Researching the future

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In 1948, we opened our first research centre in Ridgefield, Connecticut. Located a short drive from New York City, the centre, over the years, became home to more than 140 scientists focused on challenges in formation evaluation. Perhaps the location encouraged creative thinking through its relaxed environment, or perhaps its early position on the world's largest oil and gas producing continent made it the right place to be. Either way, as the company grew, so did our needs in research and a second centre was opened in Cambridge, UK in 1982. The intervening 35 years had seen considerable change in the industry with activity beginning to move east to follow the development of new oil and gas areas. The benefits of Cambridge, however, not only as a centre of academic excellence but also as a city close to hydrocarbon activity in the North Sea were apparent. Proximity to academia brought talent, being adjacent to growing business brought customers and investment. These two ideas remained as our world of research developed further and they lie behind the move of our first research laboratory from Ridgefield to Boston, Massachusetts in 2008.

At the same time the world of IT enabled communication around the world. Remote centres could exchange information more easily and more quickly. Partly as a consequence, our next research centre openings were much smaller – in Stavangar, Moscow, Dhahran and now Rio de Janeiro. In each case we were following the expansion of exploration and production activity while remaining close to customers and close to academic centres of excellence. It was as if the ideas of the laboratory could be tested in a customer field almost immediately.

Within any technical field, and certainly within oil and gas development, research is an essential activity. This is becoming more and more important as easier hydrocarbon supplies become exhausted. Reservoirs are becoming more complex, their production more difficult, their location more remote, and their environmental conditions in terms of temperature and pressure more extreme. So while research must address harder problems, its real purpose remains unchanged. And that purpose is perhaps twofold. First there must be a certain amount of fundamental work, where the question to be answered is often the question itself and where the impact on the business is difficult to measure. The potential of such a project is usually large, and failure to succeed should not be a surprise. Second, we must also engage on projects that consolidate earlier work. This sometimes becomes easier as enabling technologies are developed elsewhere. In this case, the question is known, the impact easier to measure, while potential and risk are much better known. We should still not be surprised by failure, however.

But above all, research must support new product development, and while this means solving hard problems and looking at new technologies, it is driven by needs from both inside and out. Advancement occurs by the creative solution of hard problems and our purpose is to develop technology for where the business is going to be in three to 10 years time.

This means that our research activity is characterised by three things.

First, taking such a long-term perspective allows us to make step changes in technology performance. At its best, research allows us to reduce and overcome scientific risk so we can direct our investment in areas of technology with higher confidence of substantial commercial success.

Second, the fundamental scientific understanding we develop gives us economies of scope. In other words, the science developed by research over our history can be applied to other oilfield businesses. And we can leverage this fundamental understanding to rapidly develop and deploy new differentiated products and services across our technology portfolio.

Third, no company has all the resources to overcome the technology challenges in the oil and gas industry all by itself. We must choose where we lead, and by effective networking and collaboration on a global basis gain access to complementary resources to extend our science and technology footprint to cover commercially valuable areas.

Within Schlumberger, the research and engineering organisation exists to deliver the new technologies needed by three product groups – Reservoir Characterisation, Drilling and Reservoir Production. These are aligned with the workflows of our customers as they move through the natural stages of exploration, development and production of oil and gas resources. Our six research centres cover a geographical and technical footprint that supports a worldwide engineering, manufacturing and sustaining organisation of 65 centres in 15 countries employing 15,000 people. Such geographical diversity offers a significant advantage beyond proximity to customers and academia in harnessing 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 while Singapore

- is developing expertise in project conception following its success as a manufacturing base

The three factors that characterise our research guide almost all of our current research themes. Perhaps the best way to see this is to look a number of examples.

The first is the optimisation and control of the entire drilling process. While integration of the different components of the drilling system, both in the drillstring and with the drilling fluids, can considerably optimise that process, we are now seeking a step change that can best be described as safe, reproducible drilling performance. The goal is to achieve predictable consistency, assure repeatability, improve efficiency and reduce the cost of well construction.

This involves some fundamental science around the mechanics of drilling, as well as in the automatic algorithms that mirror how humans evaluate data and take steps to control. The area is sufficiently fertile to have broad application and the control and automation of the drilling system is only the first in what we see as the deployment of automation and control in reservoir management, particularly in completions and reservoir monitoring. It is particularly timely, since automation is becoming recognised as essential for the continuous observation and control in oil well drilling.

