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Field of the Future: Making BP's Vision a Reality

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Abstract

Rapid changes in digital technology are revolutionising the ways in which we acquire and process data and are improving the quality and efficiency of decision making. Through the application of these digital technologies, both new and existing, BP aspires to operate its assets at the technical limit of efficiency, recovery and cost.

To make this aspiration a reality, BP has implemented a programme called FIELD OF THE FUTURE. The scope of this programme 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. The purpose of grouping these technologies under a single programme is to obtain maximum leverage from these technologies by ensuring appropriate integration between them, making strategic choices about where they are deployed and ensuring rapid propagation of early learnings.

This paper describes the portfolio of technologies needed to deliver its vision of FIELD OF THE FUTURE. The following technology themes form the core of BP's FIELD OF THE FUTURE Programme:

- Real-time reservoir management
- Production optimisation
- Remote performance monitoring and collaboration
- Advanced collaborative environments
- Connecting global know-how and expertise, 24/7

The paper will also describe how BP is deploying these technologies and capabilities, with particular emphasis on the revised business processes and enhanced people capabilities needed to underpin successful deployment at scale across its assets.

Finally, the paper will summarise current status of technology development and deployment in BP, the successes achieved to date and challenges that remain.

1. The origin of BP's FIELD OF THE FUTURE Programme

1.1. Internal and external environment

Rapid advances in digital technology are revolutionising the ways in which we acquire and process data and are improving the quality and efficiency of consequent decision making. These advances offer the oil industry a very significant opportunity to address the challenges of improving recoveries from existing and new fields, of improving operating efficiency in the face of unfavourable demographics, and of developing new fields in difficult and remote geographies.

It is a paradox that whilst the technologies to acquire and transmit data in real time or near real time has been available for a number of years, the oil industry has, with some exceptions, been slow to adopt these technologies for large scale deployment. Take-up is now improving as tools are being made available to post-process data, the industry begins to appreciate the degree of organisational change needed to exploit these technologies, and as the appropriate targeting of these technologies becomes clearer.

BP is addressing all of these challenges through its FIELD OF THE FUTURE programme which is one of the Technology Leadership Areas which BP believes will be key to delivery of its future business plans in Exploration and Production.

2.2. First steps in a real-time revolution

BP's FIELD OF THE FUTURE programme 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 in order to build a track record, to re-affirm the prize and to build a technical and architectural foundation for subsequent 'bigger moves'.

Early results have been very exciting, with numerous examples of production increases through, for example, improved sand management, well management, reservoir imaging, onshore/offshore collaboration and remote equipment monitoring. Reserve benefits have also resulted, from the application of streamlined reservoir performance

prediction approaches pioneered under BP's FIELD OF THE FUTURE programme.

Over the next two years BP will deploy its core FIELD OF THE FUTURE technologies at scale in areas where it believes they will have greatest impact. This will provide the opportunity to gain further experience with the application of these technologies in several different operating environments.

In the longer term BP believes that the programme has the potential to increase recovery from BP's fields worldwide by around one billion barrels, an improvement of approximately 5% on current reserves, which is within the range indicated by external studies for the benefits of this kind of programme (1).Within a decade, FIELD OF THE FUTURE is expected to be impacting more than 95% of BP's production.

2. Technology development and deployment

The activities/technologies currently associated with FIELD OF THE FUTURE broadly fit into two areas: Remote Performance Management and Optimisation.

Remote Performance Management includes technologies for well/reservoir and facilities monitoring and is currently an area of focus in BP. A large part of this activity is to do with developing and applying new tools for managing and post processing real time data. BP is also developing improved surveillance methods such as Life of Field Seismic to allow improved reservoir imaging, and is developing downhole flow technology to improve conformance in some of its waterfloods.

Optimisation challenges include the construction and maintenance of appropriate models needed to link with optimisation routines. New technology is being developed in this area also to facilitate reservoir optimisation by coupling real time data flows to BP's Top-Down Reservoir Modelling (TDRM) Technology toolkit and by further extending the capability of the toolkit to rapidly evaluate reservoir management options at all time scales (2).

