

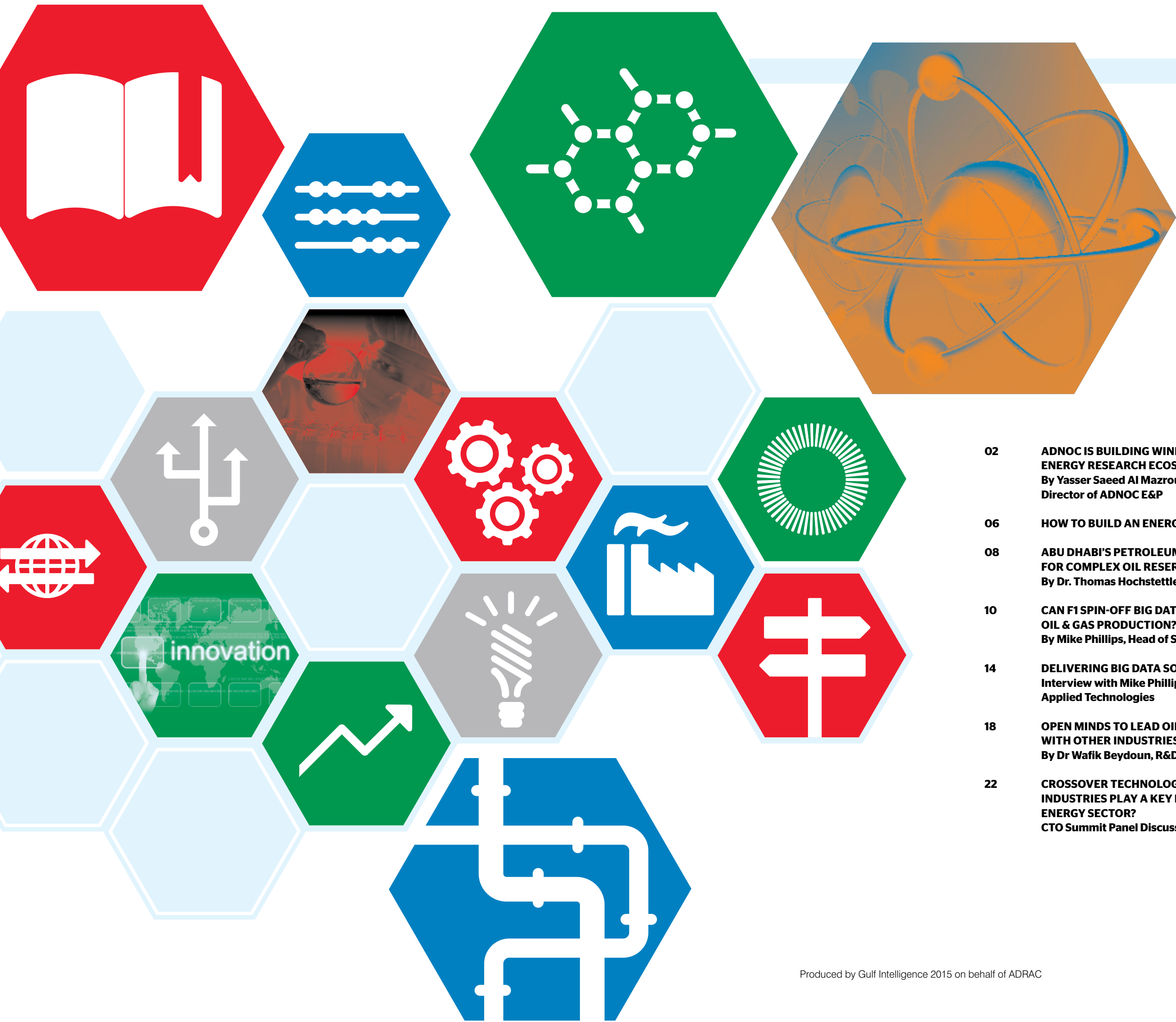


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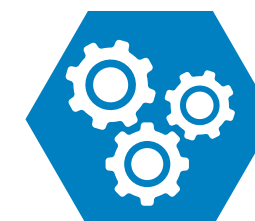


Driving R&D from Innovation to Motion!