It also involves networking and collaboration. For example last December we conducted a test in Texas that compared a human driller against automatic methods for controlling a drillstring. Drillers control the rate of penetration through the weight on the bit and the speed of rotation. Humans can be conservative – too much weight stalls drilling, and too much rotation causes excessive shock and vibration. The experiment showed that with continuous measurements of downhole power and motor speed, an algorithm could optimise weight on bit and rotation to triple the rate of penetration. These are early signs of the potential we see to create step improvements in the drilling process. Although some integration of the drilling system components helped make this happen, we also need a network to access the components for drilling technology from a number of small start-ups and academic institutions.

Modelling provides rapid-response testing of research theory

A second example is the family of technologies that is driving sensor miniaturisation. This is aimed primarily at the needs of reservoir characterisation. Industries such as wireless telecommunications have profited from enormous strides in miniaturisation – the development of mobile phone handsets is one of the most striking examples as devices have become more sophisticated with ever expanding functionalities fitting into ever smaller packages at rapidly decreasing cost to the consumer.

The step change in performance will come from achieving comparable changes in oilfield sensors. This is driven by the need to characterise ever more complex reservoirs in greater detail, yet we are currently hampered by practical engineering limitations of size and weight, and more challenging environmental conditions of pressure and temperature – all of which limit deployment – as well as the prohibitive cost of implementing more sophisticated measurements.

Miniaturisation makes possible several technology directions to address this. The obvious is packing more functionality into the same footprint, as well as by making completely new measurements enabled by physics and chemistry at these scales. One of our best examples, which has already reached commercial service, is an instrument that packs a grating spectrometer along with a number of other miniaturised sensors capable of measuring the downhole properties of reservoir fluids in situ. The tool is only a few inches in diameter but is capable of supplying real-time information from the bottom of a well to surface.

But more interesting is the fact that the same underlying technology can be deployed on several modes of conveyance – on wireline, logging-while-drilling, completions instrumentation, and perhaps even drill bits – meaning that downhole sensing has the potential to be far more pervasive than anything we've contemplated before. But most exciting is that our thinking on the architectures of the platforms for such sensors has fundamentally changed and that we now see the possibilities for proliferating measurement technologies across many different services.

Technologies from other industries

In terms of fundamental science, we are well-positioned to profit from the enormous advances in academic and industrial science in the fields of microfabrication in silicon and other materials, driven by electronics VLSI, of microfluidic lab-on-chip developments for the biomedical and life sciences, and of fiber optics and photonics for the telecom and instrumentation industries. But it's not a straightforward transplant from those industries as there are key challenges in implementing these technologies in materials and forms robust and reliable enough to be practical and useful for the oilfield environment.

To make this happen we need to tap a wealth of external expertise via a network of contacts and collaborations with university partners and with other companies outside the oilfield. Over the last three years, we believe we have established leadership in the longer term science themes for the application of nanotechnology in the oilfield that we expect to have application in deepwater, in hydrocarbon recovery, and in unconventional resource development.

My last example concerns reservoir production for materials for applications in cementing and stimulation. Materials form a vast area where myriad needs exist in harsh environments – high pressure, high temperature, corrosive conditions. Above all we seek to make step changes in services for well integrity, pressure pumping and completions. For example for well integrity, we are interested in making a step change in the performance of cement by designing composites that can be used in extreme high temperature or extreme low temperature environments where appropriate products do not exist today. For stimulation and completions we are pursuing directions in so-called "smart materials", materials which can change their mechanical and chemical behaviour in response to environmental triggers, expecting to achieve step changes in efficiency compared to the mechanical solutions available today. Our investigation into functional materials has many potential applications – a basic one is using such materials to cleverly place proppant to maximise productivity.

Like other step changes, this theme too requires some fundamental science. One major change in the last five years has been the ability of computer modelling to predict the macroscopic behaviour of materials. When married to experimental methods in characterisation this has allowed us to pursue a couple of major themes around functionalising new materials – the intelligent combination of material components to alter properties – in some cases mechanical, in others chemical. Indeed fundamental investigation into cement has allowed us to develop a more complete understanding of its setting under extreme conditions – leading us to believe we will be able to design superior cement materials in the future.

Each of these examples highlights the principles that guide research and engineering in Schlumberger today. Whether we are seeking to exact a step change in performance, gain a deeper understanding of fundamental science or develop knowledge through collaboration and partnership, a common organisational framework ensures that the necessary investment is correctly apportioned. When Schlumberger published its first annual report in 1957, the report carried the subhead "First in the Field, Foremost in Research". Today, Schlumberger remains consistent in that purpose and intent, although research has by necessity evolved in order to serve the future needs of the business. ■