Field of the Future: Vision to Reality

Rapid changes in digital technology are revolutionizing how data are acquired and processed and how the quality and efficiency of decision making are improved. By use of digital technologies, both new and existing, BP aspires to operate its assets at the technical limit of efficiency, recovery, and cost. The company implemented a program called Field of the Future (FOTF). This program covers development and deployment of technology and business-process solutions to most aspects of oil- and gasfield operations—from reservoir to export, in both mature and new fields, onshore as well as offshore.

Program Origin

Internal and External Environment. Rapid advances in digital technology offer the oil industry significant opportunities to address challenges of improving recoveries from existing and new fields, of improving operating efficiency in the face of unfavorable demographics, and of developing new fields in difficult and remote geographies.

Technologies to acquire and transmit data in real time or near real time have been available for several years. However, the oil industry has, with some exceptions, been slow to adopt these technologies for large-scale deployment. Take-up is improving as tools are made available to post-process data, as the industry begins to appreciate the degree of organizational change needed to exploit these technologies, and as the appropriate targeting of these technologies becomes clearer.

This article, written by Technology Editor Dennis Denney, contains highlights of paper SPE 99777, "Field of the Future: Making BP's Vision a Reality," by ***C. Reddick,*** *SPE, BP, prepared for the 2006 SPE Intelligent Energy Conference and Exhibition, Amsterdam, 11–13 April.*

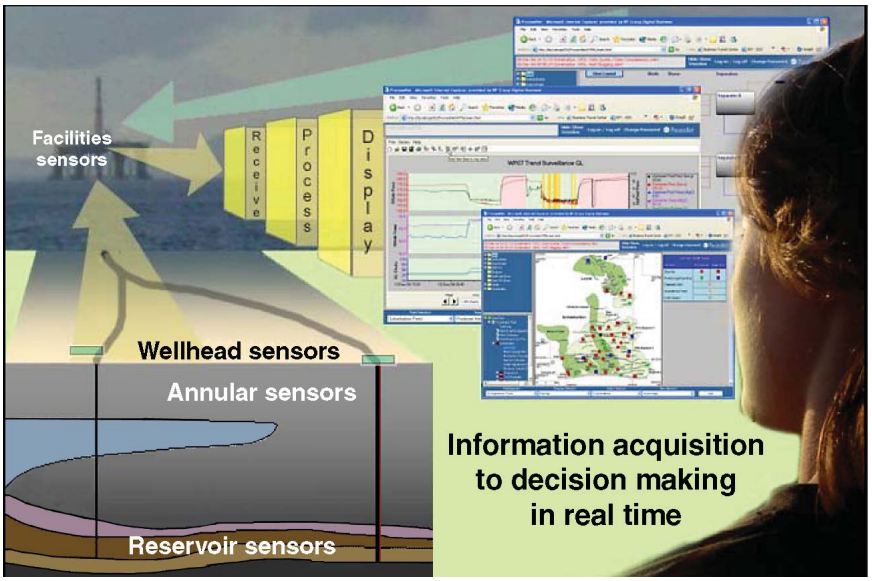

Fig. 1—ISIS Web interface.

First Steps in a Real-Time Revolution. The subject program was established in 2003 with an initial focus on engagement and deployment, the objective being to deploy core technologies in a limited number of assets to establish operating history, to re-affirm the prize, and to build a technical and architectural foundation for subsequent bigger moves.

Early results show numerous examples of production increases through, for example, improved sand management, well management, reservoir imaging, onshore/offshore collaboration, and remote-equipment monitoring. Reserves increases have resulted from the application of streamlined reservoir-performance prediction.

Technology Development and Deployment

Remote performance management includes technologies for well/reservoir and facilities monitoring. This activity develops and applies new tools for managing and post-processing real-time data. Surveillance methods, such as life-of-field seismic, to improved reservoir imaging and downhole flow technologies to improve conformance in waterfloods are being developed.

Optimization challenges include new technology to facilitate reservoir optimization by coupling real-time data flows to top-down reservoir-modeling technology and by extending the capability of the tool kit for rapid evaluation of reservoir-management options at all time scales.

Wells- and Facilities-Data Processing. The BP Integrated Subsurface-Information System (ISIS) addresses the technology and processes required to move well data from the point of acquisition through to decision makers, thereby enabling production decisions and implemention of relevant actions. ISIS allows users to access and view surveillance data in real time. It cleans and conditions data, then alerts users to changes in the well: a proactive approach to reservoir-perfor-

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mance management. **Fig. 1** shows how onshore users can observe up-to-the-minute offshore data.

