SPE 99243

Integration of People, Process and Technology for Right-Time Production Management and Optimisation in Brunei Shell Petroleum

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This paper was prepared for presentation at the 2006 SPE Intelligent Energy Conference and Exhibition held in Amsterdam, The Netherlands, 11–13 April 2006.

Abstract

Intelligent wells and Smart Field concept have been introduced, and recently applied in some assets as a solution to increase production, reduce deferment and increase recovery. The value of Smart Field however can only be fully realized by integrating three main elements, Technology, Process and Resources. Combining subsurface smart well technologies, real-time data gathering, integrated modeling and control elements through appropriate resources and skills are core to close the smart field value loop and will result in better optimization, cost saving and enhancing ultimate recovery.

Brunei Shell Petroleum (BSP) is a regional lead E&P Company and one of the Shell Companies to apply Smart Field value loop concept. Smart well applications have been implemented for a long time before in BSP. In mid 2003 BSP have taken further steps beyond Smart Well applications, when smart field value loop concept has been initiated in its East Asset. Subsurface smart well technologies, surface control engineering and real-time application systems have been integrated to achieve higher production gains, cost saving and enhance ultimate recovery.

The smart field philosophy is not only about automation, it is about making available the three key ingredients that are needed to efficiently operate any machinery: reliable performance data, an integrated suite of tools to turn these data to information and operational advisories and a cadre of appropriate skilled professionals that use the information to make the right decisions.

The objectives of this paper are to share the experience on smart field applications and operations in BSP, demonstrate the value of integrating Smart Field elements, demonstrate the importance of team integration to achieve the value loop and share the challenges encountered, lessons learnt and recommendations.

Introduction

The Smart Field hardware installations in BSP have significantly grown in the last two years across the 3 development Assets. The main objectives of the smart field applications are to monitor, manage, optimize and control the production for better reservoir management, production increase and enhancing the UR.

More than 100 down-hole smart well equipments (PDHG, DTS, ICV, Wireless Gauges and eGLV) are currently installed in East, West and Land Assets. All these equipments are linked to the SCADA and corporate monitoring systems. Additionally, BSP has integrated the smart well equipment with smart field tools (Fieldware, Production Universe and Databroker) to fully utilize the data and convert them to useful information for better and faster decision and actions by relevant parties in the subsurface and surface communities.

In mid 2003 BSP have taken further steps beyond Smart Well applications, by introducing the smart field value loop concept in its East Asset. Subsurface smart well technologies, surface control engineering and real-time application systems have been integrated along the Value Loop. Closing the Smart Field Value Loop will result in higher production gains, cost saving and enhancing ultimate recovery. Combining real-time data gathering, integrated modeling and control elements through appropriate resources and skills are core to close the Smart Field Value Loop.

Shell has identified Iron Duke Greater Area development as the 1st smart field demonstration project for “closing the value loop” in the region and among Shell Companies. Iron Duke Greater Area consists of 4 platforms and a production of more than 7700 m3/d nett. The main objective of applying smart field value loop in the ID Greater Area was to increase production by reducing deferment and establishing continuous optimization of the wells. Various technologies (hardware and software) have been deployed and a lot of activities and upgrades have taken place to be able to close the value loop and achieve the targeted values. It is believed that some gains have already been achieved.

Smart Well/Field Technology in BSP

Smart Fields is the name Shell has given to its solution to this challenge. Grown from the Smart Wells concepts, Smart Fields provide the Assets with the capabilities to continuously optimize their performance and forecasting.

The central concept of Smart Fields is the Value Loop. This means, data acquired on the asset is used to interpret and model the asset, options are generated and evaluated, decisions are made and the result is fed back through actions on the asset. Such value loops can cover a small or large part of the asset, and short or long time scales (Fig. 1).

