FORESIGHT

into operations can help oil and gas companies work proactively to identify, resolve, and prevent operational problems—and increase uptime and productivity.

Oil and Gas: Building the Predictive E&P Organization

Business white paper

Table of Contents

Introduction

Upstream oil and gas companies work in a dynamic, complicated environment—and that means that there are plenty of opportunities for things to go wrong, from failed pumps to broken drills.

Oil and gas companies have become adept at responding to such issues in their exploration and production (E&P) operations. The problem, however, is just that—they are responding, which means reacting after the fact and, in essence, working constantly just to keep up with changing operational realities. The result, too often, is delay and increased expense—things that no company wants, especially in an industry where rising production costs, time-to-market pressures, and increased regulatory scrutiny mean that the margin for error is constantly growing thinner.

All of this has prompted some in the industry to look for new, more proactive approaches to operations. Among these is IHS Cambridge Energy Research Associates, Inc. (IHS CERA), the global consulting firm, which has developed the concept of "the predictive organization." A predictive organization pulls information together "to develop an understanding of future asset-wide behavior" in order to "proactively and optimally manage the asset today with a knowledge of what's going to happen tomorrow," notes a recent IHS CERA report.[1]

IHS CERA has been working with HP to gain an understanding of how predictive technologies and processes work across various industries, and how they can be applied by upstream oil and gas companies. As the firm reports, a holistic approach to the predictive organization "has the potential to transform how E&P firms develop and operate their oil and gas assets."

The question is, how can you make the move to being more predictive? It will undoubtedly require significant effort and investment. To help, HP has created a framework for planning, taking focused action, leveraging technology, and pursuing an evolutionary course to becoming a predictive organization.

Companies may need to look to the long term to become truly predictive on any kind of large scale, but they also need to look at the short term in getting started. As IHS CERA reports: "The need for a new set of tools to help oil companies manage…complexity and maintain safe, efficient, and environmentally sound operations has never been greater."

Building the predictive organization

In creating the predictive organization, you do not have to make a single, enterprise-wide leap forward. You can move ahead gradually, applying predictive capabilities to some parts of the organization where the need is greatest, and bringing other areas along as appropriate. At the same time, HP believes that companies should look at this effort as a three-stage process, and chart out a step-by-step plan for building their predictive capabilities. To move ahead, companies need to:

- *Improve operational visibility.* This stage involves the creation of a single source of the truth, agreed to by all relevant parts of the organization. This deeper, more consistent visibility is a prerequisite for the next two stages, and in essence, a critical foundation of the predictive organization.

- *Implement modeling and predictability.* Improved operational visibility and a single source of the truth can provide a data foundation for using analytics processes and techniques to create a forward-looking view of operations. In particular, efforts in this stage should focus on understanding the follow-on effects of specific operational events, which in turn can be used to help understand the probabilities of where and when problems are likely to occur.

- *Enable action and control.* This involves the delivery of analytics-driven insight to decision makers in real time or near-real time, enabling them to use it to take action that avoids problems, for monitoring and reporting on results, and for driving continuous improvement efforts. This stage typically focuses on providing timely, actionable information to employees. However, in the long run, action and

control processes will evolve toward the automated detection of and response to problems for increased efficiency and speed in managing issues.

There are several fundamental, technology-driven capabilities, or "levers," that can be used in various combinations to help companies take those three steps. These include *information management, advanced analytics, sensing,* and *cloud computing*.

Information management
As mentioned above, a single version of the truth for all relevant parts of the organization is critical to creating the predictive organization. However, developing that view has not always been easy. Information at oil and gas companies is typically managed in various silos, with functional groups such as well production and geotechnical engineering each maintaining their own separate databases. Information management can help bring that information together. To be effective, it should encompass the end-to-end information lifecycle, from acquiring data from a variety of sources to delivering information to decision makers. Effective information management is the key to successfully forging one view of operations, and ensuring that this view is accurate, trusted, and ultimately used by all relevant parts of the business.

Technology plays an important role in effective information management. You can bring greater standardization to data through a federated approach that essentially uses master data management (MDM) to link data from non-integrated systems, while essentially leaving that data in place. Or, you can build a centralized corporate data store, which can provide access, consistency, and speed to support the entire "sense and respond" loop needed for predictive capabilities. Either way, the key is to manage data so that the company has a single version of the truth that can be accessed by decision makers and automated systems across the organization.