In both areas, consideration is being given to the underlying infrastructure required to facilitate delivery of the prizes from these technologies, including working environments, workflows and other infrastructure.

2.1. Wells and facilities data processing

2.1.1. Overview and benefits

BP is developing two products – ISIS and D2D – for post processing wells and facilities data respectively, which together form an important part of BP's FIELD OF THE FUTURE technologies. Although they were originally developed separately, they are now being combined into a single product to enhance integration.

ISIS (3) (Integrated Subsurface Information Systems) is addressing the technology and processes required to move well data from the point of acquisition through to decision makers, enabling them to make production decisions and implement the relevant actions.

ISIS allows users to access and view surveillance data in real time. It automatically cleans and conditions data and alerts users to changes in the well, creating a more proactive approach to reservoir performance management. Amongst other benefits, onshore users can observe up-to-the-minute offshore data. The raw data are displayed in the form of easy to display and interpret graphs and plots, enabling users to extract more information and it is made readily available to a wider community.

D2D (Data to Desktop) is the ISIS counterpart for facilities, Subsea and Pipelines. D2D provides facility visualisation with operating data backed up with applications running online which provide dashboard displays, monitoring of plant performance, and automation of repetitive tasks. The ISIS/D2D system has been built on processing industry web-based applications, which have been extensively configured using logic and processes developed by BP.

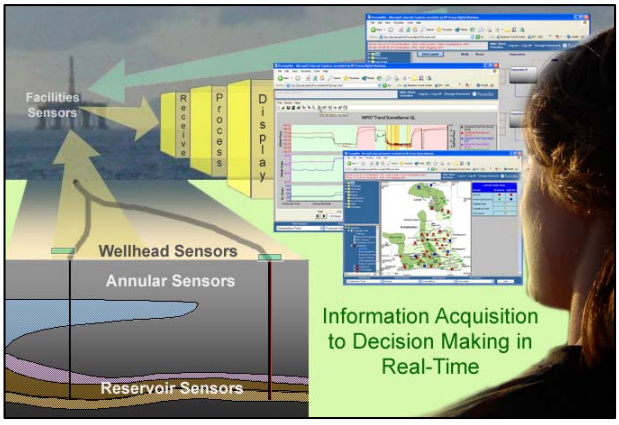

Figure 1: ISIS web interface

ISIS/D2D are important tools that are already delivering significant benefits to BP's assets in the area of remote performance management.

2.1.2. Case example - ISIS/D2D in Schiehallion

The Schiehallion field, located 150 km west of Shetland in 400m of water, was the site for both the first application of ISIS and a first implementation of D2D. An ISIS/D2D surveillance database was constructed with 20,000 data tags from in-well pressure and temperature sensors through topsides equipment to the export system, which are sampled continuously into mirrored offshore/onshore data historians, via a shared satellite link.

It has been shown that improvements in reservoir performance management based on this new information display have delivered up to 3,000 b/d of incremental oil.

Some of the benefits of implementing ISIS/D2D in Schiehallion include:

Increased production: The Web-based ISIS interface has allowed the Schiehallion team to increase production and avoid losses through more efficient start ups, more effective control of unstable wells and better communications with the offshore team. Coupling ISIS with sand detection technology has greatly improved operation of sand prone wells.
Cost-savings: Considerable time and effort has been saved in the collection, quality assurance and accessibility of data.
Further opportunities: Additional functionality is being developed which will further improve surveillance capability, and which will lead in turn to improved understanding of reservoir performance and to improved reservoir management in BP's assets. Given the success of this early implementation, a wider roll-out programme will be undertaken in 2006/7.

2.2. Life of Field Seismic

2.2.1. Overview and results

BP installed the first field-wide permanent seabed seismic array in the Valhall Field in 2003 enabling reservoir performance to be monitored through Seismic Surveillance (4) (4D seismic) on demand.

