International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622
National Conference on Advances in Engineering and Technology
(AET- 29th March 2014)

RESEARCH ARTICLE OPEN ACCESS

Optimization of Drilling Program Using Intelligent Oil Fields: A Preliminary Study

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ABSTRACT

The upstream oil and gas sector is a very competitive sector and to succeed in this 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 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 and optimize drilling programs 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.

This paper discusses the preliminary and basic study of intelligence technologies for oil and gas industries for data assimilation. Making the transformation to an Intelligent Oil Field is dependent on data management and integration. Without it, key insights are lost and analysis is not producing the best interpretations. A modern drilling rig or offshore platform uses a diverse array of specialist contractors, each of whom need to communicate data to the oil company operating the rig, and to each other. Historically this was done with serial transfer of ASCII data, but as the volume of information grows, a new technology is needed.This was provided by WITSML, an example of a standardisation effort for real-time drilling data which facilitates integration of disparate computer systems.

Keywords–Intelligent Oilfield, Data Integration, WITSML.

I. INTRODUCTION

The intelligent oilfield consists of 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 [1].

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. Similarly, for drilling programs, a standardization effort for real-time drilling data was created using WITSML (Wellsite Information Transfer Standard Markup Language) [2].

II. INTERGRATED OPERATIONS (IO)

Integrated operations (IO) refers to new work processes and ways of performing oil and gas exploration and production, which has been facilitated by new information and communication technology. The most striking part of IO has been the use of always-on videoconference rooms between offshore platforms and land-based offices. This includes broadband connections for sharing of data and video-surveillance of the platform. This has made it possible to move some personnel onshore and use the existing human resources more efficiently. Instead of having e.g. an expert in geology on duty at every platform, the expert may be stationed on land and be available for consultation for several offshore platforms. It's also possible for a team at an office in a different time zone to be consulting the night-shift of the platform, so that no land-based workers need work at night [3].

Tools like videoconferencing and 3D-visualization also creates an opportunity for new, more cross-discipline cooperation. For instance, a shared 3D-visualization may be tailored to each member of the group, so that the geologist gets a visualization of the geological structures while the drilling engineer focuses on visualizing the well. Here, real-time measurements from the well are important but the down hole bandwidth has previously been very restricted. Improvements in bandwidth, better measurement devices, better aggregation and visualization of this information and improved models that simulate the rock formations and wellbore currently all feed on each other. An important task where all these improvements play together is real-time production optimization.

In the process industry in general, the term is used to describe the increased cooperation, independent of location, between operators, maintenance personnel, electricians, production management as well as business management and suppliers to provide a more streamlined plant operation [4].

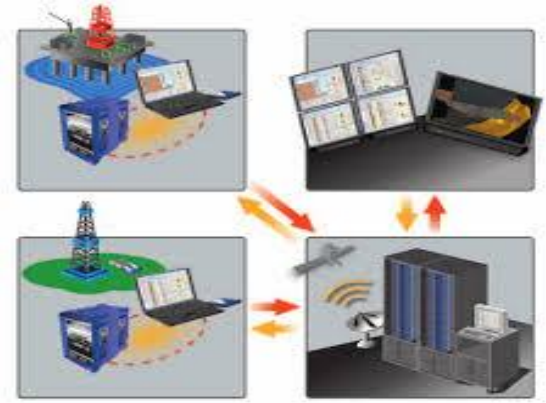

Fig 1: Oil and gas drilling optimization technology

By deploying IO, the petroleum industry draws on lessons from the process industry. This can be seen in a larger focus on the whole production chain and management ideas imported from the production and process industry. A prominent idea in this regard is real-time optimization of the whole value chain, from long term management of the oil reservoir, through capacity allocations in pipe networks and calculations of the net present value of the produced oil as shown in Figure1 [5].

A focus on the whole production chain is also seen in debates about how to organize people in an IO organisation, with frequent calls for breaking down the Information silos in the oil companies. A large oil company is typically organized in functional silos corresponding to disciplines such as drilling, production and reservoir management.

This is regarded as inefficient by the IO movement, pointing out that the activities in any well or field by any of the silos will involve or affect all of the others. While some companies focus on their inhouse management structure, others also emphasize the integration and coordination of outside suppliers and collaborators in offshore-operations. For instance, it is pointed out that the oil and gas industry is lagging behind other industries in terms of Operational intelligence.

Ideas and theories that IO management and work processes build on will be familiar from operations research, knowledge management and continual improvement as well as information systems and business transformation. This is perhaps most evident in the repeated referral to "people, process and technology" in IO discussions.

III. INTEGRATING PEOPLE, PROCESS AND TECHNOLOGY

Intelligent oilfield solution has five key performance- oriented implementation components (see chart below).

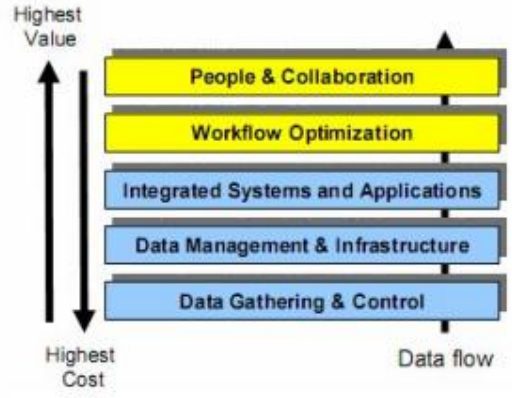

Fig 2: Components of Intelligent Oilfield

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 as shown in Figure 2.

