The Role of Predictive Analytics in Asset Optimization for the Oil and Gas Industry

WHITE PAPER

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IN THIS WHITE PAPER

This White Paper describes the business challenges facing the oil and gas industry relative to asset optimization. It also describes the current state of predictive analytics for asset management and provides an example of its use in the rail industry. Finally, it reviews the potential application of predictive analytics in the oil and gas industry to improve oil and gas recovery rates, reduce asset maintenance costs, and reduce non-productive time.

SITUATION OVERVIEW

The Business Challenge: Asset Optimization

The oil and gas industry is an asset-intensive business with capital assets ranging from drilling rigs, offshore platforms and wells in the upstream segment, to pipelines, LNG terminals, and refineries in the midstream and downstream segments. These assets are costly to design, build, operate, and maintain and, as such, asset life-cycle costs are an important metric for the industry. A quick analysis of the financial statements of the five supermajors (BP, ConocoPhillips, ExxonMobil, Shell, Total) shows that plant, property and equipment on average accounts for 51% of total assets. Among this group of companies, the average value of plant, property and equipment is over $100 billion.

A recent benchmark study conducted by IDC Energy Insights regarding the IT systems used by the energy industry to manage large capital projects found that it was not uncommon for an oil and gas company to manage hundreds of active projects with project values ranging from tens to hundreds of millions of dollars. In some cases, the total value of all active projects exceeded $30 billion.

Due to the costs associated with these capital projects and assets, oil and gas companies are focusing on strategies to reduce non-productive time (NPT), increase production from existing reserves (i.e., enhanced oil recovery), and control maintenance costs. Indeed, NPT for exploration and production assets is often in the 20%–30% range. According to a white paper by the Athens Group titled *The State of*

NPT on High Specification Offshore Rigs: First Annual Benchmarking Report, "NPT costs drilling contractors from $100–$150+ million per year, depending on the components used in the calculation."

These problems are compounded by the aging workforce issue facing the oil and gas industry. It is expected that up to half of current engineers and scientists in the oil and gas industry will retire in the next decade, taking their collective skills and knowledge with them as they leave. As many as 40% of U.S. petroleum engineers currently employed by the industry will retire by 2015. This will create a talent shortage that is unlikely to be filled by new hires.

More recently, as a result of the Macondo well incident in the Gulf of Mexico, IDC Energy Insights expects to see broad federal and state regulatory and policy changes that will significantly increase regulatory requirements related to health, safety, and environment (HSE) in the oil and gas industry. These changes are predicted to increase the focus of oil and gas companies on a range of business areas including HSE and asset management.

Taken together, these issues are forcing the oil and gas industry to focus its efforts on increasing asset utilization through the optimization of asset-oriented business processes and the proactive intervention in operations, often based on the use of predictive analytics.

Predictive Analytics

Predictive analytics is an area of statistical analysis that deals with extracting information from data and using it to predict future trends and behavior patterns. The core of predictive analytics relies on capturing relationships between explanatory variables and the predictive variables from past occurrences, and exploiting it to predict future outcomes.

Predictive modeling draws from statistics and optimization techniques to extract accurate information from large volumes of data. Modeling techniques produce interpretable information allowing oil and gas personnel to understand the implications of events, enabling them to take action based on these implications.

In the oil and gas industry, predictive analytics builds on prior investments in enterprise asset management (EAM) systems, combines real-time data from sensors and other acquisition techniques with historical data to predict potential asset failures, and enables the move from reactive (scheduled, break-fix) to proactive (condition-based, preventive) maintenance.

EAM has been traditionally used in the oil and gas industry to manage detailed information about assets including asset location, asset hierarchies, asset condition, and work history. It has also been used to schedule and manage work orders associated with the assets and manage the materials and equipment needed to complete the work.

However, the work performed on the assets has rarely taken real-time data regarding the condition of the assets into consideration.

More recently, the cost-performance of sensor and communications technologies has enabled the widespread collection of real-time data on asset conditions such as vibration, strain, pressure, and temperature. These sensors are less labor intensive, can be placed in hazardous or inaccessible environments, and are often more accurate and timely than manual data collection techniques.

Predictive analytics can be used to analyze the real-time data from the sensors in the context of historical data and asset information held in the EAM system to predict future conditions such as faults or failures and produce alarms or schedule maintenance or replacement. Predictive analytics also complement other existing systems such as data historians and SCADA systems.

