



Smart Fields®

Intelligent Energy

Malcolm Brinded

Executive Director Exploration & Production
Royal Dutch Shell plc

Intelligent Energy Conference, Amsterdam
25th February 2008



Malcolm Brinded is Executive Director of Exploration & Production and a Member of the Board of Royal Dutch Shell plc.

He joined Shell after graduating in Engineering from Cambridge University and has worked for Shell companies in Brunei, the Netherlands, Oman and the UK. In 1998 he became Managing Director of Shell UK Exploration and Production; from 1999 until 2002 he was Shell Country Chairman in the United Kingdom.

He is a Fellow of the Institutions of Civil and Mechanical Engineers and of the Royal Academy of Engineering. He was appointed CBE in 2002 for services to the UK oil and gas industry.

He is a member of the Russian Foreign Investment Advisory Council and of the Nigerian President's Honorary International Investor Council.

The concept of the digital oilfield can help companies to meet the energy challenge, but is cutting edge technology enough? In this speech, Malcolm Brinded discusses Shell's Smart Fields® programme and how it enhances lifecycle field management by integrating innovative technology that connects data to people that can make smart, fast decisions.

Today I want to focus on three questions. First what do we mean by Intelligent Energy and Smart Fields® and what really makes a field smart; second, what benefits do we see from Smart Fields today in both mature and new fields; and third, what about the Smart Field of the future, how do we see them developing. This is not just about hardware and technology, it is more an issue of how we will have the people capability we need to manage disruptive change in our industry. Let me try and answer the first question, because for people at Shell aligning on what we mean by this whole thing is very important.

Smart Fields®

For us, a Smart Field is an asset that we can continually optimise 24 hours a day, 7 days a week. And the underlying philosophy is that the total value we can get from a field depends on how thoroughly we can locate the hydrocarbons in the ground, how efficiently we can recover those hydrocarbons and how we can optimise the production and the wells facilities and overall field performance throughout the field life cycle, on timescales ranging from seconds to field life.

Optimisation for equipment, for gas lift, takes place in real-time for production or pipeline systems; it is about days and weeks and for the reservoir; and water flood management we've got to think in terms of months and years.

To be able to optimise the field 24 hours a day, you need processes, tools and technology that enable teams to gain total integrated awareness of their asset's current and predicted behaviour to give them ability for real-time decision-making and analysis.

So you have to think in terms of processes: for effective field management asset teams

need good quality data at the right time; they need up-to-date integrated models and the ability to use those models effectively for field optimisation. Improved processes enable us to shorten the life of the cycle time from data to decisions, whether we talk about advanced process control, integrated production system optimisation, field reservoir modelling or field life scenario planning.

Smart tools enable us to bring the full spectrum of hardware into play, from downhole pressure gauges and inflow control valves to distributed pressure and temperature monitoring to 4D seismic to field-wide compaction monitoring, all of that information needs to be gathered and integrated. On the people side, the key is collaboration, because new ways of working are enabled by bringing together in one room, or especially virtually, all the skills that can jointly interpret the information to make faster and better decisions that give improved field performance.

Methodology

Putting the Smart Fields vision into practice is not one-size-fits-all, because every asset has unique features. Geological, environmental, economic and even political circumstances differ from case to case and that will differ the way that the fields may be optimised and in fact the solution for the whole field operation.

At Shell we have a company-wide methodology that tries to bring Smart Fields thinking up front into every project plan. It identifies the most appropriate technologies and enables their application and it is a structured process to help everybody bring a vision of what Smart Fields can be into their asset and their business. It starts at the concept

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selection phase where the screening matches the appropriate level of Smart Fields solution to the specific needs of the project and then takes it into the field management plan to look at how future field optimisation decisions will be made underpinned by the optimum, rather than the maximum, amount of data acquisition. And getting that balance right is absolutely key. The plan is then brought to life with standardised work methods and through the right enabling technologies and that particularly means setting up the right collaborative work environment to improve integration between the various technical disciplines in decision-making.