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Driving R&D from Innovation to Motion

*ADNOC is Building Winning Strategies to
Create an Effective Energy Research Ecosystem*

**By Yasser Saeed Al Mazrouei, Chairman of ADRAC
2015 and Deputy Director of ADNOC E&P**

Building on its foundations as one of the world's biggest oil companies, to establish a pioneering energy research and development hub in Abu Dhabi is a logical extension of ADNOC's existing capabilities that will stand proudly alongside the UAE's declared ambition to put the first Arab probe on Mars by 2021.

The government of the United Arab Emirates has declared 2015 as the Year of Innovation. The aim of this initiative is to enhance the country's global competitiveness by setting it apart as a world innovator within a 7 year period. To reach this ambitious goal, we do realize that innovation & technology are neither an option nor an alternative. They are a necessity and prerequisite for the UAE to ensure sustainable development through the growing demands of the 21st century.

ADNOC has moved swiftly over the last decade to build the foundations for a world-class energy research ecosystem in Abu Dhabi, and allocated significant funding towards this project that has grown year-on-year. It is equally critical, however, for the country to address timely and relevant research challenges, leverage on opportunities arising from the UAE's role as a major hydrocarbon center, focus on ensuring that R&D is employable not only in the UAE but also in other Middle East states and the rest of the World.

At the core of this research strategy is to deliver a roadmap for the ambition to exploit our oil reservoirs to levels far beyond current levels, to reach 70% recovery rates, which is double the world average. Some people think this is an unrealistic target, but we think it is unrealistic to leave 30% un-recovered underground. Considering the US Geological Survey estimation of conventional petroleum resources, a 1% increase in recovery could yield what is equivalent to three years of the current worldwide production level.

Over the years, ADNOC's business model of collaboration with International oil majors, such as Total, Shell, BP and JODCO, has enriched our collective experience. The same level of synergistic collaboration has been extended in the field of research and development to include the service companies, such as Schlumberger, and academic institutions.

The UAE was the highest ranked Arab country in the 2014 Global Innovation Index, and in the ADRAC 2015 Industry Survey 44% of respondents said that the most important contribution that international energy companies partnering with ADNOC could contribute to help elevate the UAE



to a top 20 country in R&D was to locate mission critical research labs in the UAE that support global operations. While 28% of respondents said IOCs could also support the ecosystem by providing services to Incubate, Mentor and Partner with young local Innovation Entrepreneurs.

The Abu Dhabi International Research & Development Conference & Exhibition, ADRAC, was established in 2012 by ADNOC as the first international R&D conference to be held in the Middle East to bring new ideas to life in the region for future deployment in the region.

"The ADNOC Research Center, a world class upstream research center focused on EOR in carbonate reservoirs, will be the latest addition to the Abu Dhabi R&D ecosystem when it opens later this year."

The technological advances and the significant investments made globally and regionally in R&D are already evident: from the CO₂ injection projects in UAE, the Middle East's successful EOR initiatives in Oman and heavy oil field pilot developments in Kuwait to the world's first solar plane circumnavigating the globe starting from Abu Dhabi.

The challenges are inevitable but fortunately addressable if a pragmatic approach is employed, with such essential building blocks like The Petroleum Institute University and Research Center established in 2001. Similarly, with challenges are opportunities for creating a niche energy R&D center of excellence that sits in the middle of a region that is 3 hours flying time from a third of the world's population.