The 1st deployment of smart well technologies in BSP was in 1999. Since then smart wells have significantly grown in BSP across all Assets. Most of these installations however exist in the East Asset and currently includes:

1. **Monitoring & Measurement**
   - Permanent Downhole Gauges (PDHG's)
   - Distributed Temperature Sensing (DTS)
   - Cable-Less "Retrofit" Gauges
2. **Control**
   - Inflow Control Valves (ICV's)
   - Electric Gaslift Valves (EGLV's)
   - Production Universe "Real-Time Optimisation"
3. **Modelling**
   - Production Universe (PU)
   - FieldWare Applications

Most of smart wells in Brunei Shell Petroleum are equipped with Inflow Control Valves (ICVs) to control multi zones wells, Permanent Downhole Gauges (PDHG) to monitor downhole pressures and temperatures and Distributed Temperature Sensors (DTS) to monitor the temperatures along the well on distribution basis. The down-hole data are transmitted from the well sites to the BSP corporate database through various data transmission means (RTU, wireless, cables, and communicated through smart field monitoring and optimization tools to convert data to useful information for better and fast monitoring and actions. The down-hole data are used for short-term production optimization by the Operation staffs and long-term optimization by the Sub-surface staffs (Fig. 2).

Smart Field Organization

The key success factors toward implementing Smart Field technologies are the people, skills & process.

1. BSP's Smart Field Organization

BSP have established a dedicated Smart Field team outside the Asset teams structure to ensure local "Smart Wells/Field"-related activities can be supported and to provide a link to Shell's Global Smart Fields team. The team structure consists of:

1. a "Smart Fields Champion" who will support Smart Fields initiatives at management level.
2. a dedicated multi-disciplinary Smart Field team, in which surface, subsurface and IT/DataManagement focal points are involved who are responsible to make sure that Smart Fields are driven forward in BSP in an integrated manner and that a link to Shell's Global Smart Fields team is provided. Their main activities will consists of:
   - Regular dialogue with the different Assets
   - Inclusion of projects in to the cooperate planning process
   - Supporting local BSP Smart Fields related activities
3. a "Smart Wells/Field Implementation Engineer" who is the "Subject Matter Expert" with the responsibility for recommending equipment and day to day management of the relevant contracts as contract holder. This position will report to the "Smart Fields Advocate"
4. an "Administrative Support" for the "Smart Wells/Field Implementation Engineer"

BSP's Smart Field team obtains support from Shell's Global Smart Fields team (EPT-RSF) in the Center, whenever required, with time, expertise or funding to facilitate progress and remove obstacles that may prevent achieving the deliverables for BSP's Smart Fields Demonstrator projects and the development of the global capabilities (Fig 3).

2. Skills & Resources

Skills and Resources play major role in Smart Field and they are the most critical factors to successfully deploy smart technologies. BSP has established a multidisciplinary organization consisting of subsurface, surface and IT parties to implement Smart Field. Some training has been conducted to offshore relevant parties and Smart Field Team has issued Smart Field awareness course materials. The East Asset has established an offshore smart field team to assist in implementing smart field applications and carry out maintenance activities. The team is delivering high benefits and values on areas in data clean-up and achieving quality. The main deliverable of the team has been on the area of communication link with the Information Technology team and the Production Technologists. This communication link has facilitated in the solving of long outstanding issues. The team is delivering high benefits and values, which proved the importance of having such a team in the operating location (Fig 4).

A new way of working will be applied whereby the silo-ed way of operating the fields has to be moved towards a way whereby different technical and operational functions have to understand their contribution and impact on the other parts of the "value loop".

To ensure that the required skills are available in BSP, training programmes are or will be made available in BSP's Learning and Development Training Center containing all the Smart Fields elements (awareness, technical, work processes, changed work dynamics etc.)

3. Key Roles and Challenges

A key role in the Smart Field plan is the commitment to carry

out the planned activities. It is important to recognize that Smart Field Team does not have the capability to execute projects and that we are reliant on customers for this activity. A critical challenge is to better align customer and Smart Field activities such that BSP can actually realize the potential benefits.