But technology is just one aspect of sound information management. You also need to have effective information-governance processes in place—something that many oil and gas companies have not addressed in a systematic manner. This means ensuring consistency in terminology and measurements across the organization, so that various groups are working on an "apples to apples" basis.

It also means establishing who will "own" the data and be responsible for its management. Ideally, ownership should be given to a group that encompasses two knowledge domains: the technology skills to help ensure data quality, *and* the business skills needed to make sure the information is useful and meaningful in supporting operations. This combination of skill sets will help ensure the alignment of IT and business perspectives—and engender the trust in information that is needed in the predictive organization.

Advanced analytics
Analytics technologies have traditionally been used to support strategic decision making, typically through a fairly lengthy process that produces insights to help guide long-term plans. But analytics has evolved, and today it is also being applied to operational processes and providing real-time support for front-line decision makers. Here, the focus is not on long-term planning, but rather on reducing time-to-action in driving efficiency and uptime— or avoiding failures that have the potential to disrupt operations.

Advanced analytics can help companies monitor assets more closely and stay on top of the high volumes of production data coming from the digital oil field. It enables them to identify trends, simulate production to find "cause and effect" links between production events, and ultimately predict the behavior of assets.
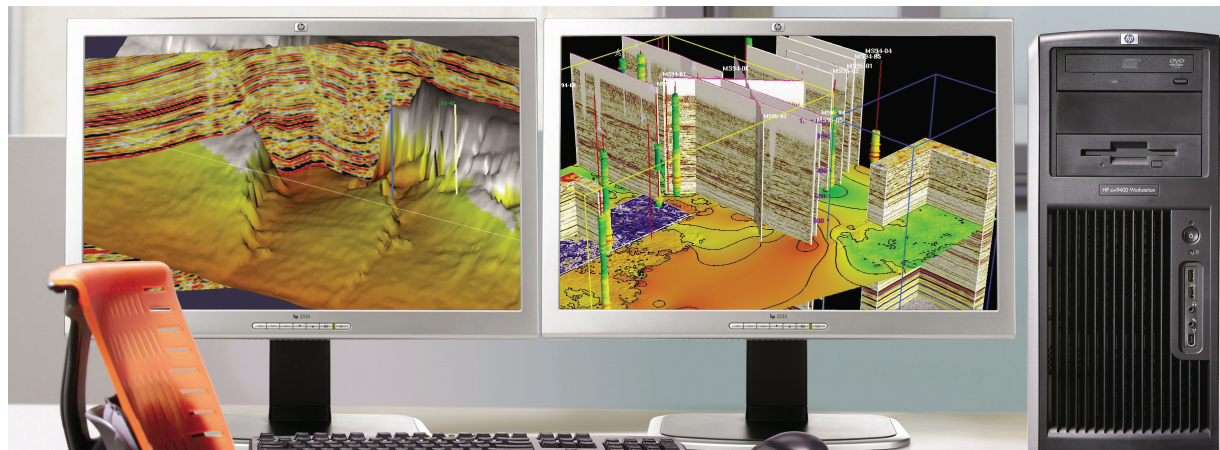
Advanced analytics can be applied in E&P operations in a number of ways. For example, companies may use analytics to take a systemic view of a single oil well, from bottom-hole assembly through well bore, riser, and topside processing equipment. Information about temperature, pressure, flow rates, and so forth can then be analyzed to better understand a variety of processes. Such data could be used to identify patterns in flow attributed to fluid composition and choke setting, which in turn could be used to create alerts when flow is disrupted. That data could also be used to monitor equipment for performance changes due to hydrate buildup, allowing for more-effective condition-based maintenance or workovers. Or it could be used for root-cause analysis of equipment or process failures.

Advanced analytics can be used to help decision makers act with greater speed and precision. But these tools can also be used to trigger automated actions to head problems off early. By automating the capture, analysis, and interpretation of physical processes, oil and gas companies will have an opportunity to significantly shorten time-to-action in predicting and resolving problems. The automation of predictive processes will also be key to managing the industry's growing volume of operational data, and to distilling timely, concise insights out of the flood for use by decision makers.