In the interim years the PI has been joined by The Takreer Research Center, which is focused on refining petroleum products, such as overseeing process modeling and product development; The Borouge Innovation Center that focuses on petrochemical products, such as the development

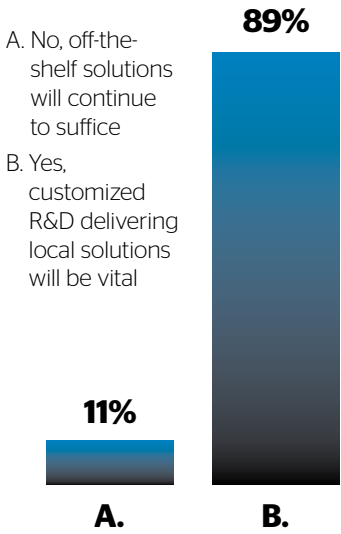
of pipe, film and molding applications; and the Gas Research Center that addresses the current and emerging challenges of all disciplines in gas processing and development.

In spite of the current downturn in the oil and gas markets, ADNOC's strategy remains focused on investing in and fostering the intellectual capabilities of its staff through enrolling employees in focused higher education programs, and attentive efforts are made to ensure efficient integration of cutting-edge technical solutions in the field. Perusing fundamental and applied research is given a high priority to achieve this goal.

The ADNOC Research Center, a world class upstream research center focused on EOR in carbonate reservoirs, will be the latest addition to the Abu Dhabi R&D ecosystem when it opens later this year. The Middle East hydrocarbon field's landscape is dominated by the giant carbonate fields with many reaching maturing phase, and 89% of respondents to the ADRAC 2015 industry survey said customized research solutions would be needed to reach future production target levels. 

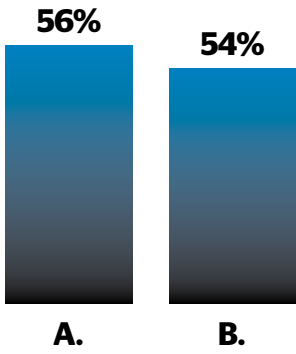
How to Build an Energy R&D Ecosystem for the 21st Century?

Q1 Abu Dhabi is in the midst of renewing its onshore concessions for 40 Years after the previous 75-year-old concessions expired in 2014 – will bespoke in-country R&D be more important in the coming decades to reach production targets than it was in previous decades?



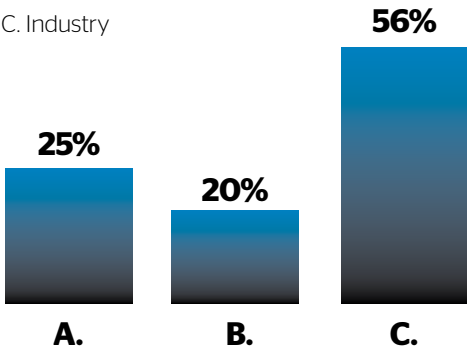
Q2 The most influential advances may not be new technologies, but rather, innovative combinations of existing technologies or processes – for Technology Optimization & Deployment, is it Better to be:

- A. An Early Adopter
- B. Fast Follower



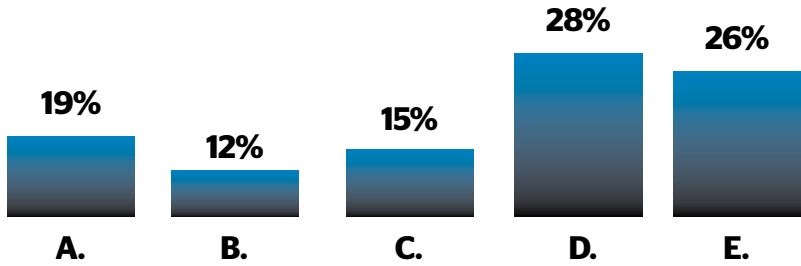
Q3 Basic or pure research is conducted solely for the purpose of gathering information and building on existing knowledge, as opposed to applied research, which is geared towards the resolution of a particular question – Which stakeholder bears the greatest responsibility to ensure that Abu Dhabi's emerging R&D eco-system can deliver Applied Research?