- Regular dialogue between Smart Field Team and Assets
- Identification of working focal points in the Asset Units, such as Production Universe super users and smart well engineers.
- Inclusion of identified projects in the corporate planning process
- Earlier engagement with Project Teams

A further key challenge is manpower, BSP has put a smart field multidisciplinary team in place where subsurface, surface and IT focal points are involved. BSP has made an important move toward enhancing the strength of smart field team when a dedicated IT department was formed to provide the support to the Smart Field IT infrastructure and applications systems. The Information Real-Time department (IRT) is the Central Real-Time Operations Support team that execute the IT aspects of the SmartField projects that complies to the Group's Data Acquisition & Control Architecture Standard (DACA). It should be realised however that IRT requires more staffs to keep supporting Smart Field at adequate level. Failing to increase the number of staffs in IRT would result in deceleration of the ongoing and planned smart field projects in BSP, which in turn would negatively impact the production and reservoir monitoring.

The table below shows the various responsibilities of key players in the realization of Smart Field Realization:

	Party	Responsibilities
1	Smart Field Team	Regular dialogue with assets to ensure/assist in the implementation of Smartness as per Smart Field Strategy. Custodian of smart field strategy, and provide technical support and coordination among teams/disciplines in BSP, SIEP and vendors.
2	Project leaders	Ensure that selection criteria, VARs and/or field reviews consider Smart Field application as the first development option. To liaise with Smart Field team, to discuss on the use of technology relating with surface and sub-surface areas.
3	Chief PE's	Provide support to Smart Field Team, ensure that smart Field has been considered as part of field development and ensure that Smart Field projects are in the budget plan.
4	Head of Operations	Support the implementations, review logistics and resource requirements to align with the implementation plan.
5	Asset Managers	Ensure that budget requirements are placed as per the implementation plan for the subsequent years, 2006 onwards.

Results & Discussions

More than 98% of the installed smart wells equipment in Brunei Shell Petroleum were successful and added values to business.

1. Smart Well Values example

Figure 5 shows a snapshot of the well's performance after 6 days of production. This well is a horizontal snaked well with 3 completion zones. It is completed with 3 inflow control valves, a dual permanent downhole gauge and fibre optic distributed temperature-sensing system (Fig. 6). The data from dwnhole equipment are transmitted online to relevant engineers in the main offices.

The well was kicked off with all 3-inflow control valves (ICVs) open. The March 25th plot shows the well geothermal gradient and the April 1st plot shows the gradient during production. The temperature changes only above 5400m. There is no change in temperature in the toe of the well. This means the toe of the well is not flowing. This demonstrates clearly that selective cleanup is required and that ICV's are essential. Based on above, it was decided to close the top two ICV's and open the bottom ICV, which resulted in cleaning out the toe of the well and was shown by the DTS.

2. Smart Field Values example

Another example of Smart Field values is shown in figure 7. The figure illustrates the benefits of establishing online gaslift optimization in an offshore platform in the East asset (Fig.8) using real time Shell's Fieldware application tool. A FieldWare application tool called Production Universe (PU) has been deployed in BSP as part of Smart Field value loop for production optimization. BSP was able to achieve a continuous gaslift optimization on 8 wells in an East offshore platform using smart online modeling (Production Universe). FieldWare PU continuously estimates well oil, gas and water production. The production estimates are then automatically fed-into an online optimization model which automatically and continuously adjusts the amount of gas lift gas injected into each well to maximize production. Production gains of about 260m3/d nett, has been seen in 8 wells in an offshore platform where these techniques have been applied.

All of the above has been done with very little change to existing installed infrastructure (instrumentation, telemetry, communications and hardware) as the platform was already equipped with good instrumentations and some smart wells equipment. The achieved values are encouraging as there has been little physical change, which made the installation faster. All of this has been achieved by embellishing the existing BSP infrastructure with Shell's FieldWare software applications.

3. Data Transmission Trial

BSP Smart Field IT team successfully commissioned Champion West Well Jacket 03 (CWWJ-03) to Champion 7 (CP-7) WiLAN pilot installation, the first installation in the Process Control network. WiLAN (wireless bridging network) technology provides a reliable data communication at a very high transmission rate (11 Mbps) within the limit distance of 7 kilometers from its base located in CP-7. The installation has

been carried out as part of Smart Field Demo Project to achieve remote monitoring, process automation and operation of smart wells in ID Greater Area. The team successfully commissioned the 2nd WiLAN on CPDP12. This provides data communication for the CP320 well' s DTS (Distributed Temperature Sensing) data from the Field to the Desktop.

