially affected stakeholders, individual contributors, leaders and teams from wide-ranging geographies must be aligned with a common vision that keeps the greater good in mind. IBM has deep experience in recognizing key change issues and in bringing proven practices to bear to develop and maintain the necessary alignment.
**Process**

- Program and project management and roadmap development—Understanding what must happen in each phase, and why it is necessary, lies at the heart of change management—particularly in an undertaking as large and complex as an intelligent oilfield. Such an initiative demands full-time coordination throughout an organization, along with a clearly articulated solutions strategy and a plan to deploy it. IBM can help by leveraging its rigorous program- and project-management capabilities. These capabilities help to create a vision and roadmap designed to bring an intelligent oilfield initiative to fruition in a way that integrates the crucial components of people, process and technology. IBM can help develop a roadmap that capitalizes on lessons learned, leading practices and a client’s unique corporate culture. The roadmap is designed to provide a holistic view that helps to accelerate implementation. IBM’s experience also helps clients sequence projects to realize the most significant benefits for both greenfields and brownfields early in the program lifecycle.

- More efficient integration between IT and the business—IBM has found that the intelligent oilfield can bridge the business-to-IT technology gap and facilitate the introduction of new and more effective business processes. IBM’s capabilities help simplify intelligent oilfield implementation by addressing the integration and rationalization of relevant petrotechnical and business applications, systems and databases. This can include developing single-point data entry, simplifying or eliminating point-to-point interfaces and building a more flexible IT infrastructure.

**Technology**

- Innovative technologies—IBM offers a broad range of innovative technology solutions that can help upstream oil and gas companies anticipate problems such as equipment and production impairment or failure before they happen, which can help reduce the costs associated with downtime and repairs. One such technology is a federated early-warning system designed to provide near-real-time data cleansing, calibration and normalization; pattern detection; and ontology management. (Ontology, in this context, means relatively generic data that can be reused by different kinds of applications or tasks.) And by implementing other technologies such as middleware, a data warehouse or IBM’s SOA capabilities, IBM can help to simplify the intelligent oilfield IT architecture. These innovative technologies provide plug-and-play processes and information capabilities in a framework designed to enable an organization and its people to collaborate on a deeper, more efficient, global level.
The single version of the truth—To the user, the intelligent integration of applications, systems and databases means a single data point for any given circumstance. No longer will multiple versions of the same data exist in local or unconnected databases. Having a single version of data and the information derived from it eliminates the time-consuming need to explain and reconcile multiple versions of data coming into engineering, accounting and other departments—and it helps to reduce work redundancy, thereby improving efficiency. The single version of the truth becomes a key enabler for people to make higher-quality and repeatable decisions. It is particularly important when regional or global experts, working in remote collaboration centers or control rooms, rely on accessible information to make key decisions.

The industry experts at IBM Global Business Services and PhD-level professionals at IBM Research collaborate to supply leading-edge business consulting, rigorous process know-how and change-management expertise. They couple these capabilities with world-class hardware solutions and innovative, industry-proven software applications—all focused on offering a comprehensive intelligent oilfield solution that is applicable today.
For more information
To learn more about IBM Global Business Services and IBM solutions for intelligent oilfields, contact your IBM sales representative or visit:

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