Using analytics in support of predictive operations requires more than technical and mathematical abilities—it also requires a thorough understanding of the process in question. Thus, it is critical to include business subject matter experts in these efforts; doing so makes it possible to complement technology-driven findings with knowledge of the business context and an understanding of the true significance of events in real-world operations.

Similarly, operational analytics initiatives should be focused and relatively narrow, especially early on. Each initiative should target specific business problems. Otherwise, the volumes of data and the tremendous number variables involved are likely to be overwhelming, and the outputs of the analytics process will do little to help decision makers identify and respond to operational events.

Sensing
The evolution of sensors is moving forward, and oil and gas companies will need to take advantage of this advancing technology to get a more comprehensive and timely perspective on operations.

Sensors can provide a broad range of operational measurements, and companies that deploy more of them will naturally have a better handle on the actual state of their operations. For example, where today a company may use a small number of discrete sensors to gain a vibration reading on a piece of equipment, it may in the near future have many multi-modal sensors monitoring factors such as rotational speed, temperature, energy consumption, or any other factors that can contribute to a fuller picture of the equipment and process in question. What's more, sensors will not only be providing a broader range of data, but higher quality data as well, as advancing technology and the increased use of redundant sensors reduces false readings and the "sensor drift" that can require frequent recalibration.

The growing use of sensors—and the growing intelligence of those sensors—is expected to drive growing volumes of operational data that have to be managed and understood. A typical production facility may soon have more than 10,000 sensors monitoring 200 to 300 parameters. Thus, companies will need to have real-time analytics capabilities in order to take full advantage of advanced sensing technologies, and to be able to use large amounts of sensor data to fully understand processes.

Such systems are not currently available as single, packaged solutions. However, an HP Labs initiative entitled "Live Business Intelligence," or "Live BI," provides a window into the type of capabilities that will enable companies to make full use of sensor data. This effort is creating an integrated analytics platform designed to transform very large amounts of real-time streaming data and historical data into timely insights. Using massively parallel processing, it will apply analytics not only to sensor data, but also to a variety of both structured and unstructured data, giving E&P operators deeper production intelligence and letting them identify patterns, visualize and detect events in real time, and alert operations staff to developing problems.

Cloud computing

Cloud computing will play a key role in enabling the broader use of sensors. As more and more data is generated by intelligent sensors that are monitoring operations, analytics processes will be inundated. Before long, it will simply not be practical to run all of that data back through the network to a centralized data center. The sheer volume of data moving back and forth would strain the network, and the resulting latency in end-to-end networks and systems would mean that data may not be accessible in a timely fashion—thereby negating the value of predictability.

With that in mind, HP anticipates that over time, oil and gas companies will need to migrate a measure of their analytics capabilities out from the data center and closer to the sensors—or even into the sensors

themselves, at least in terms of preliminary analyses of data. Analytics capabilities will be delivered over the network, as a service, and execution of analytics processing will be handled in the most appropriate locations, with remote and centralized analytics capacity working in concert. This will require a "define once, deploy everywhere" approach, with the analytics service being common and therefore usable across the network to produce consistent information about operations.

In short, growing data volumes and the industry's relentless time and cost pressures will require oil and gas companies to use cloud computing to provide predictive analytics on a large scale, wherever and whenever it is needed in the organization. This may be through a private cloud, or through outsourcing arrangements that can enable the company to have the analytics service it needs without having to pay for the entire underlying infrastructure.

Finding the way to business results

The predictive organization requires changes in many areas, and it will not be created overnight. For the time being, predictive processes will focus on delivering information to human decision makers to help them determine when to take action. The widespread use of automated responses to potential problems is still some ways off. This is not just a technology issue—indeed, much of the technology is already available. Rather, oil and gas companies will have to build their confidence and comfort level with having machines handle preemptive actions based on predictive analyses. Confidence will probably be developed over time, as companies gain more experience with such automation. This can be gained not only through tests in live operations, but also by using predictive analytics and automation models on historical data and measuring their accuracy against the known outcomes of past events. Experience will need to be complemented by education and change management efforts designed to help people work effectively with the new systems.