4. Remote Operation of a Smart Field

Brunei Shell Petroleum was able to demonstrate the ability to remotely operate on of the smart wells in the Iron Duke Greater Area demonstration project. Figure 9 below illustrates the overall communication with respect to closing the loop of the well. In brief a Shell Research staff was brought in to model the reservoir performance of a 5 zone Smart Well. The activity required closing and opening of zone valves whilst putting the well on test. The data of the well and the test data were used in the modeling to establish the well behavior. It was able to successfully implement the operation by controlling and monitoring the multi-zones well at the BSP HQ.

The definite learning is that the frontline activities and the associated difficulties of working in a normally unmanned offshore facility whilst achieving real-time data to predict the well potential.

Both Frontline technician and the research mathematician had shared vision to achieve a common goal whilst appreciating each other's role.

Strategy

The strategy is to use new, to be developed and existing technologies for their production systems (surface and subsurface) to ensure that their assets can be, continuously and pro-actively, optimized whilst maximizing the ultimate recovery. For all new assets it will assure that smartness screening has been applied and the appropriate level of smartness is included.

The level of smartness is an approach to the operating and design philosophy. The impact of smart fields happens at asset level. The Smart Fields Value Loop is the framework that links and integrates the required capabilities for the assets.

BSP has identified the required Smart Field level with staircases and implementation plans to reach the right level of smartness of each asset (Fig 10).

Implementation of smart field technology however should move in parallel with level of smart field skills of the relevant teams to ensure optimum utilization of technology and therefore high values.

Conclusions & Recommendations

Successful implementation of Smart Field concept in the demonstration projects in ID greater area and Champion West fields have significantly added values through better production optimisation, well surveillance & reservoir management and enhancing ultimate recovery. Brunei Shell Petroleum considers the Smart Field applications as the basic selection for the green and brown fields. It is realised that the key successful factors for the Smart Field applications are integration of 3 elements Technology, People and Processes. Therefore, a dedicated Smart Field team was established to ensure an optimum approach is properly followed for the implementation.

Integration of multidisciplinary teams is the key success factors, however, it is not easy to achieve due to different levels of skills and diverse responsibilities and priorities. Common understanding is that subsurface disciplines (mainly Production Technologist) are the concerned community with the Smart Well/Field concept. However, experiences of Smart Field implementations in the demonstration projects demonstrated the required heavy involvements and contributions from the other disciplines in the organisation.

Offshore/Field Operation supports are a key enabler toward successful implementation of the Smart Field. It was realised that early involvement and engage of Field Operation and the IT staffs enabled excellent progress of Smart Field projects.

We learned from our experiences with implemented and ongoing BSP's Smart Field projects that following measures should be in place for successful and smooth implementation:

- Before implementing Smart Field applications in a certain field, a level of smartness should be established to identify gaps, solutions and required infrastructure for an optimum operation philosophy.
- A dedicated Smart Field team, consisting of multidisciplinary organisation should be established.
- Early engagement with relevant teams and parties should be conducted.
- Field Operation teams are the key enablers and therefore, they should be engaged in all Smart Field process, from opportunity framing to the evaluation of the outcomes.
- The required skills should be developed and enhanced in parallel with the technology implementation and infrastructure upgrades. Failing to build needed skills would result in not realising the full benefits and values of the applications.
- The values of Smart Field include both short-term and long-term visions. Therefore, justifying for Smart Field applications should incorporate both views and should integrate all involved items and the full cycle of the production of the field.

Acknowledgments

The authors would like to thank Brunei Shell Petroleum Company Sdn. Bhd and the Petroleum Unit for their approvals to publish this paper. Special thanks to Hji Kamaludin, Darat Asset Manager and Philip Holweg, Head of Darat Production Technology.