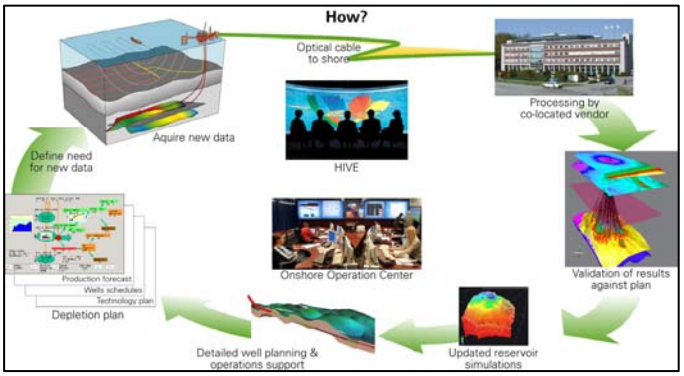

Figure 3: Seismic surveillance in BP

Development of the Life-of-Field-Seismic (LoFS) system allows real time monitoring of reservoir processes with full spatial coverage to help us to manage these reservoirs for higher well deliverability and higher field recoveries.

With LoFS receivers permanently installed on the seabed, BP can now reliably detect small changes in the reservoir and act upon them quickly with fully processed data available just days after surveying is complete. The permanent array enables reservoir engineers to obtain high-quality, cost-effective surveys where multiple repeats are required. The real value of this technology is to allow the reservoir to be surveyed more intensively so as to improve the understanding of reservoir performance to inform reservoir management decisions later in field life.

2.2.2. First LoFS implementation: Valhall

The first installation of LoFS was completed in the Valhall Field in the Norwegian sector of the North Sea, where 30 wells are due to be drilled in the area covered by the system as part of the redevelopment of the field under waterflood.

120 kms of seismic cable, containing 10,000 sensors, have been trenched into the seabed and permanently connected to a platform-based data recording system. The field stand-by vessel has been upgraded with a 2000 cu ins air gun array to be available 'on demand' as the seismic source vessel. A 3D survey is being acquired every 3-4 months and six surveys have now been completed. Data is brought ashore via a fibre-optic link and will be processed in. LoFS data enables quality reservoir management and Base Well Management decisions to be taken.

LoFS is delivering:

- A step change in repeatable seismic data quality – 2-3 times better than the best towed streamer data to detect smaller dynamic changes
- A breakthrough in turnaround times - acquisition "on demand" in 2-4 weeks, processing time reduced to less than a week
- Improved static images – Multi-azimuth for improved images and multi-component for seeing through gas clouds.
- Dynamic images reflecting changes in pressure, hydrocarbon production and water injection for improved placement of new infill drilling locations
- Real-time Reservoir Management – dynamic information "on demand" every 2-4 months for optimal well intervention
- Support for Base Management Decisions including optimising remedial activity (reperforations, Fracs, CTCOs, Acid washes etc.), optimising zonal production and injection rates and providing real-time surveillance data (the 'seismic spinner' survey).

2.3. I-Wells

2.3.1. I-Wells in BP

Intelligent Well technologies provide reservoir performance information and the ability to control the in-flow or injection profile without intervening in the well. Reservoir surveillance and the ability to act on such information, serves reservoir management optimization. Performing these functions without the need for intervention is important in deep water environments and other high cost operating environments where not only is the cost of intervention high but also the opportunity for intervention is significantly less than conventional operating situations. Furthermore, reducing intervention frequency not only reduces costs but also operational risk.

New technology is being developed and piloted by BP to extend capabilities of existing versions of I-well technology and develop new concepts.

2.3.2. Down-Hole Flow control

Down-Hole Flow Control consists of permanently installed flow control devices that can be commanded from the surface to Shut-off, or regulate flow from different intervals within the reservoir.

BP has installed flow-control in a number of wells to date to manage wells producing from layered systems. In the future, BP plans also 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 layered systems, thereby maximizing the efficiency of water flood programs and increasing recoverable reserves. BP is sponsoring significant technology development in the area of flow-control technology for injection service. In three years, BP will have installed flow-control in injection wells in HPHT, extended reach and other demanding environments that will impact a total injection rate in excess of 1 million barrels of water per day.

