

Keynote Session: The Future is Here—The Value of Innovation and Integration



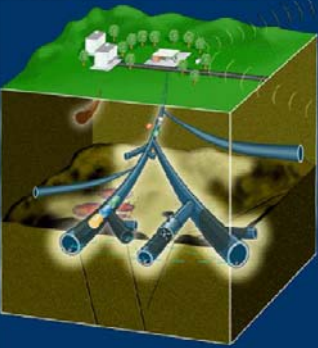
Mr.Chairman, Fellow Panel Members, Ladies and Gentlemen—good morning. Thank you for having me here today at this, the second Intelligent Energy conference. I've paid careful attention to the program and am going to do my best to answer the three questions set by the conference committee. First, how advanced have we become in the implementation of the digital oilfield, second whether people, process and change management issues are bigger than those of technology and third, how large is the gap between corporate vision and field reality.

But first a little history. It was only just over ten years ago, that we were all talking about a concept called real-time reservoir management. Through this concept, we were expecting to be able to monitor and control in real time all the key processes associated with a producing hydrocarbon reservoir. Set against oil and gas demand projections, the objective was to revolutionize oil and gas production practices to usher in a new era of productivity that could boost average recovery rates from 35 to 50% or more. How little has changed for that target remains much the same today. And while the industry has come to know this concept through a variety of names such as Smart Field, Digital Oilfield, iField or Field of the Future, the vision has become much more far reaching than these names imply. In my view, it has become more and more about collaboration and connectivity, and how information and knowledge can flow from drilling to production and maybe even further to the delivery of refined hydrocarbon products to the end-user.

In assembling my notes I found an easy connection between the digital oilfield and intelligent energy. For if 'digital' equals 'technology', then 'intelligent' equals 'people'. I'm therefore going to use my time to talk as much about the future ways in which technology and people will need to develop as I am about any specific components of the digital oilfield. But let's start with today's state-of-the art technology.

Intelligent Completions Balance Reliability & Complexity

- The technology is being deployed in an increasing number of fields
- Systems have become simpler with reliability the top concern
- Operating experience has confirmed expectations that systems would be able to control reservoir fluid movements
- Results have led to increased reserves, increased recovery and more cost-effective operations



2

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Intelligent completions are key components of the digital oilfield and their deployment has already become reality with a number of fields adopting the technology uniformly and universally. Initial concerns about reliability have been addressed through a balance between this and system simplicity that renders them robust in practice. Field experience has demonstrated that the early laboratory experiments that indicated feasibility of controlling fluid movements through downhole valves were correct—with the results speaking for themselves. In one North Sea field for example intelligent completion technology enabled successful development of a structurally complex formation with numerous fault segments and indications of locally varying fluid contacts. From 2001 to 2006, recoverable reserves were doubled as the intelligent completions permitted increased sweep efficiency, created better reservoir drainage and reduced intervention costs. In another case in the Gulf of Mexico, intelligent completions increased predicted recovery by 28% through commingling production efficiently, and in a similar approach in Nigeria their performance was sufficient to convince the regulatory authorities to permit commingled production as the completions allowed back-allocation of production to individual reservoir layers.

However, one of the goals of intelligent completion technology should be to ensure that no producible reserves are left behind. When coupled with more complex well designs that permit production from multiple reservoirs, fewer wells will be able to produce more hydrocarbons. This approach of course has been enabled extensively by the increasingly sophisticated steerable drilling assemblies that can drill long-reach high-angle wells which can then be equipped with the technology needed to facilitate production optimization as dynamic changes in the reservoir occur.

Indeed, the importance of drilling technology in the digital oilfield cannot be overestimated. There is a growing school of thought for example, around the possibility of ‘arthroscopic drilling’ in the improvement in recovery factors. Just as arteries and veins carry blood to the extremities of the

body so an arthroscopic collection of wells can carry hydrocarbons to the surface, provided the mechanical energy is there to propel them.