- A. Government
- B. Academia
- C. Industry



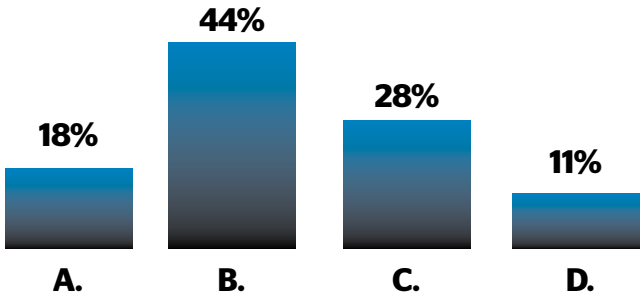
Q4 Over the next 20 years, which of the following technologies will have the biggest game-changing impact on the oil and gas industry?

- A. Big data & analytics
- B. Automation & Robotics
- C. Nanotechnology
- D. Advancements of existing EOR technologies
- E. None will stand out over the others



Q5 The UAE was ranked 36th in the 2014 Global Innovation Index, and ranked 44th within the R&D category – What is the most important contribution that international energy companies partnering with ADNOC can contribute to help elevate the UAE to a top 20 country in R&D?

- A. Help meet the funding gap as UAE currently ranks 59th in financing R&D
- B. Locate mission critical research labs in the UAE that support global operations
- C. Incubate, Mentor and Partner with young local Innovation Entrepreneurs
- D. Achieve gender balance in all levels of employment





Abu Dhabi's Petroleum Institute Seeks Increased Productivity for Complex Oil Reservoirs with Bespoke R&D Solutions

Dr. Thomas Hochstettler, President, The Petroleum Institute

Investment in research and development (R&D) can be considered as buying down the risk that a country or organization faces.

For The Petroleum Institute University and Research Center, and our main shareholder ADNOC, the reason for investing in R&D is to have a laser focus on delivering bespoke solutions to the particular challenges that Abu Dhabi is confronting in what are complex oil reservoirs. The absence of a local R&D capacity could in due course result in serious problems.

Innovation and R&D have become top priorities

for all governments in the region in recent years amid recognition that in an increasingly globalized world, a country's competitive edge and ability to attract foreign investment will largely be determined by its ability to gain competitive advantages through innovations.

The Petroleum Institute was established in Abu Dhabi in 2001 with a goal of becoming a world-class institution in both engineering education and energy industry research. In pursuit of this goal it now has some 2000 undergraduate and graduate students, over 200 faculty, and in the last decade has become

"The Petroleum Institute was established in Abu Dhabi in 2001 with a goal of becoming a world-class institution in both engineering education and energy industry research."

a leading teaching and research institution in the Middle East region.

The campus has modern instructional laboratories and will soon host a major research center, the PI Research Center (PIRC) scheduled to open in 2015 with a focus on Enhanced Oil Recovery, with a PhD programme to be introduced next year.

Education and research are often viewed as two separate activities, but they're very much a holistic activity. A research-intensive university helps train students not only for today's jobs, but also for tomorrow's. This is one way of buying down the risk as a nation looking to the future, to develop a cadre of people who are invested in the future to tackle important challenges.

The responsibility we all face is how do you translate science into innovation? This question is becoming increasingly more complicated for academic institutions to answer as change outside is happening faster than many can adapt to with new information technologies disrupting multiple industries, including oil and gas, in real-time. In the space of a 4-year undergraduate degree course standard industry equipment and processes can now become obsolete.

The issue about the future is something that concerns us deeply because every time we make a hiring decision, whether it is in the field of electrical

engineering or computer science or something else, we now have to ask ourselves if we are going to move forward with that field.

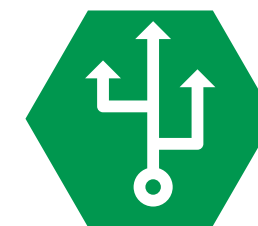
I think the answer has to be "Yes!" Because even though we offer degrees only in fields that relate directly to the oil and gas industry, and increasing EOR, so many new disciplines are now part of petroleum engineering – big data computing downhole; nanotechnology; robotics.