An Example From the Rail Industry

Other asset-intensive industries have already begun to see benefits from the use of predictive analytics. One example is the Train Automatic Performance Analysis System (TAPAS) implemented by Southern Rail in the U.K. Southern Rail runs an extensive set of train services between London and the South coast including the Gatwick Express. The business carries around 150 million passengers a year, manages 159 stations and a fleet of nearly 300 new and refurbished trains, 7 days a week and up to 24 hours a day.

Southern's 46 Class 455 rolling stock units were experiencing reliability and operational issues resulting in 56 cancellations and 2,300 delay minutes in every four week period. So, in partnership with HSBC Rail, Southern embarked on an improvement program with an initial focus on the Class 455 fleet. When the installation of "black box" recorders was made mandatory for all trains, Southern saw the opportunity to extend the data being collected beyond the minimum required for safety to an enhanced set that would allow the company to monitor the behavior of critical components, as well as track train movements using GPS. This data formed the basis of the TAPAS project, which included the development of predictive analytics for condition-based asset maintenance aimed at improving the reliability of train services. Using a holistic or systems approach Southern were able to identify potential failures before they happened, reducing routine maintenance and preventing repeat failures. This translated into increased reliability and less time spent in maintenance, which ultimately benefited Southern's passengers.

Within a year of the system going live, Southern was able to exceed its original target of doubling the reliability of the Class 455 Fleet. It was also able to reduce delay minutes caused by congestion, unnecessary stoppages, and reduced traction due to track conditions. Currently, reliability has increased to triple the original figure, delays and cancellations have been reduced by over 60%, the maintenance effort required to keep the car doors working (a weak point in the system)

has been reduced by nearly 70%, and fines for poor performance have been reduced by over £1 million per year.

Southern is now applying predictive analytics to TAPAS data to retrain its operators to be more consistently efficient as a population, to drive more safely and to consume less fuel, thus extending the optimization beyond asset maintenance into other areas of business performance such as safety, passenger comfort, and sustainability.

FUTURE OUTLOOK

Applying Predictive Analytics to Oil and Gas Asset Optimization

Predictive analytics are already starting to be deployed in the oil and gas industry. In his keynote speech at the 2010 Intelligent Energy conference, Doug Suttles, Chief Operating Officer of BP Exploration and Production, described the use of predictive analytics in the Prudhoe Bay field in Alaska by stating that:

> "In the Prudhoe Bay field in Alaska we have new and better tools to improve recovery rates from a mature super giant field. To understand more than 30 years' of production history, we need a great set of tools to manage and integrate massive amounts of data — both old and new. So far we have increased the recovery factor from approximately 40% to more than 60% since we initially sanctioned development… Constantly integrating real time field performance data with predictive tools has and will continue to play a significant role in Prudhoe's development."

In a paper titled *An Intelligent Platform to Manage Offshore Assets*, presented by C. Piovesan and J. Kozman at the 2009 SPE Annual Technical Conference, the authors state that:

> "What is needed in order to properly evaluate, manage and mitigate the impact of equipment downtime on production is an alarm system to inform instrument and control engineers of under-performing or critical conditions on equipment before it begins to degrade production and the revenue stream."

The paper further posits that:

> "Advanced tools such as neural networks, self-organizing maps, or other artificial intelligence technologies [can be] used to evaluate equipment sensor readings against performance envelopes or thresholds developed from predictive algorithms."

Acquiring the information to lengthen the lifespan and improve availability of production assets is fundamental for oil and gas companies seeking to improve production. Data from available benchmarking indicates that the oil and gas industry lags behind others in achieving top scores in terms of overall equipment effectiveness (OEE). To increase their score, translating into several hundreds of thousands of additional barrels of oil, oil and gas companies need to act on the availability component. Predictive analytics and modeling is crucial.

Predictive analytics support oil and gas companies by addressing the challenge of critical equipment performance, life cycle, integrity, and security, and increase utilization. In some cases, equipment operators are able to completely avoid failures by taking early corrective action. The use of predictive analytics increases the span of diagnosis and planning time that falls between an event and the consequent functional equipment failure. It also supports the challenges of diminishing and limited personnel expertise and is capable of reinforcing the ability to intelligently operate multiple assets from a central location, for instance in the drilling environment. Finally, predictive analytics go beyond early warning by providing insights into the roots of problems.

To reach their full potential, oil and gas companies need to take a holistic or systems approach to asset optimization and thus have the right information at all levels of the organization in order to make the right decisions. At the production unit level, they should understand how equipment is performing. Automated analytics could be used to improve uptime, efficiency, and throughput. At the facilities level, managers should understand production as it relates to their customers, so they can make the right decision about procurement, production scheduling, and shipping. At the enterprise level, executives should relate production to the larger business context and understand the impact of fluctuating costs, changing market conditions, and asset performance.