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Intelligent Oilfields

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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.

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.

Introduction

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.

Integrating People, Process and Technology

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.

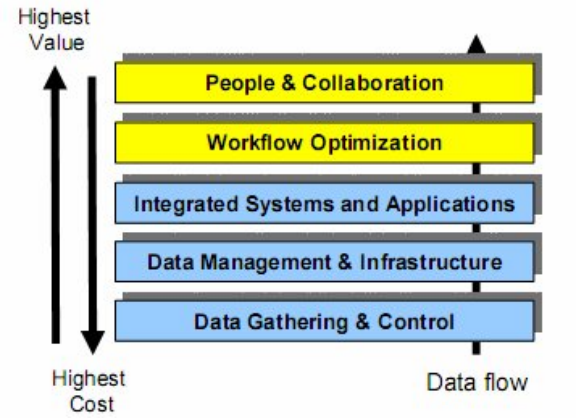

Fig 1: Components of Intelligent Oilfield

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).
- Non-technical (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 auto-mated controls.

Integral Components of Intelligent Oilfields

People and Collaboration

The most important 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.

Workflow Optimization

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 & Applications

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.

Data Management and Infrastructure

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.

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.

Data gathering and control

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.

Critical Success Factors

Change management

This is a critical success component 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. Successful readiness planning helps to identify risk areas over the life of the project. And by under-standing the implementation environment— including related processes, oilfield technology and IT project. Integration points, dependencies and synergies between

the intelligent oilfield and other company initiatives should also be identified.

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.

Processes

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. Project Management 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.

Innovative Technologies

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 SOA capabilities. 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.

Case Studies

Here is the sample scenario post implementation of Intelligent Oilfield Predictive maintenance algorithms.

1. An alarm in the ROC indicates a 60% probability that 'sanding' is occurring on an offshore well, a suggested treatment is advised,

2. The knowledge worker changes the sensors to sense every 2 seconds versus every 5 seconds. At the same time, the knowledge worker analyzes well history for the problematic well in addition to wells in the vicinity.

3. The knowledge worker also searches global database for examples of similar cases and evaluates treatment actions.

4. Based on the increased sensing frequency and time elapsing, probability of sanding increases to 80%. In addition, trend analysis by the knowledge worker helps to confirm the problem. The knowledge worked alerts the field personnel to the problem and a recommended course of action.

   The field personnel shuts the well down before the costly issues caused by sanding occurs, alerts the service company with the problem history, and completes a SAP work order on-line.

6. History and treatment is updated in the ROC system, the ontology is revised, and the well is brought on-line

Here are the two case studies at major global oil and gas corporations.

Client Situation

Large (>15,000) number of onshore wells, Business unit contains legacy apps and systems that prevent easy changes excessive time hunting for the "single source of truth"

Approach

Worked with key leaders to define the SOA Strategy for the business unit, consistent with the global approach, Program management that included third-party providers and company resources, Worked with users to define business processes, Developed assessment / audit guidelines that "certifies" new apps and systems as SOA-compliant

Results

To date, business processes have been mapped to enable an SOA framework

Client Situation

Client has global IOF* program, High-rate, deep offshore wells have a history of premature failure from

sanding, Operators and engineers must sift through too many unnecessary alarms

Approach

Assessed current approach to well failure prediction and identification, Leveraged IBM Research capabilities to discern key patterns in data streams (rate, pressure, temperature & choke), Tested performance in 20 wells – SMEs and current processes Vs IBM Event Early Detection

Results

90% agreement between SME* and the Event Early Detection software, Software coded for commercial use

About the Author

Neeraj Gupta is Oil and Gas Solutions leader for Asean/South Asia at IBM. He has over thirteen years of international experience with leading oil/gas companies. He holds an integrated Master's degree in Applied Geophysics from Indian Institute of Technology at Roorkee.

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Abbreviations Used

*NPV: Net Present Value, *SOA: Services Oriented Architecture, IOF: Intelligent Oilfields, SME: Subject Matter Experts