Reference

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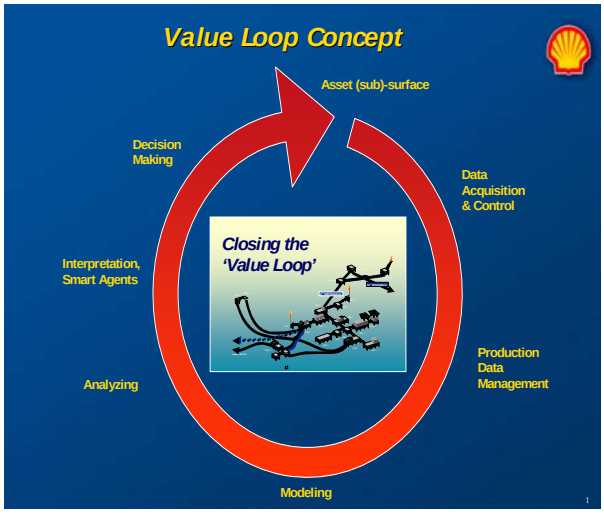

Fig. 1 Smart Field Value Loop

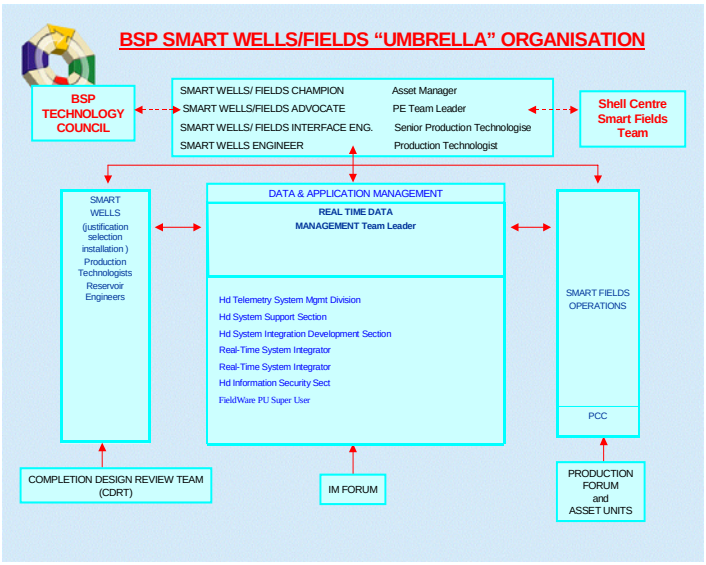

Fig. 3 BSP's Smart Field Organization

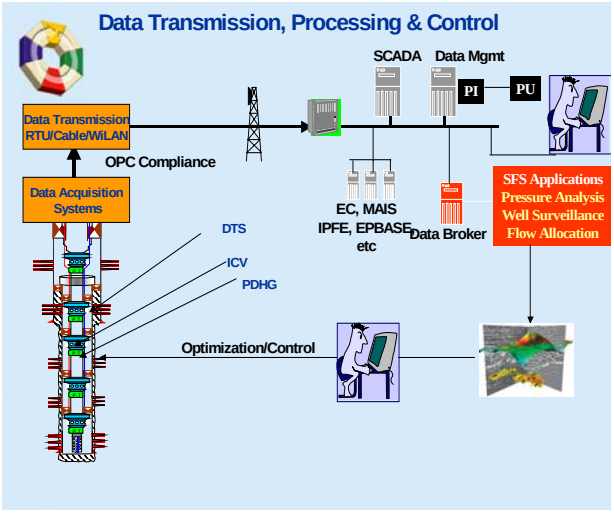

