Technology makes the difference: pursuing advances for business & society

Phil Watts*

Technology is central to energy companies' performance, prospects and ability to contribute to society. Continuing advances are essential for meeting business challenges and responding to societal expectations. Technology success depends on people's skills, understanding and creativity. Shell companies are committed to developing technology in such areas as geophysics, integrated subsurface modelling, intelligent wells, deepwater engineering, gas liquefaction and gastoliquids. They systematically encourage and harness the creativity of Shell people and engage with the wider scientific community. They have developed new processes for utilising technology more effectively in their worldwide operations, for example in cutting drilling costs. They gain additional value from commercialising innovations.

All companies today rightly focus on the bottom line. In such a competitive and demanding environment, any business which didn't would soon regret it. But some of you may feel the role of technology and of those who develop and use it has been downplayed in the process.

I believe technology is central to our industry to our present performance, future prospects and ability to contribute to society. And our success depends more than ever before on the skills, understanding and creativity of our technologists. So I am very glad to have this opportunity to stress my own belief in technology and to tell you how we think about it in Shell.

A personal journey

Like most of you, I suspect, science caught my imagination at school. I went on to study physics at university, in Leeds. When I graduated I was idealistic, perhaps even unrealistic, and wanted to use science to help people. So I spent two years as a teacher in Sierra Leone. This was a humbling and formative experience. I would recommend such an opportunity to any young person.

But something worried me. I was teaching science to bright and able students who had very little chance of getting a job in which they could use it. So I decided to go into industry. Where I thought science could be put to use through technology to benefit people. Where it could help meet people's needs, provide jobs and create wealth.

Of course, like most people, I was also attracted by the prospect of an exciting, stimulating and rewarding career, involving foreign travel. But, again like most people, l also wanted to feel that what I was doing was worthwhile.

So I went back to university to study geophysics and became a Shell seismologist in 1969. I quickly found myself in Borneo and Java. It certainly lived up to my desire for excitement – jungle, swamps, volcanoes and deep water. I then went on to manage exploration, in Norway where there was a different kind of excitement in the discovery of the giant Troll gas field in 1979 and then here in the UK.

In due course, I progressed into wider management. There have been two constant themes: the need to respond to increasingly tough business conditions with volatile prices and intense competition, and the need to engage with society understanding and responding to people's concerns and expectations.

And, like others in this industry, I have come to recognise that the energy we produce on which the world depends may also threaten vital natural systems. However, I remain highly optimistic about the power of technology, driven forward by the competitive vigour of business to meet this and other challenges.

As a Royal Dutch/Shell Group managing director, I am responsible for the Group's global Exploration & Production and Downstream Gas & Power businesses. These are challenging portfolios, in challenging times.

The oil price has bounced back with a vengeance, but we would be ill-advised to let up on cost leadership, performance improvement and portfolio management. There are still tough decisions to be made for the future. But we continue to focus on technology in Shell, more so, I think, than some of our competitors.

*Managing Director of the Royal Dutch/Shell Group.

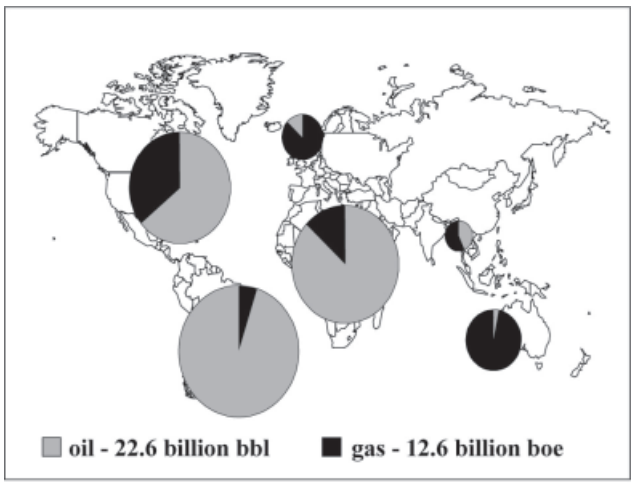

Figure 1 Global deep-water oil and gas discoveries to mid-1999 (in greater than 500 m water depth).

The seismic adventure

Geophysics is now a far cry from when I started. Seismic acquisition was just converting from analogue to digital equipment, and processing was pretty well limited to stacking the data. But the digital revolution was beginning. As we all know, it was to transform seismics and the industry. Digital recording allowed computer processing of the data using techniques originally developed in communications theory and eventually the use of 3D seismic images.

