On and offshore development projects are extremely capital-intensive investments for any oil and gas organization. Maximizing return on these investments not only requires the correct mix of people, processes and technology, but a dedication to continuous improvement and operational excellence. As with any enterprise in competitive markets, owners try to improve shareholder value by increasing production while lowering operating expenses.

Ultimately, the focus is on the sustainable performance of the organization and on boosting economic, environmental and social health. Faced with enormous technical, regulatory and competitive challenges in current markets, oil and gas producers need to ask:

- How can the organization optimize production from a large asset base with fewer on- and offshore personnel?
- How can shut-ins and interventions caused by sanding, equipment failures and other abnormal conditions be predicted and prevented?
- How can critical optimization data concerning a variety of assets be made available to key personnel throughout the organization in order to best use the skills of specialists in improving business process and decision-making efficiency?

In response to the business and technical challenges listed above, the vendor community and upstream companies themselves have started to address these problems, with some impressive results. Advanced information technology is now playing a key role; helping many upstream companies continuously improve production while lowering operating expenses. Today, Abnormal Condition Monitoring of both on and offshore oil and gas wells is generating additional production benefits in the range of 5%. In addition, producers are extending reservoir life and lowering the overall cost of production through significant efficiency improvements in operations and maintenance functions.

This paper will discuss three topics that have been critical success factors in several large-scale well optimization programs worldwide:

1. Abnormal Condition Monitoring
2. Condition-Based Maintenance
3. Information Visualization
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The Importance of Abnormal Condition Monitoring

The ability to intelligently monitor hundreds or even several thousand of wells from a single location and provide accurate performance information to users worldwide provides significant optimization benefits just in itself. Imagine simply consolidating critical information relative to the real-time health and performance of each asset, making this information available in real time on the desktops of all of the appropriate stakeholders anywhere in the organization, providing a solid foundation for sound decision-making. With the appropriate IT infrastructure in place, companies are now using their organization’s knowledge reservoir: engineering, production, maintenance and even vendor personnel with expertise covering all of the company’s assets, regardless of where they are located. It’s a simple concept, but bringing the data to the people rather than trying to bring the people to the data generates tremendous benefits. In addition to the better production optimization decisions being made in the context of both on and offshore applications, another direct benefit is that field operators or reservoir and engineering specialists are making fewer costly and time-consuming well visits.

There are, however, significant challenges for those who intend to set up a centralized monitoring system. Most notably, these include:

- lack of critical instrumentation
- inadequate network and communications infrastructure (especially offshore)
- the challenge of large scale data collection, cleansing, storage and retrieval

Because of the strong business case that now exists for optimizing business processes with support from appropriate technology, the potential benefits can now be achieved by any oil and gas producer.

The Move to Condition-Based Maintenance

Most upstream organizations today use either or both of the following traditional maintenance models. On one hand, “failure-based” or “reactive” maintenance occurs when equipment is left unmonitored until one or more failure modes have been observed. On the other hand, “preventative” maintenance approaches involve visiting an asset on a regularly scheduled basis, assessing the performance of that asset and applying necessary maintenance to ensure optimal performance.

In practice, most upstream organizations use a preventative maintenance program for critical equipment, which receives the majority of the maintenance technician’s time, while other assets are maintained on a less frequent schedule or allowed to run to failure. The large number of assets relative to the number of available maintenance personnel makes it impossible to perform preventative maintenance on all equipment without compromising the safety of employees and incurring significantly increased cost.

With the availability of data and critical information regarding the health of important assets, companies have begun to shift away from these older maintenance paradigms toward condition-based and predictive maintenance methods. A condition-based methodology is one where maintenance is applied to an asset based on (a) the current condition or health of the equipment and (b) the impact of poor performance on business and operational goals. Under this model, maintenance is planned and delivered to those assets that are underperforming and which have the most significant negative impact on the business. This ensures maintenance is applied where the greatest benefits will be received while avoiding maintenance where it is not required. In essence, equipment maintenance or a well intervention is performed only if it is truly needed.

Advanced data analysis (“data mining”) techniques are now available to determine the health of assets. These tools allow monitoring applications to identify patterns in the data that are often precursors to a variety of common well faults, such as sanding and slugging, and can therefore be used as predictors. Once developing abnormal conditions are detected, appropriate users are alerted and can take appropriate action to prevent abnormalities from escalating into serious health hazards and unplanned detractors from production and revenue streams.
Automated condition-based performance monitoring technology is changing the way upstream companies are operating their wells and associated equipment. In fact, the most advanced companies have developed performance-monitoring centers where a group of senior operators, along with other domain experts (reservoir, production, maintenance), are tasked with optimizing production at a specific operating field, across a region, or around the globe. Multiple systems monitor the performance of each well and alert appropriate personnel when faults or performance degradation are detected. With the necessary information at their fingertips, users can effectively troubleshoot complex problems remotely and assist with critical production optimization decisions in near real time.

Figure 1 – Well-Based Well Event Monitoring

**The Importance of Information Visualization**

Interestingly, the greatest challenge for any centralized large-scale monitoring application has proven not to be how to get the data, what to calculate, or how to store the information, but rather, how to effectively display the results. In the case of upstream oil and gas wells, large applications can give users the ability to retrieve performance information from several thousand wells. Without an automated alerting mechanism used in conjunction with a carefully designed interface, experience has shown that users quickly drown in the sea of performance data generated by these systems. As a result, truly successful applications must be able to present performance data from several thousand wells such that users are quickly able to identify those that are currently having the greatest negative impact on the business.
In effort to solve this problem, Honeywell identified “tree mapping” technology as an effective way to visualize large volumes of performance data. Tree mapping facilitates a fast visual comparison by presenting a vast amount of information through a single display. Simple controls allow the user to change the display criteria and filter the data set viewed. It’s now possible to view all of the wells from a large installation on a single screen, circumventing the need for time-consuming “drilldown” and making it possible to prioritize across an entire operating region or field. Rather than displaying performance data in tabular form, tree mapping technology uses shape, size, color and grouping of geometric areas to impart key information about individual wells.

In figure 3, 491 onshore oil wells are represented simultaneously by individual colored boxes and are grouped by “field operator routing”, as indicated by the black banner and border around individual groups. In this example, the size of each box is determined by oil production (bbl/day) and the color is determined by the number of outstanding faults logged. From this diagram, very quickly, users can identify the largest producing wells with the greatest number of faults: the big, red boxes (i.e. the bad actors). Since the human eye is naturally drawn to the largest and most colorful boxes, it becomes a simple task to find problems worthy of further investigation or a site visitation, even with large numbers of assets. Using the tree-mapping interface, users can drill in on the poor performers to access additional diagnostic trends, performance data and fault statistics for in-depth troubleshooting.
Conclusion

This paper has examined the role that advanced information technology is now playing in increasing production, lowering the costs of production and improving the overall sustainability of upstream oil and gas companies. A shift away from traditional preventive and failure based maintenance methods is underway, with companies moving toward condition-based performance monitoring and maintenance. Upstream producers are applying the latest condition-based performance assessment and monitoring techniques across large numbers of assets with significant success. In particular, they are now able to apply strong central technical resources across many assets in an environment of cost cutting and continuous improvement, allowing them to continue managing and operating a large asset base with limited resources. The benefits generated include production increases in the range of 5% overall, increased reservoir life, lowered cost of production, and significant improvements in operations, maintenance and decision-making capability.