2.3.3. Distributed Temperature Survey

DTS (Distributed Temperature Survey) is an emerging technology that offers the potential of providing a real-time assessment of inflow or injection distribution. This is accomplished by installing an optical fiber in the well that senses the temperature every meter along the path of the well. This temperature information is analyzed with the help of thermal simulators to resolve the inflow or injection distribution. This is accomplished without intervening into the well thereby saving the very costly and potentially risky conventional logging operation.

ISIS will integrate DTS (Distributed Temperature Sensing) data to enable proactive management of wells and reservoirs. BP currently has a number of installations in dry trees, which are expected to grow significantly in the next few years. BP is also looking at extending the technology for use in subsea wells.

2.4. Optimization

2.4.1. Maximum Value

The objective of Production Optimisation (5) is sometimes defined as ‘to produce the maximum value from the installed wells and equipment’. Using a production optimizer ensures that the Asset is operated at the top of its theoretical performance, obtaining the most revenue possible for its products at the minimum cost. Maintaining and using the optimizer on a continuous basis ensures these benefits are maximized through the full operating period of the asset.

This is achieved by the building of appropriate, mechanistic models of the Asset and then wrapping a numerical optimiser around these models. This manipulates the degrees of freedom of the models, so that the models are left sitting at the most profitable operating point, which obeys all the constraints that are operating on that Asset.

2.4.2. Azeri Field Optimizer

A comprehensive field model (from reservoir to customer) with an optimiser has been created in BP’s Azeri operations to recommend the selection of well and facilities operation which maximises the value of export products.

This solution is characterised by an innovative, robust approach to modelling optimisation, with an easy to use customised interface. The potential payback is measured in days and the asset is planning to use the tool for central decision making. The application includes an extensive data reconciliation, and parameter estimation capability together with rigorous off line ’what-if’ functionality.

2.5. Underpinning Activity - Advanced Collaborative Environments

2.5.1. Real-Time decision-making

Real-Time data and its benefits will be fully exploited only if we adapt the way we work and can make decision in real time. The aim of Advanced Collaborative Environments (ACE’s) is to enable our decision makers to take important decisions in real time.

BP has an active ACE Programme (6) with 10-15 installations in place or planned in 2006 covering most operational areas including wells/facilities/pipeline management and drilling. The objective of the ACEs is to bring together the right information, to the right people, at the right time, and create real time and multidiscipline decision environments supporting drilling and production operations. In this sense the ACE is really the engine room of FIELD OF THE FUTURE decision-making.

These environments will allow people to work collaboratively regardless of distance, making better decisions, faster, thereby enabling enhanced productivity and delivering operational performance improvements. ACE programme is a classic example of how digital underpins the business and Advanced Collaborative Environments are a fundamental step to help BP to become a hyper-connected, highly visual, collaborative company.

The ACE Programme will bring significant value to BP through:

• Better Operational site to office communication and multi-disciplinary collaboration.
• Better decisions faster through the integration of real time data, technology, and operational work processes.
• Improved integration of technical specialist expertise with operational decision-making
• Uniting two or more geographically dispersed teams

2.5.2. Na Kika Onshore Operations Centre

The Na Kika Onshore/Offshore Operations Support Centre is a new way of working which fully implements remote collaboration within production operations. Only one year from initial concept to operation, the 'always on' centre is changing the way people work together, through improved work processes & the application of smart technology.

The OOSC enables improved decision making through the utilization of real time data on demand, clearer communication and collaboration, shared context between the offshore and onshore teams, and an expanded pool of 'connected' resources. Early testing of the OOSC began in late 2003 (Na Kika first production) and completion of the OOSC was in early Q2 2004, with the co-location of asset team members (including the Ops Mgr and an operator position).

In the first 6 months of operations, the OOSC has delivered significant financial benefits, associated with improved decision making in reduced cycle time. The Ops Centre has enabled a 'one touch' culture, where issues and opportunities are quickly identified and solutions applied. The centre is on track to deliver considerable operations efficiency improvement.

During the recent Hurricane Ivan storm recovery efforts, the centre was used by many DW asset teams to accelerate the planning and execution of storm remediation. As a result of the transparency of information and people, the recovery efforts from this storm event, were greatly accelerated and production losses minimized.