The Data to Desktop (D2D) system provides facility visualization with operating data backed up with applications running online that provide dashboard displays, monitoring of plant performance, and automation of repetitive tasks. The combined ISIS/D2D system was built on processing-industry Web-based applications.

Life-of-Field Seismic. A permanent fieldwide seabed-seismic array was installed in the Valhall field in 2003, enabling monitoring of reservoir performance by use of seismic surveillance (4D seismic). The life-of-field seismic system allows real-time monitoring of reservoir processes with full spatial coverage to help manage these reservoirs for higher well deliverability and higher field recoveries.

With seismic receivers permanently installed on the seabed, small changes in the reservoir can be detected reliably and acted upon quickly with fully processed data available just days after surveying is complete. The permanent array enables obtaining high-quality, cost-effective surveys where multiple repeats are required. The real value of this technology is in enabling more-intensive reservoir surveillance to improve the understanding of reservoir performance and inform reservoir-management decisions later in field life.

Intelligent Wells. Intelligent-well technologies provide reservoir-performance information and enable control of the inflow or injection profile without intervening in the well. Reservoir surveillance, and the ability to act on such information, improves reservoir-management optimization. Performing these functions without the need for intervention is important in deepwater environments and other high-cost operating environments.

Downhole Flow Control. Downhole flow control uses permanently installed flow-control devices that receive commands from the surface to shut off or regulate flow from different intervals within the reservoir. Flow control has been installed in several wells to manage production from layered systems. Plans exist to implement flow-control technology in targeted water-injection wells. Injection service is a relatively new application for flow control, particularly in sand-prone reservoirs. The objective is to achieve balanced water injection into the layered systems, thereby maximizing the efficiency of waterflood programs and increasing recoverable reserves.

Distributed Temperature Survey. Distributed temperature survey is an emerging technology that offers the potential of providing a real-time assessment of inflow or injection distribution. This assessment is accomplished by installing an optical fiber in the well that senses the temperature at 1-m intervals along the path of the well. These temperature data are analyzed with the help of thermal simulators to resolve the inflow or injection distribution. The analysis is accomplished without intervening into the well and running a potentially risky conventional logging operation.

Optimization. The objective of production optimization is sometimes defined as producing the maximum value from the installed wells and equipment. Use of a production optimizer ensures that the asset obtains the most revenue possible for the least cost. Maintaining and using the optimizer on a continuous basis ensures that these benefits are maximized through the full operating period of the asset.

This optimization is achieved by building appropriate mechanistic models of the asset, then incorporating these models into a numerical optimizer. This method manipulates the degrees of freedom of the models, so that the models are maintained at the most profitable operating point, complying with all constraints operating on that asset.

Advanced Collaborative Environment (ACE). Real-time data and their benefit will be exploited fully only if adapted to the way people work to make decisions in real time. BP has an active ACE program with 10 to 15 installations in place or planned in 2006, covering most operational areas including wells, facilities, pipeline management, and drilling. The objective is to bring the right information to the right people at the right time and create real-time and multidisciplinary decision environments supporting drilling and production operations. In this sense, the ACE program is the "engine room" of FOTF decision making. These environments will enable people to work collaboratively, regardless of distance, to make better decisions faster, thereby enabling enhanced productivity and delivering operational performance improvements.

FOTF Deployment Focus

BP chose its initial focus as deployment of FOTF technologies in selected BP-operated oil and gas assets in areas where the company expects to accrue maximum benefit most quickly. Looking ahead, one choice will be the pace of application of these technologies in other operating environments. As the company gains experience with early deployment of these technologies, the scope of future deployment will become clearer. In the meantime, new projects are configured with the infrastructure required for FOTF operation.

Lessons Learned

Close cooperation between business units and the E&P technology group will continue to be critical to delivery of the program. Each business unit is taking the lead in the development of one or more aspects of technology by undertaking field trials, by providing input to technology-program steering boards, and by providing gatekeepers for the technology-development stage-gate process. Many business units also have appointed FOTF managers to oversee and coordinate deployment of technologies within their areas. Communication of the vision, the business case, and examples of early success has been very important for securing business-unit engagement.

Remaining Challenges

Tracking value generated by individual technologies remains a challenge but is critical to successful deployment at scale. Assessing value generation across the segment for all the elements of this program is being achieved but is not easy.

Regulating the pace of implementation and focusing it on areas of most effect will require continual reinforcement of strategic direction. This task sometimes will create tensions, which must be addressed if the program is to stay focused on the most important parts of the business.

Technology on its own will not deliver the desired benefits, and significant effort will be needed to introduce the accompanying personnel and business-process change. JPT