Shell was among the first to use 3D commercially starting with a survey at Schoonebeek in the Netherlands in the mid 1970s. Seismic migration went from being a special process to a 'must have'. 3D seismic greatly reduced the uncertainties in drilling high cost wells. This was particularly important in the North Sea. With growing confidence in the technique, Shell companies led the industry in committing to 3D in the 1980s. At the beginning of the decade, we were recording just a few hundred km^2. In 1991, we shot nearly 18 000. I remember it often took a lot of persuading to convince sceptical partners that 3D was worth the extra cost as can still be the case with new tools. 3D started off as a tool for development and appraisal. Initially, we only used it over producing fields. But as seismic contractors vied with each other to add more and longer streamers, larger gun arrays, and bigger and bigger vessels, it became possible to shoot 3D economically over much wider areas.

Indeed, it became the economic way to work. Trying to connect up the many 'postage stamps', as we called small surveys, led to huge overlaps and additional costs. So we changed to carpeting an area with 3D what I called 'wall to wall' seismic. Of course, 3D is no longer the exclusive preserve of the seismologist, but part of an integrated multidisciplinary drive to understand and model subsurface structures, properties and fluid content, and to reconstruct the processes that created them. Integrating seismic data within the petroleum life cycle remains a key driver.

During the late 1980s, we used 3D seismic within Shell as an example of successful technology dissemination. Quickly disseminating new techniques and sharing learning remain fundamental. Geophysical technology continues to advance within the industry. I believe we can still claim to play our full part. Seismic imaging continues to be driven by technology advances in migration. We have continued to focus on this area. Prestack imaging and prestack depth migration are now applied routinely to entire 3D data sets providing much clearer definition.

Old surveys are being reacquired with new techniques, such as this high resolution survey in Brunei. Or, with those which provide new images, such as multicomponent seismic. These developments are vital to exploit other industry developments, such as the accurate targeting of multilateral horizontal wells.

Now, a new dimension has been added to 3D time. Time-lapse, or 4D, seismic can be used to track production in the reservoir seeing what is left behind and where. Norske Shell used time-lapse seismic on the Draugen field updating a 3D survey done just before production started in 1993. They found the expected water flow had been disturbed by a fault. They changed the planned location of a new well and were rewarded by record production of over 70 000 barrels a day.

There is bound to be increasing focus on maximising production from mature reservoirs. We see 4D as a key technology for doing this. Other seismic techniques have also developed rapidly, in particular in the field of visualisation and interpretation. We are all now familiar with large scale visualisation CAVES, although the technology has only been available a couple of years. Such 'reality centres' are important for developing shared understanding among multidisciplinary teams. We are working to extend visualisation on interpretation workstations and desktops to allow us to work together in worldwide 'virtual' teams. We are even experimenting with a device called a 'haptic' mouse to extend

our sense of the subsurface to actually 'feel' it. It seems a long way from the jar of colour pencils which was the primary visualisation tool when I was practising the trade on paper sections.

But one thing hasn't changed. Whatever the advances in technology, the results still depend on the skills, understanding and imagination of interpreters. The quality of the people matters more than ever. The development of seismology has been one of the great adventures and fundamental transformations of this industry. It certainly hasn't come to an end.

A technology palette

But, of course, geophysics is very far from our only technology. Let me try to give you just a flavour of the range of advanced techniques we are developing or applying in Shell. Seismic data are just one source of date for integrated subsurface models combining static geological and dynamic flow models.

In Shell we have continued to focus on developing proprietary modelling and simulation tools when others have been moving to third party products. We believe we get very good value from this investment. We began producing from the Leman field in 1968. It was expected to last 20 years. By using the latest technologies we now expect to keep producing until at least until 2020. For example, a visualisation of the top of the reservoir from a 3D seismic volume shows the complexity of the faulting. Reservoir modelling then determines the extent of the remaining gas reserves which can be accessed with horizontal wells.