Real-Time Operations Centers

- The required technical expertise can be assembled for better decision-making
- Data communications technology makes remote job monitoring increasingly possible
- Coaching and support can be brought to younger engineers to provide help where needed

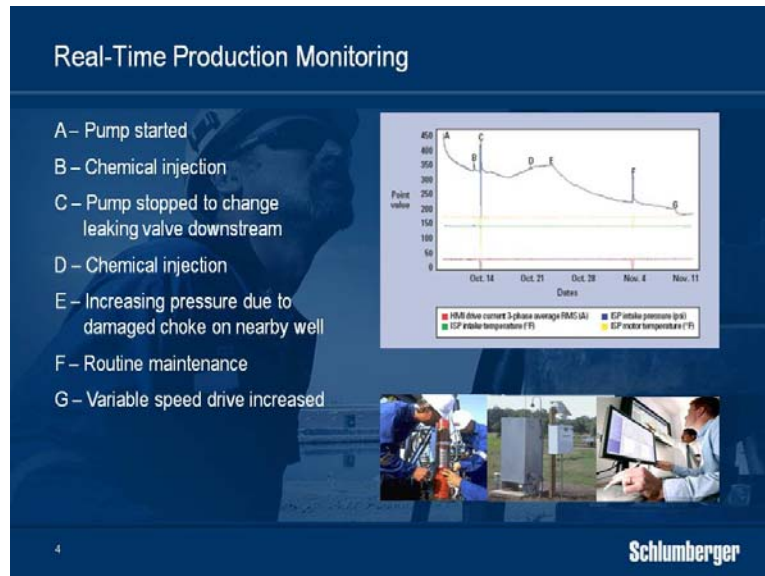


3

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But arthroscopic drilling requires real-time capability using the sort of operations centers we saw earlier this morning. These are another component of the digital oilfield. They permit all the required expertise to be assembled to the best advantage and help us take the expertise to the problem rather than bringing the problem to the expertise. Today's data communications technology between field and office has made real-time operations through remote monitoring increasingly possible. This means that not only can the appropriate technical expertise be brought to the operation for better decision-making, it also means that coaching and support can be brought to younger engineers providing help where needed.

In turn this leads to changed working practices, which lead to significant efficiency gains. Our own experience for example, has shown that remote drilling operations centers can multiply drilling engineer productivity two-fold or three-fold when measured by the number of wells that can be supervised simultaneously. This is far from being insignificant when you consider that the Schlumberger center in Aberdeen can follow operations on up to 28 rigs simultaneously with a full backup of petrotechnical experts as well as a team of seasoned drilling experts.



Production operations also benefit from digital oilfield concepts. In this example, the electrical submersible pump (ESP) system deployed used a new-generation pump digitally enabled with built-in sensors, surface power and communications infrastructure and remote surveillance and control equipment. Linked to personnel with diagnostic and remediation skills, the communications system provided continuous Internet access to real-time downhole pressure, temperature and pump system data over a secured connection. In just the first two months after system installation the technology helped identify damaged equipment in an adjoining well that was causing decreased production in the monitored well.

These few examples show that we have made much progress in developing the digital technology that intelligent energy requires. But there is more to do in how we develop technology in the first place and this demands that we reconsider how we, as an industry, do our research and engineering. After all, technology collaboration in a global industry has every reason to be global in approach not only to share knowledge but also to harness particular cultural strengths. Innovation, for example, is a key facet of engineering in France; Russia is renowned for its mathematical strength; China is one of the largest investors in nanotechnology and Singapore is developing expertise in project conception following its success as a manufacturing base.