In thinking about the predictive organization, oil and gas companies tend to look at proactively addressing equipment and process problems in E&P. But those operations are just one aspect of the business, and today, some companies are exploring the potential of predictive tools in commercial processes such as marketing and finance.

HP, for example, has implemented an internally developed forecasting tool that allows it to predict revenues and costs in operations across the organization, allowing better control of finances. With its complex business, HP traditionally had only limited visibility of revenues ahead of quarterly announcements. With the predictive tool, which is based on research conducted at HP Labs, HP is now capable of predicting and tracking those figures throughout the quarter. Six weeks into the quarter, it can forecast end-of-quarter revenues within 1.3% of the ultimate actual results. HP has since deployed this tool as an enterprise-wide portal, which allows decision makers to review data by region, country, and product line, helping them respond to changes and take advantage of opportunities.

HP is now working with oil and gas companies to develop similar models and tools for that industry. A recent pilot at one major company used predictive tools to look at costs in a variety of production operations, and resulted in an order-of-magnitude improvement in the accuracy of cost forecasts.

With the effective use of such tools, oil and gas companies can be in position to not only head off issues that drive up costs, but also to make better decisions in terms of when to draw down on capital, for example, or whether to finance an ongoing project through debt or cash flow from operations. Or, when entering new markets, a company could move with a better understanding of what its risk position will be months ahead of time and what type of contractual arrangements would be best from a financial perspective.

As oil and gas companies adopt these types of tools, they will be able to leverage their efforts and extend their finance-oriented predictive capabilities into E&P processes. Many of the techniques and tools can be easily modified for "re-use" in more technical areas, helping oil and gas companies move ahead on the journey to becoming predictive organizations.

To make the most of their predictive capabilities, oil and gas companies will also need to leverage the collaborative technologies that are already taking hold in the industry, such as video conferencing and shared applications. Critical business skills are in short supply in the industry's workforce, and key people often work in different parts of the world. Thus, collaboration among decision makers will play a vital role in enabling action and control in predictive processes. The ability to connect skilled people through real-time collaborative tools can help facilitate the rapid interaction and decision making that is vitally important to the predictive organization.

There is significant potential value to be achieved through predictive capabilities, even without the automation of monitoring and response. For example, oil and gas companies are likely to see reduced costs through an improved ability to limit and manage maintenance interventions; to reduce headcount; and to resolve and even prevent production problems. In HP's experience, improved predictive capabilities can improve the efficiency and yields for production processes by approximately 2%, while event-based maintenance can reduce unplanned equipment downtime to nearly zero. Predictive capabilities also have the potential to help companies increase revenue, thanks to greater accuracy in predicting flow disruption in wells or pipelines, which can increase throughput and help reduce time to first oil.

As companies build their predictive-organization infrastructures, they can look for other ways to use these capabilities. For example, environmental and government regulatory pressures on E&P operations are likely to keep increasing, and a number of observers believe that more rigorous processes around compliance may become a basic requirement in acquiring a license to drill. Companies will be able to use their predictive infrastructures not just for production control, but also for environmental monitoring and to demonstrate to government agencies that they are proactively avoiding environmental problems. Such predictive, environmentally oriented capabilities may well become a basic competitive necessity in the field.

Summary: putting the pieces together

Overall, HP believes that oil and gas companies can follow an evolutionary path to the predictive organization—one that will allow them to gain experience and build their skills incrementally while reducing the risks associated with change. First, you can use the three-stage process of *improving operational visibility, implementing predictive capabilities,* and ultimately *enabling action and control*—a framework that enables companies to better understand where they are going, and to plan accordingly. Second, you can use the four key "levers"—*information management, advanced analytics, sensing*, and *cloud computing*—to execute your plans and make the predictive organization a reality.

Looking ahead, the industry will continue to change, and predictive capabilities can play an important role in adapting to that change. The pressure to find and produce oil is likely to continue to increase, and the cost of operations is likely to keep rising, especially as far-flung frontier markets and unconventional resources, such as oil sands and ultra-deepwater operations, become more prevalent. In that world, the need to move quickly and cost effectively will be more important than ever—and the ability to predict and address problems early on and gain closer control over operations will be a powerful competitive weapon.

[1] Source: "Toward the Predictive Organization," IHS CERA Inc., 2010

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