Fig. 2 Data Transmission, Processing & Control

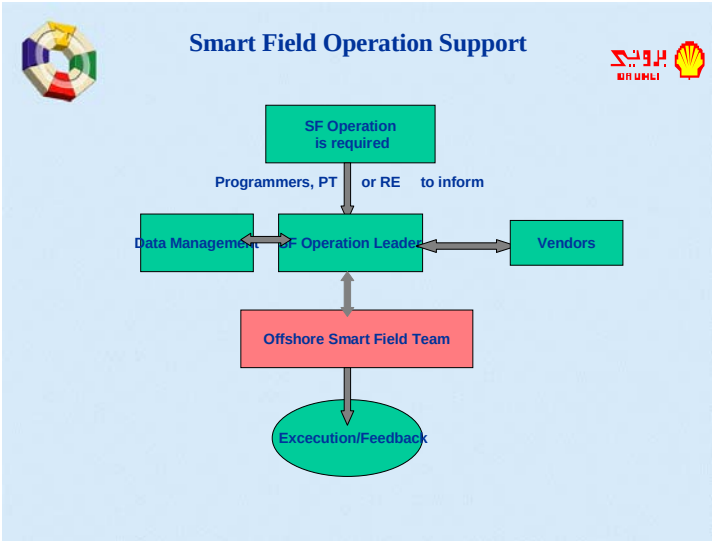

Fig. 4 Smart Field Operation Support

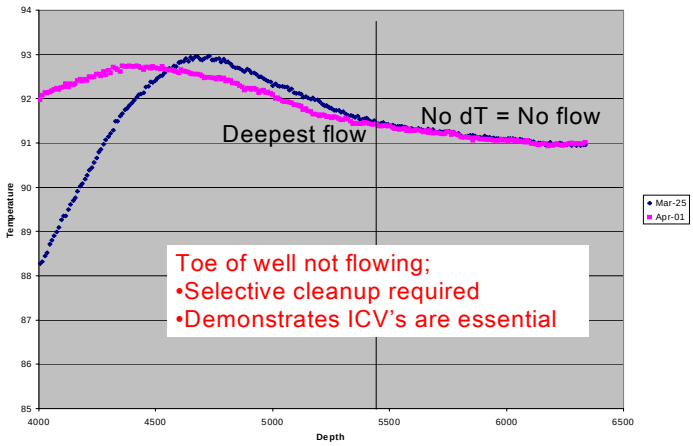

Fig. 5 Smart Well Value Example

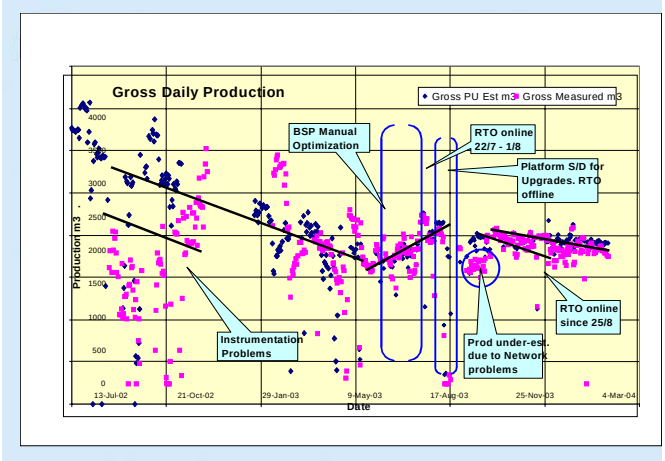

Fig. 7 Online Gaslift Optimization