IV. INTEGRAL COMPONENTS OF INTELLIGENT OILFIELDS

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.

V. DATA INTEGRATION FOR THE INTELLIGENT OIL FIELD

Exponential data growth is making it essential for the integration of visualization, compute and data resources. Even though much of the infrastructure for oil field operations was built to handle unique requirements, the consolidation of activities necessitates that IT architects rethink it given the processes required today. For example, as scientific disciplines work more closely together, they have needs to access and work with cross-functional data that may have been considered non-essential in the past. Additionally, processing and interpretation are no longer conducted most efficiently as separate operations, but are performed in a continuous loop. The number of processing jobs has also multiplied, making speed to interpretation a high priority.

5.1 Finding the path to an Intelligent Oil Field

Making the transformation to an Intelligent Oil Field is dependent on data management and integration. Without it, key insights are lost and analysis is not producing the best interpretation to improve operational decisions. This is likely the most difficult transition to make due to the silos that are firmly entrenched and the limited access to cross-functional data, but arguably one of the most important.

There are three places to look for making progress:

- Estimate the processes that will benefit from real-time data. Create pilot projects to prove value. Then look for ancillary processes that can be most easily integrated to add incremental values.
- Create standardized data models based on rationalization or consistent interpretations of the data.
- Establish data governance models that guide the use of the data, its storage and management.

Selecting where to start should be based on the drivers that contribute to your company's overall business strategy. Data integration that presents new ways of analyzing information will also require adjustments to business processes and workflows. It may also expose limitations in obtaining the data you need from legacy systems that will need to be addressed. Taking the time to assess these possibilities will help you to formulate a plan that can facilitate much greater results than if these considerations are not made at the start.

VI. WITSML (WELLSITE INFORMATION TRANSFER MARKUP LANGUAGE)

A modern drilling rig or offshore platform uses a diverse array of specialist contractors, each of whom need to communicate data to the oil company operating the rig, and to each other. Historically this was done with serial transfer of ASCII data, but as the volume of information grows, a new technology is needed. This was provided by WITSML. Wellsite information transfer standard markup language (WITSML) is a standard for transmitting technical data between organizations in the petroleum industry. It continues to be developed by an Energistics facilitated Special Interest Group to develop XML standards for drilling, completions, and interventions data exchange.

6.1 Purpose

The drilling, completions, and interventions functions of the upstream oil and natural gas industry needs universally available standards to facilitate the free flow of technical data across networks between oil companies, service companies, drilling contractors, application vendors and regulatory agencies.

The WITSML (Wellsite Information Transfer Standard Markup Language) initiative was started to address this need, and through its success, is now influencing petroleum industry data standards beyond the original scope.

WITSML(tm) Standards support the "right time" seamless flow of drilling and completions data between data producers and data consumers to speed and enhance decision-making in the drilling and completions domain.

The WITSML Special Interest Group (SIG) is open to all industry organizations who wish to contribute to the further development of the WITSML Standards. Energistics has custody of the standards and hosts the SIG. Energistics makes these and other industry standards available for use by all industry companies through a licensing agreement that is free of any fees or charges.

6.2 Standards Used

WITSML Standards are defined using the W3C Internet standards for XML (notably XML Schema) and Web Services (including SOAP and WSDL)). The WITSML Standards define Web Services that define client/server interactions, known as the WITSML Application Programming Interface specifications. The WITSML Standards define more than 20 industry domain specific XML data object schemas to support drilling, completions, and intervention business functions.

6.3 Versions of Intelligent tools

WITSML Version 1.3.1 was released in March 2006. This was superseded by Version 1.3.1.1(bugfix), release in March 2007. WITSML Version 1.4.1 was released in September 2011. It is the current stable version.

VII. 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; ontology management, 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.

VIII. CRITIQUE

The security aspect of reducing the offshore workforce has been raised. Will on-site experience be lost and can familiarity with the platform and its processes be attained from an onshore office? The new working environment in any case demands changes to HSE routines. Some of the challenges also include clear role and responsibility definitions and clarifications between the onshore & offshore personnel. Who in a given situation has the authority to take decisions, the onsite or the offshore staff. The increased integration of the offshore facilities with the onshore office environment and outside collaborators also expose work-critical ICT-infrastructure to the internet and the hazards of everyday ICT. As for the efficiency aspect, some criticize the onshore-offshore collaboration for creating a more bureaucratic working environment.

IX. CONCLUSION & FUTURE WORK

Intelligent Oilfields, Digital oilfield of the future, iFields, eFields, Smart fields-These are all names for the industry efforts to use instrumentation and software to optimize operations in all domains for oil and gas exploration and production (E&P).

To achieve this goal, all of these technologies must work together and softwares like WITSML make integration of these technologies possible, enabling near-real-time production optimization and moving closer to realizing the benefits of the digital oilfield at a low-cost, low-risk, and highly innovative environment for the configuration and running of advanced optimization processes. A preliminary studies have been carried out in this paper to understand the knowledge of oil and gas parameters estimation using intelligent techniques and tools.

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