Dhahran Research Center—A Model for the Future

- Dedicated research center on Science Park close to King Fahd University campus and close to major oil company
- Chartered to focus on improving the performance of carbonate reservoirs
- Part of a worldwide network doing both fundamental research and supporting product development
- Solving hard problems and looking at new technologies in reservoir development



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Harnessing regional strengths is one of the reasons why we inaugurated a research center in Saudi Arabia. And while this center is destined to become a focal point for the all-important study of the carbonate reservoirs, locating it in Dhahran made perfect sense for two other reasons. First it's close to the headquarters of a certain large oil company, and second it's near to one of the world's leading universities for the education of petroleum engineers and scientists. In my view, this is a modern model for oilfield research and development harnessing as it does research facilities, access to academia, proximity to the end user, while remaining part of a network of research and engineering centers around the world. The Dhahran research program is already centered on aspects of the digital oilfield with the integration of deep-reading measurements that track fluid movements far from the individual wells.

Such a modern model of research and engineering is not unique to the oil and gas business. Other industries can help us pursue our own technology development. We see a variety of new applications for innovative technologies drawn from industries such as aerospace, automotive and biomedical, all of which are capable of helping meet intelligent energy challenges. We can certainly reap substantial benefit, but only if we as an industry adopt a more coherent and aggressive approach.



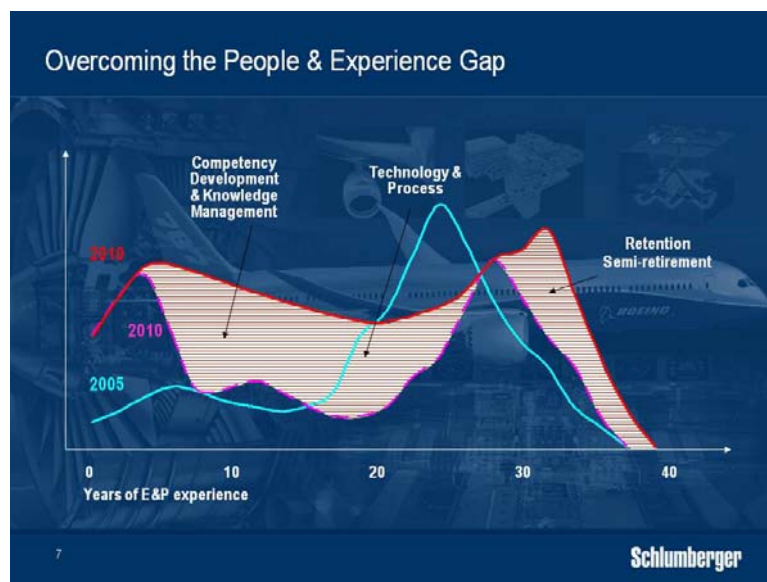
The aerospace industry, for example, has historically been a developer of new materials and sensing technologies that have subsequently found application within the oil industry. The range of requirements for operational military and commercial structures is broad and often extreme in terms of environment. Structures need to be strong, lightweight, tough and capable of maintaining these properties under high loads, at high temperatures and in corrosive environments. These are almost exactly the requirements of the upstream oil industry and many of the high performance alloys we use today owe their origin to aerospace-driven developments. In a more limited sense this is also true of composites, which have yielded some materials that find use in the oil industry with others to come. This trend has not stopped and in fact seems to be accelerating as aircraft designers in Europe and America adopt a wide range of ambitious new technologies that will give aerospace systems more multifunctional properties for use in fuselages and other aerospace structures.

New composite materials are also finding use in jet engines. The GE 90 engine now in commercial service uses substantial composites for the main rotor blades and the stated goal of GE is to engineer a totally composite jet engine. This would obviously require very high temperature and reliable mechanical performance, but if successful, has profound implications for upstream applications assuming that the cost is not prohibitive. And while on the subject of jet engines, we should not forget that the vast majority of engines in flight as we speak are transmitting real-time data back to monitoring centers charged with surveying engine performance and advising operators of potential issues and maintenance needs. The digital oilfield is a very similar application.