3. Field of the Future: Making BP's vision a reality

3.1. Strategic approach

The objective of the FIELD OF THE FUTURE Programme is to integrate the technologies described above, to develop them to meet BP's business needs and to implement them at pace and scale across BP's assets.

3.1.1. FotF Technology Focus

As already mentioned, the FIELD OF THE FUTURE activity is focussed on two main areas:

- Remote performance Management, and
- Optimisation

BP has carefully selected the technologies to be integrated into the FIELD OF THE FUTURE Programme, and by pulling all these technologies together in a centralised programme, BP is presenting its assets with a consistent, integrated technology suite. Ultimately, BP believes that the set of FIELD OF THE FUTURE technologies will have a bigger impact altogether than the individual implementation of each of its components.

One of the challenges that the industry faces is to be clear about the applicability of these technologies. Some of them will eventually be deployed in most assets, whilst others will be applied more selectively. Whilst the idea that all technologies will be applied in all assets may be appealing, BP does not believe that this is either practical or desirable.

The journey to conclude the development of FIELD OF THE FUTURE technologies will be a long one, and will not be completed until BP has reached its goal of having the capability of remotely performance managing and optimising the bulk of its production.

3.1.2. FIELD OF THE FUTURE Deployment Focus

BP has chosen initially to focus deployment of FIELD OF THE FUTURE technologies in selected BP operated oil and gas assets in areas where BP expects to accrue maximum benefit most quickly.

Looking ahead, one of the choices that BP will need to make is the pace of application of these technologies in other operating environments. As BP gains experience with early deployment of FIELD OF THE FUTURE technologies, the scope of future deployment will become clearer.

In the meantime, BP is ensuring that its new projects are configured with the infrastructure required for FIELD OF THE FUTURE operation, so that when they are put on stream they can benefit to the fullest extent possible from FIELD OF THE FUTURE technologies.

3.2. Global Prize

Recent successes in BP's FIELD OF THE FUTURE programme have been very encouraging, and it is fully expected that this success will continue as deployment gathers pace.

The ultimate prize of 1 billion barrels of additional reserves is believed to be realisable in the longer term through the full integration of real-time performance management with optimisation activities.

3.3. Lessons learned

Close co-operation between the BP's Business Units and BP's Exploration and Production Technology Group has been, and will continue to be, critical to the delivery of BP's FIELD OF THE FUTURE vision. Each of the Business Units involved with the FIELD OF THE FUTURE programme is taking the lead in the development of one or more aspects of technology by undertaking field trials, by providing input to technology programme steering boards and by providing gatekeepers for BP's technology development stage gate process. Many Business Units have also appointed FIELD OF THE FUTURE managers to oversee and co-ordinate deployment of FIELD OF THE FUTURE technologies within their areas.

Communication of the FIELD OF THE FUTURE vision, business case and examples of early success has been very important for securing Business Unit engagement. With a complex, multi faceted programme this is not always easy, but it is essential to continuously reaffirm the purpose and value of the programme in a consistent way to maintain engagement and momentum.

Particular emphasis is placed in BP on rapidly sharing lessons learned with these new technologies around the Business Units so as to promote their efficient take-up. This has required the establishment of new communities of interest or networks.

Finally, senior management support has been very important to underpinning success to date. This has greatly assisted Business Unit take-up and prioritisation of the programme. With their support, FIELD OF THE FUTURE is being incorporated as an integral component of related BP processes, for example those associated with Major Project delivery, Operations Excellence and Digital Business infrastructure.

3.4. Remaining challenges

Tracking of 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 complex programme like FIELD OF THE FUTURE is being achieved, but is not easy.

Regulating the pace of implementation, and focussing it on areas of most impact will require continual reinforcement of strategic direction. This will sometimes create tensions within which have to be addressed if the programme is to stay focussed on the most important parts of the business.

Last but not least is the impact the deployment of these technologies will have on the way we are working at BP. Technology on its own will not deliver the desired benefits and significant effort will be needed to introduce the accompanying people and business process change.

4. Acknowledgements

The author wishes to acknowledge BP's senior management team, the Business Units and the FIELD OF THE FUTURE Technology Unit for contributing to the success of BP's FIELD OF THE FUTURE programme.

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