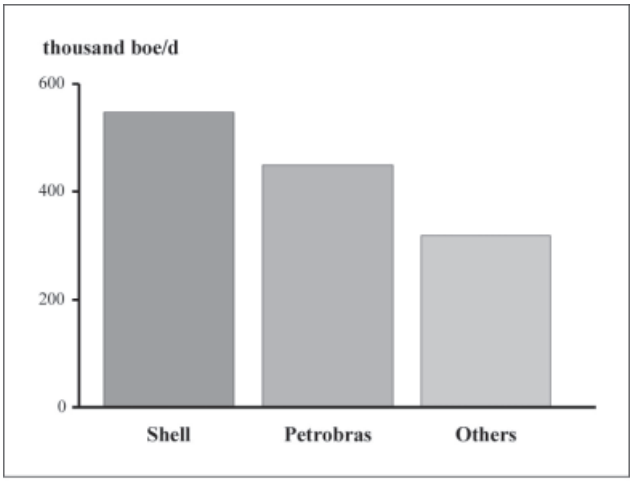

Figure 2 Deep-water operated oil and gas production mid-1999 (in greater than 500 m water depth)

Integration is being extended from the subsurface to surface facilities from reservoir to point of sale. For example, integrated subsurface and surface modelling of Sole Pit area gas fields, in the southern North Sea, enables Shell Expro to optimise development very important when costs are being driven down in liberalised gas markets.

3D seismic transformed our industry in the 1980s. In the 1990s, the prize goes to the progression of major advances in drilling long reach, horizontal, slim, multilateral, coiled tubing. The impact of such advances is illustrated in the Yibal field in Oman, still the country's most important producer three decades after coming onstream.

The ability to extract more from such mature fields will be a vital thrust and an important competitive advantage as major resource holders call on the international industry's expertise.

As with seismic, advances in well technology have certainly not run out of steam. They may be just beginning. Wells are getting smart. Combining multilateral extensions, real time measurement of reservoir conditions, automated control and downhole processing will allow us to manage reservoir performance much more effectively and with less environmental impact.

We have been putting a lot of effort into developing Shell intelligent well technology. But we believe the real rewards, which will be very substantial, will come from building integrated systems. So I am particularly pleased that Shell has formed the Well Dynamics joint venture with Halliburton combining a range of technologies and complementary experience.

One area where such wells will have particular value is in deep water because of the high cost of well support. Deep water is one of hottest topics in our industry. Over 35 billion barrels have been discovered in water over 500 m deep (Figure 1). Shell is the leading deepwater developer, with worldwide operations (Figure 2).

As you can imagine, there are huge technological challenges in extending into deeper water. Relatively few fields have been developed in over one kilometre of water. Our Ursa platform was installed in 1100 m in the Gulf of Mexico last year. But the industry's sights are already set on even deeper possibilities. The weight of the fluid column on unstable formations is a major challenge for deepwater drilling. Shell is

developing a subsea system to pump drilling fluids from the seabed.

Another key issue is how to extend drilling reach while retaining the well bore to enable the high productivity deepwater economics require. Shell expandable tubular technology expanding pipe diameter in situ offers a solution.

Others challenges involve remote intervention, extending subsea flowlines and assuring flow, and developing ultradeep platform concepts. I am optimistic we will continue to advance. But there is another important point. Deepwater is unforgiving, physically and economically. There's no tolerance for failure. Success depends on integrating a range of advanced technologies. Experience helps.

Deep water is one source of new resources. Oil sands are another. Shell Canada's Athabasca oil sands project uses the latest low temperature extraction techniques, environmentally friendly water recycling and gas-fired cogeneration, and hydrogen upgrading. It will produce high quality fuel for North American motorists. What is important is that the technology for exploiting non-conventional resources, if that distinction now has any meaning, is developing very rapidly. Present high oil prices shouldn't blind us to the competitive pressures. The ability to develop and harness new technology will be essential for commercial success, even survival. People who work in the LNG business know what competition means.

There are always more potential projects chasing buyers than the other way round.

Shell LNG designers have been able to drive down the capital and also operating costs of LNG plants (Figure 3). There is no magic bullet. It depends on a comprehensive toolkit of technologies.

But it's really about people developing a cadre of experts with shared experience of research, design and operations. This hard won technological competence provides the judgement to push limits, for example in installing the largest ever processing trains in the new Oman LNG plant. The plant, which exported its first cargo last month, is the cheapest ever greenfield development. We continue to expand our LNG toolkit. Floating LNG plants offer the possibility of commercialising smaller offshore gas fields. Our floating concept has been matured, is very competitive, and is ready for commercial application.