Born Smart

As of now all the projects that we operate in Shell are Born Smart. This means we will have the right combination of smart well design from the outset, and will be looking at the instrumentation and the integrated field management with the impact that that can have on maximising production and recovery from the very start and reducing development costs. One example of a smart field is the Champion West field that was discovered back in 1975. when I was working in Brunei – it sounds a long time ago. In those days we simply couldn't figure out a sensible or economic way to develop this new complex field that we'd found. It lay untapped for 25 years because its hundreds of small accumulations with thin reservoirs and different fluid fields, gas and gas oil and oil, made it uneconomic to develop. The eventual solution was to drill smart snake wells that snake vertically and horizontally through several accumulations with the ability to measure and control flow from the separate sections. After using the snake well concept in some surrounding fields we went back to Champion West, built a new unmanned platform and drilled a number of multiple drainage snake wells with smart completions up to eight kilometres along hole length, over 4 kilometres through the reservoir. Champion West became a success and has contributed

50,000 barrels a day at peak of production to Brunei Shell. That area of Brunei now produces over a 100,000 barrels a day of production from five fields, one of them being Champion. And these fields have a remaining life of over 50 years.

We've looked at how we actually want to operate. The production optimisation collaboration centre that was set up in 2006 creates a collaborative working environment. It brings together petroleum engineers, well services, offshore operations staff in virtual real-time decision-making and I think it embeds a completely new way of working in the organisation, based on the philosophy of how the field should be managed. It really means one operation based on one data set, one plan and one common set of priorities. That doesn't sound like rocket science, but it is a huge step for oil and gas companies and leads to better, faster decision-making.

Another example of a field Born Smart is Sakhalin. The Piltun field offshore Sakhalin is a completely different design challenge because of the harshness of this severe sub-arctic weather in a remote and environmentally very sensitive offshore location with multiple stacked oil and gas reservoirs that require remotely controlled and reliable well completions. The wells cost many tens of millions of dollars each, so reducing their number at the outset was crucial. So we opted for multi-zone producers and injectors that will enable good waterflood and fracing management. Smart well completions allow downhole monitoring and control, which gives much faster response times to unexpected reservoir behaviour and the ability to constantly adjust water injection and production by the zone. Because we control the valves from the surface, we reduce the number of well interventions and over the field life that saves over a hundred million dollars and all of the safety exposure of those additional interventions.

“As of now all the projects that we operate in Shell are Born Smart.”

The last new project I'd like to mention is Ormen Lange gas field offshore Norway where Statoil Hydro was the development operator and which will supply 20% of the UK's gas. Ormen Lange was Born Smart and Statoil Hydro incorporated predictive control software for flow assurance because in these long pipelines to shore, the hydrate and slug flow control is absolutely crucial. With the flow control they have in place, operators can view what's happening now and particularly, view what-if scenarios as to what may happen in the next few hours and tomorrow and make much more informed decisions as to what to do next. So at First Gas, operations people were able to actively work with the support people in Christiansen in the collaborative work environment that's been installed.

Shell took over as operator last year after close collaboration with Statoil Hydro through the development phase. We put in a network of permanent acoustic ranging sensors that monitor sea floor deformation to detect reservoir compartmentalizations, so this is additional flow of information that's integrated into field management. These sensors detect changes of just one centimetre in the reservoir compaction whereas traditional seismic monitoring would not really deliver results that are reliable until you've seen 15 centimetres of compaction. So when we think of Intelligent Energy and Smart Fields there are many aspects to it.

Existing assets

I'd like to talk about existing assets if I may because we tend to think about putting this stuff on new fields.

When we decided to retrofit one of our fields in the North Sea we applied a standard Smart Fields Foundation package with standardised architecture, data applications and integrated work processes that are all about forging teamwork and again improve decision-making between onshore and offshore operations staff. It's been one of the key improvements, the

introduction of this Smart Fields Foundation, to the mature Nelson field in the North Sea.

The example I'm going to give you is around gas lift optimisation because in the past there was a huge amount of data and number of staff involved; but each staff member knew only what they had to do in their part in the process. This meant an inevitable lack of coordination between all the players, slowed down the platform restarts and it took up to 48 hours after every trip to return this complex operating system to full capacity. So the staff members mapped what they did and we basically went in and used software and optimisation programs and some additional hardware to change and automate a huge part of the way that operations were done.

A particularly key part was optimising the distribution of lift gas, which enables the operators to focus on other tasks during the start-up. We had new tools and workflows in place inside 6 months and platform restart times shrank to about 12-18 hours and that means we get almost 20,000 additional barrels every time the platform restarts.