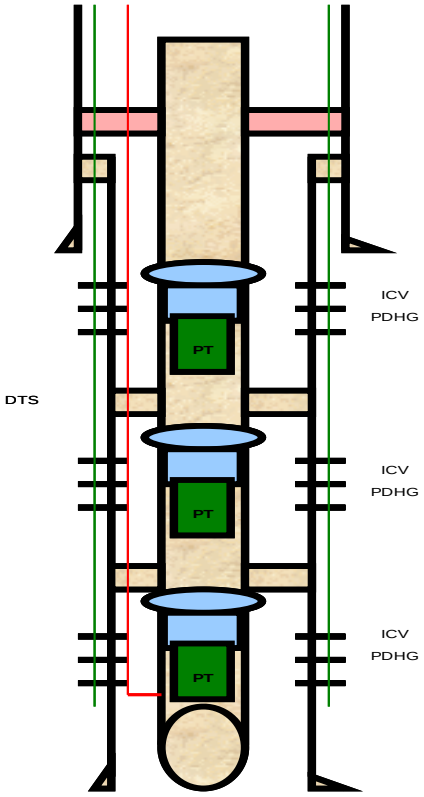

Fig. 6 BSP's Typical Smart Well Completion

Fig. 8 An East Offshore Platform

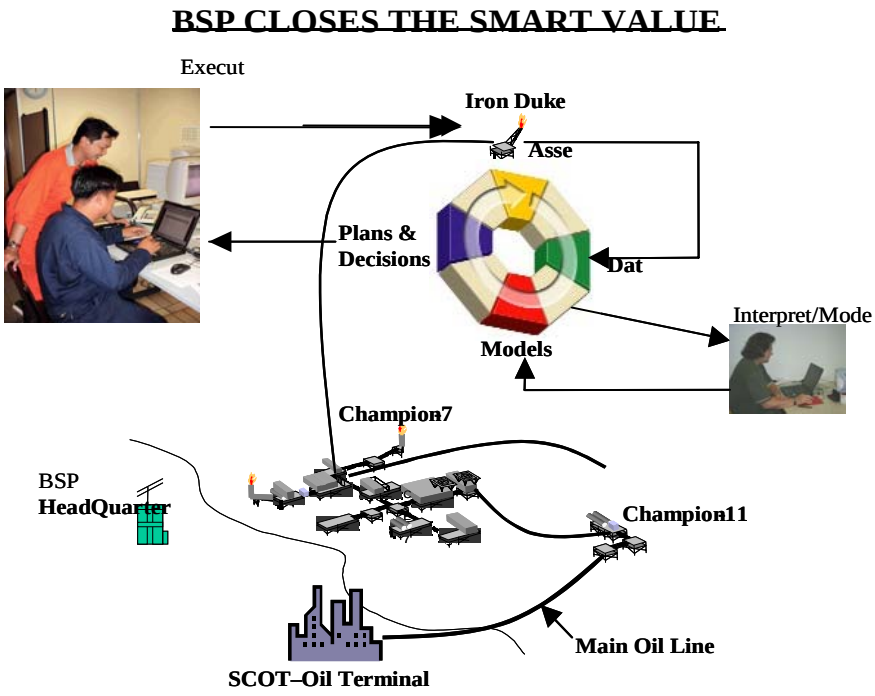

Fig. 9 Remote Operation of a Smart Well

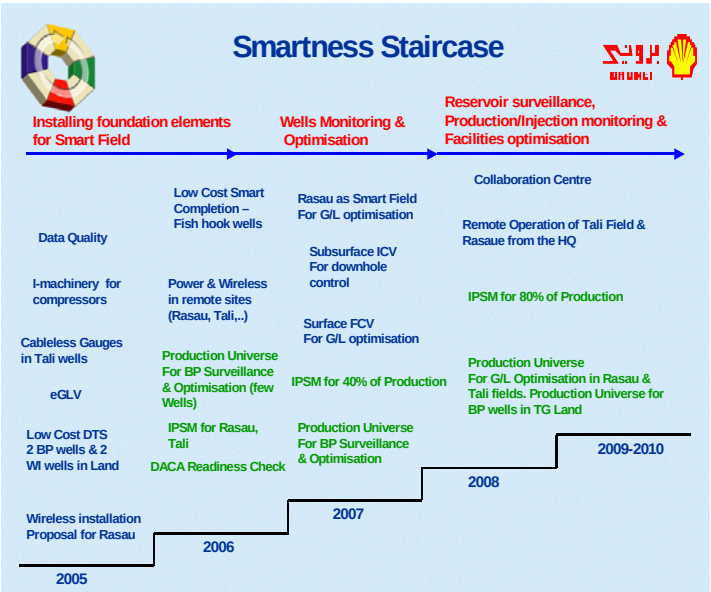

Fig. 10 Smart Field Staircase for one of BSP's Asset