We believe our proprietary gas to liquids technology has an important future. It is already proven at a commercial scale in Malaysia. A breakthrough in catalyst technology in our

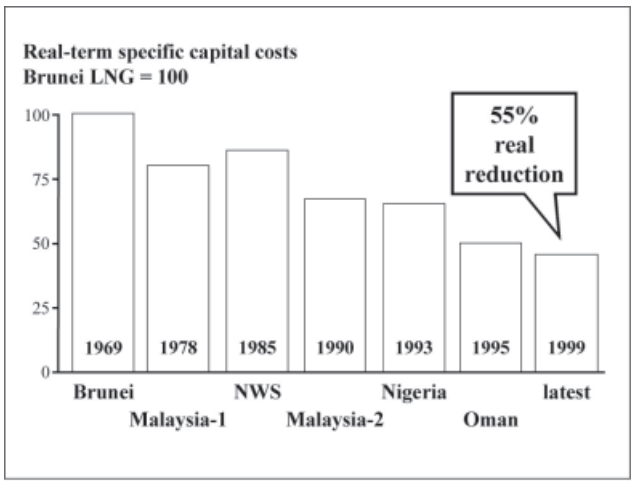

Figure 3 Reducing capital costs—Shell LNG plant design 1969–99.

Amsterdam laboratory has cut costs significantly. Gas to liquids now offers an alternative to LNG or complementary building block for commercialising distant gas reserves. It delivers ultraclean, high quality products in increasing demand as fuel quality standards rise.

Power generation is another way of extending the gas value chain from molecules to electrons. We see it as a vital extension of our gas business helping add value from retail to reservoir. Our main power vehicle, InterGen, is a leading independent power developer with a worldwide portfolio. It applies advanced generating technology to maximise efficiency and minimise impact. For example, its Rocksavage combined cycle gas plant is guaranteed to achieve 58% thermal efficiency, the most efficient such plant in Britain.

There is only time to offer a flavour of some of the technologies which excite us. But having these is only part of the story. Let me turn to the vital question of making the most of technology.

We continue to stress our internal capacity to develop technology in world class research centres in Rijswijk, Amsterdam and Houston. These laboratories work in both revolutionary research seeking the new ideas which will change our industry and evolutionary research pushing forward existing technologies. They also provide first class technical services to Shell operating units. But we're not so foolishly arrogant as to think we can rely totally on our own capabilities. We need to engage with the wider technology community, not

just for new ideas but to inject new thinking into our organisation. So we are developing alliances with key technology institutions around the world, from Delft Technical Institute to the Colorado School of Mines, NTNU in Trondheim to the Russian Academy of Sciences. These provide a platform for working together and sharing resources. As well as working with others, it is important to learn from different industries.

The computer games industry provided virtual reality techniques to help plan operations more cost effectively and safely, for example depicting the seabed 1000 m down off Nigeria where we are installing the facilities for the Bonga field. But we don't only seek a flow of ideas from outside. We need to encourage and harness the creativity of all Shell people. Our Gamechanger scheme encourages people to put forward ideas to a panel of their peers to be accepted or rejected within one seek. Money is available to work them up quickly before review by technical and commercial experts. Then a structured process seeks to prove value and feasibility or otherwise as quickly as possible.

Of course, innovation is not just about ideas but about implementing them to create new value, combining ideas, entrepreneurs and resources. Gamechanger acts as an internal venture capitalist. The focus throughout is on developing new business propositions to change our own game or commercialise.

The results have been striking in such areas as cheap exploration, smart wells, non-conventional energy, energy conversion and environmental improvement. Incidentally, Gamechanger has also been used externally encouraging ideas from Russian technology institutes for possible co-operative development. We see commercialisation as a way of extracting maximum value from rapidly deploying a technology while encouraging continued development and staying ahead of the learning curve. We have just formed a joint venture with the Beacon Group to develop new energy technology businesses. Beacon is a leading New York based private equity investor specialising in the energy sector in which it has already invested nearly $900 million. It's a very good reality check on a commercialisation proposal to see if a successful technology entrepreneur is willing to invest its own money in it.

The first venture of the partnership involves our Twister supersonic gas separator which has no moving parts, produces no emissions, is much smaller and saves lots of money. We expect it to sell well. But it is no good being creative if you don't apply the advances in your own operations as quickly and effectively as possible. This is particularly important in Shell, with our very wide operating responsibilities.