Let me go to another retrofit at Petroleum Development in Oman in the Middle East. It is one of the most mature of our operations, but also one of the most innovative. Some of the fields are 40-years-old, geology is very complex, with well over 100 fields in operation and recovery rates vary from 10% to 70%. They operate almost 3,000 wells and therefore PDO was an obvious candidate for applying smart technology on a fit-for-purpose basis in the right environment. We went about it using the Smart Fields Foundation approach to really optimise field management.

In the Natih field, we're running a complex gas oil gravity drainage project in a fractured carbonate reservoir with a thin oil rim. The Smart Fields application there has the goal of controlling the oil rim by accurately maintaining pressure for both oil and water in the reservoir and the levels of them through 6 aqua pump off wells and 20 oil producers, with the result that we're constantly controlling the ratio of oil and gas coming from the wells. The

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impact has been, over the last 18 months to 2 years, that we've reduced unwanted gas production by over 300,000 cubes a day and stopped flaring with no loss in oil production. It has also reduced compression needs, allowing us to shut down two compressors and maintain stable operation of the remaining seven. We've increased compressor availability also as a result of more stable operations from about 80% to nearly 100 %, again with less flaring and we've reduced maintenance costs by 15-20%. Although it is not particularly high tech, it is a great example of retrofitting to optimise reservoir management and facilities performance. At PDO today, all staff have access to real-time well and surface equipment information online from 3000 of their producing wells through a web-based view using the same consistent set of data across the company.

The future of Smart

I've given several examples of today's Smart Fields programme across Shell. What does the future hold for our industry? I think we're at an exciting inflection point. I expect the use of Smart Field technology to accelerate dramatically over the next decade. In 10 or 15 years, new assets are going to routinely deploy a whole new arsenal of smart tools and processes. I think we will harness new measurement techniques that look deep into the sub-surface using nanotechnology with tiny sensors that will inject directly and give us feedback about what's happening in the fractures and through the producing zones. And I think as a result we'll measure things that we're seeing the first glimpses of today, to give a sort of live 3D broadcast of what the fluid movements are happening in the reservoir. Human intervention will increasingly become an exception as tasks are handled automatically or remotely making the work place safer. Imagine for a moment, reservoirs that in a way begin to resemble a refinery or a chemical plant in terms of our ability to control sub-surface operations and monitor performance, advisory

systems that predict problems in production facilities in wells, that allow for corrective action, all preventive maintenance before they become acute, that increase efficiency and uptime and most importantly free engineers and operators to focus on the real opportunities to improve field performance. I think the shift is also going to be driven partly by necessity because with the era of easy oil drawing to a close all of us increasingly face more complex reservoirs and as we strive to get more out of existing fields and tackle more heavy oil and more un conventionals a much higher proportion of reservoirs will require sophisticated enhanced oil recovery techniques which of course rely much more on accurate reservoir understanding than primary processes.

Let me finish by turning to people because I think this challenge is more about humans than hardware. We all know the challenge of attracting enough talented young people to our industry but these new smart ways of working play to the strengths and interests of the new generation of young people that are joining our industry now or those still in school. And I think it will improve the attractiveness of our industry as employers because these technology-savvy newcomers that can multi-task. They have grown up not only with a sort of impossibly fast and intuitive interaction with computer games but they have also extensively participated in different and technology-driven social networks. Essentially, they are already hardwired with some of the soft skills needed for access information from multiple sources and collaborate through virtual links. So I think for the hard skills needed from operators and engineers of the future, we'll all need to upgrade our training and technology and work practices will evolve at an accelerating rate. And we must ensure that our staff stay abreast of the advances because there is no replacing the hard engineering skills that form the bedrock of our know-how, but mixing them with the right soft skills about collaborative work environments and how to work together

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will produce a powerful combination that will mean faster and better decision-making.

Our industry faces a tough triple challenge, we'll be asked to produce more energy for more people at affordable costs while reducing our environmental footprints and we'll need to do that at a time when the era of easy oil is going behind us. Smart Fields will prove indispensable in meeting that challenge.

“The kind of improvements that Smart Fields technology is bringing are key in today’s increasingly tough environment. In Shell we call these the three hard truths: meeting the demand for energy, reducing carbon dioxide emissions and doing so when the end of the called age of easy oil is approaching. Smart Fields can help us meet that challenge by enhancing recovery rates and extending field lives.”

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Shell International BV, Carel van Bylandtlaan 30, 2596 HR The Hague, The Netherlands.

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