With the ongoing miniaturization of sensing elements, new smart materials concepts with embedded sensing systems are emerging. We are likely to see a proliferation of distributed sensors for diagnostics integrated by fiber-optical and wireless communications to tie together all parts of a large structure. For aircraft, whether military or commercial, stress and corrosion monitoring easily come to mind. It follows that instrumentation of expensive oilfield intelligent

completions to monitor their lifetime health and gather distributed production information could become a high-value application area within tough cost and reliability constraints. Technology does not therefore seem to be a barrier to intelligent energy.

So far I've said very little about people. It is here that we have a more significant challenge. Intelligent energy concepts linking people and technology are already enabling us to use our human resources more effectively. Gathering experts in remote operations centers offers the opportunity to use their expertise more widely and to bring greater support to the younger generation of engineers that the industry has actively recruited over the past three or four years. But we will have to move even faster as the experience profiles within our industry clearly indicate.



The typical experience curve of the Western oil company in 2005 showed few new recruits and a peak of experienced staff preparing to leave industry over the years to come. Partly as a result, the industry responded through extensive recruitment leading to a much improved profile by 2010 as a generation of new engineers and scientists joined the industry. Yet this will not change the retirement effect and the challenge of bringing a new workforce on line faster remains. Competency development and knowledge management practices will play significant roles and add to the effect of new technologies and processes. This will demand change in the way we work, change in the way we train, and change in the way we expect tomorrow's workforce to arrive at technical decisions.

Once again, we can look at other industries to see how they are managing similar challenges. To remain consistent with my previous analogy, the global airline fleet is expected to double over the next 20 years. Flight training institutions estimate that they will need to train some 16,000 new commercial airline pilots every year over this period to meet both growth and replace retiring baby-boomer aircrew who often gained their training in the military. The training methods of the past will not suffice. The time is simply not available to allow pilots to proceed to captaincy in a

sequential manner moving from smaller to larger aircraft. New methods of simulation and visualization will help develop knowledge and promote experience sooner. New training programs are expected to take the new pilot directly into the co-pilot's site of the airliner in less than a year. Better prepared instructors will be required to create practical real-world learning scenarios in which judgment can be developed and exercised. Continual learning will be needed at all stages. All in all this doesn't sound very different to the training and development challenges that we face in the E&P industry.



The slide is titled "Final Thoughts" and features a dark blue background with a faint image of a person's hands. It contains three bullet points:

- The challenges for intelligent energy are many and include new field developments in harsher and more complex environments. Innovative technologies from other industries will help
- Increasing integration of information about the reservoir and the assets deployed will enable operations with dramatically improved safety, reliability and effectiveness
- The training and development of people will be critical

The Schlumberger logo is visible in the bottom right corner of the slide.

Ladies and gentlemen, I think we all know the age of easy oil is over and the way ahead will be more complex and more costly as we add production to meet the growth in demand while continuing to maintain the production we enjoy today. The challenges for intelligent energy include new field developments in harsher and more complex environments such as deep water and the arctic, a greater emphasis on exploring for and producing unconventional resources that include heavy oil, tar sands, oil shale and coal-bed methane, and a need for more real-time data to manage production and risk. Increasing integration of information about the reservoir and the capital assets deployed will enable oilfield operations with dramatically improved safety, reliability, and effectiveness as measured by both ultimate recovery factor and financial profitability. Measurements of rock and fluids must extend farther from the near-wellbore to cover the entire reservoir. Cables, drill pipe, tubing, umbilical pipes and seismic streamers must be instrumented at high spatial resolution to provide real-time information about their state of health to trigger replacement or maintenance at the most cost-effective yet still safe time. Data must be combined and processed intelligently to focus the operator's attention on the salient bits amidst the flood of information.

Taken together with the human resources challenge this sounds very much like a roadmap for intelligent energy. So, in answer to the organizers' questions, I consider that we have already made substantial progress in a number of the critical areas of technology and process that intelligent energy will demand. But at the same time, we must not neglect the degree of change

that the future will exact. Finally, if indeed there is a gap between corporate vision and field reality, then that will depend on people and I expect that our collective imagination will find a way to respond.

Thank you very much.