It's not a new challenge. I mentioned 3D seismic and LNG design as areas where we did get our act together, the trick is to do the same with everything. And, in today's competitive environment, to do so very quickly. We put a lot of effort into this. For example, Shell Deepwater Services has been established to use our deepwater development experience from the Gulf of Mexico around the world. And we use a range of communications techniques from web forums to worldwide business television.

The important thing is to harness people's experience systematically. Our 'Drilling the Limit' process has proved particularly powerful. It starts by understanding what is required to perform each aspect of a job perfectly, the 'limit' with present technology, and then pursues this perfection. Shell companies around the world have reduced drilling costs by more than 20% on average when they use it. Drilling times were halved here in the UK. In the Gulf of Mexico deep water, we drilled twice as fast as our benchmarked competitors (Figure 4).

We are applying similar techniques to maximise the value of our subsurface knowledge, make the best use of capital and increase production. Putting it all together, we call it all 'Realising the Limit'.

As you will have guessed, I think technology matters a

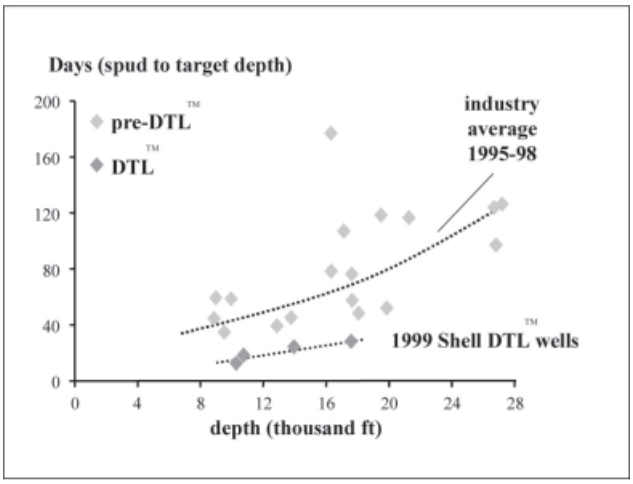

Figure 4 Drilling the Limit™—Shell Gulf of Mexico deep-water exploration drilling.

great deal. Energy industries face tough challenges, including: recovering more from mature reservoirs, accessing more difficult resources, achieving higher operating standards, profiting in highly competitive markets, finding new opportunities to squeeze costs, coping with volatile prices. Technology is the prime means of meeting such challenges as well as achieving competitive advantage and seizing new openings.

It is also vital for delivering those higher standards society requires, such as: safer operations; less intrusive seismic acquisition; slimmer, more productive wells; downhole oil and gas processing; smaller facilities; and reduced emissions and discharges. That is to say a lighter, smaller operational footprint. More fundamentally, our energy systems need to evolve in response to developing needs and concerns. We will need 'conventional' energy for a long time. The role of gas will be particularly important in reducing carbon dioxide emissions. This is a continuation of the century long decarbonisation of energy as energy companies have responded to the needs of their customers.

Evolution depends on technological innovation. I don't believe there is any practical alternative. And, as I said at the beginning, I am optimistic about the possibilities. It is already happening – cleaner fuels, hydrogen fuel cells, renewable energy. Let me give just one example. One idea from our Gamechanger process was to use gas-powered solid oxide fuel cells to generate emission-free electricity reinjecting the carbon dioxide, which is easily captured from such plants. We are pursuing the possibilities in a joint venture with Siemens Westinghouse. The obvious first market is power generation on offshore platforms, particularly in Norway where operators pay a carbon tax. The first test plant is being installed onshore in Norway.

The ability to develop and apply technology is at the heart of our businesses. It supports all the other business thrusts – meeting customer needs, adding value, achieving competitive differentiation, responding to regulatory requirements and societal pressures.

At least, that is what we believe in Shell. Others seem more inclined to give up on technology, to rely only on the market. We think this is a mistake. Time will tell. A capacity to drive forward technology doesn't grow on its own, like the weeds in my garden. It has to be carefully nurtured, like the rarest orchid. It's about people attracting the best, developing their skills, extending their experience, organising them to work together, encouraging and harnessing their creativity, valuing them and what they do.

I have no doubt that applying technology in this great business offers an exciting and stimulating career – full of challenge, responsibility, and opportunities to achieve. I also have no doubt it is a worthwhile thing to do – contributing to society which depends on our energy and looks to us for solutions. I think I made the right choice 30 years ago. It has been fun and my belief that technology makes the difference is undimmed.