In a survey conducted at the ADRAC 2015 CTO Summit in Abu Dhabi among 250 leaders from academia, government and industry, 28 percent of respondents expressed the view that the Advancement of existing EOR Technologies will have the biggest game-changing impact on the oil and gas industry over the next 20 years. While 19%, including myself, thought Big Data & Analytics will be the source of greatest transformation. Nanotechnology got 15% of the survey vote, and Automation & Robotics secured the backing of 12% of the respondents.

Ultimately, academia and research institutes don't solve these problems without engaging with the private sector. Industry is where the rubber meets the road. The PI is engaged in many ways and we need to continue building this momentum.

The PI's sponsors and affiliates include e four major international oil companies that include BP, Japan Oil Development Company, Shell and Total, and they all know exactly what they require in terms of technology, in terms of the skills that our students must have when they graduate, and in terms of the research that we should be doing.

But we need to facilitate knowledge and technology transfer in both directions because if we don't understand the critical problems faced by the energy industry, we aren't likely to focus on the relevant solutions. And alongside this strategy will be the need to align national and international energy R&D stakeholders' mandates successfully over the long term, which will require the creation of dedicated platforms that help identify the areas where collaboration for joint industry projects is most feasible and promising in terms of producing locally-relevant results. [\[5\]](#)



Can F1 Spin-Off Big Data Technology To Avert Crash In Oil & Gas Production?

How the oil and gas industry can enhance recovery using F1 race track-bred data modeling

**By Mike Phillips, Head of Simulation Systems,
McLaren Applied Technologies**



How can a racing car travelling around a short track at speeds well above 200kms for a couple of hours help overcome the challenges faced by the oil and gas industry? Let me explain. A Formula One car, or any car for that matter, is just a big physics model, a big mathematical model. It's relatively easy to construct. We use that model to design and develop the car, because simulation is faster, cheaper and more reliable than building test cars.

Once you've got a really accurate model of the car, why wouldn't you use that in a race to actually work out the performance of the vehicle and use data from the car in real time to optimize the car throughout the race? And that process is what we're rolling out, at McLaren, to other industries, including oil and gas and pharmaceuticals, to help deliver solutions that cut time, cut costs and increase revenues.

The oil industry is increasingly heavily invested in Enhanced Oil Recovery technology to maximize output from mature ageing fields, and having the opportunity to model a reservoir before spending \$100s of millions of dollars on drilling a well makes good commercial sense.

Data mining is the traditional way of looking ahead by looking backwards, looking at big chunks

of historic data to tell you what happened yesterday or last week, last month or last year. But if you can use a little bit of historic data and combine that with models and simulations of the system you were trying to achieve and use that to make forward predictions, then that's much more useful.

You can run scenarios about what the future might look like and make better decisions. If you can take that one step further and do that in real-time, then that's a real game changer. Data mining has its role, but it's only part of the story.

The trick is to understand the problem in the first place, the business challenge or the key performance indicator that the company is trying to optimize, and use data to create a tool that people can understand and use. It's very important in our work to address the human-technology interface.

More and more companies are building that capability and even if they don't want to develop tools in-house, they need to be an intelligent customer. That means they need to know what they're buying because they're probably being pitched every day by software providers who've got the latest and greatest tool that's going to solve all their problems!



I think we're different at McLaren in that we don't have a product to sell. We're selling design and technology capability to build tools. Sometimes we do partner with people to deliver that tool, but we're normally working with the end-user to design and develop a customized solution for them rather than fitting an existing solution to their problem. Happily, what we're seeing more and more is the customer having the intelligence to know what's good and what's bad.

We find that in the industries that rely on technology to enhance performance or to be better than the competition, when they get it right, it's really, really valuable; or if they get it wrong, it's really, really catastrophic.

The oil and gas industry is a great example. Very high operating costs, and therefore, non-productive time is a bad thing; but equally, the environmental cost and reputational cost of getting something wrong is also a big thing. So oil and gas is a great place to use it and is a focus of reaching out to advance the benefits of cross-bred technology that might not previously have been seen as a natural fit.

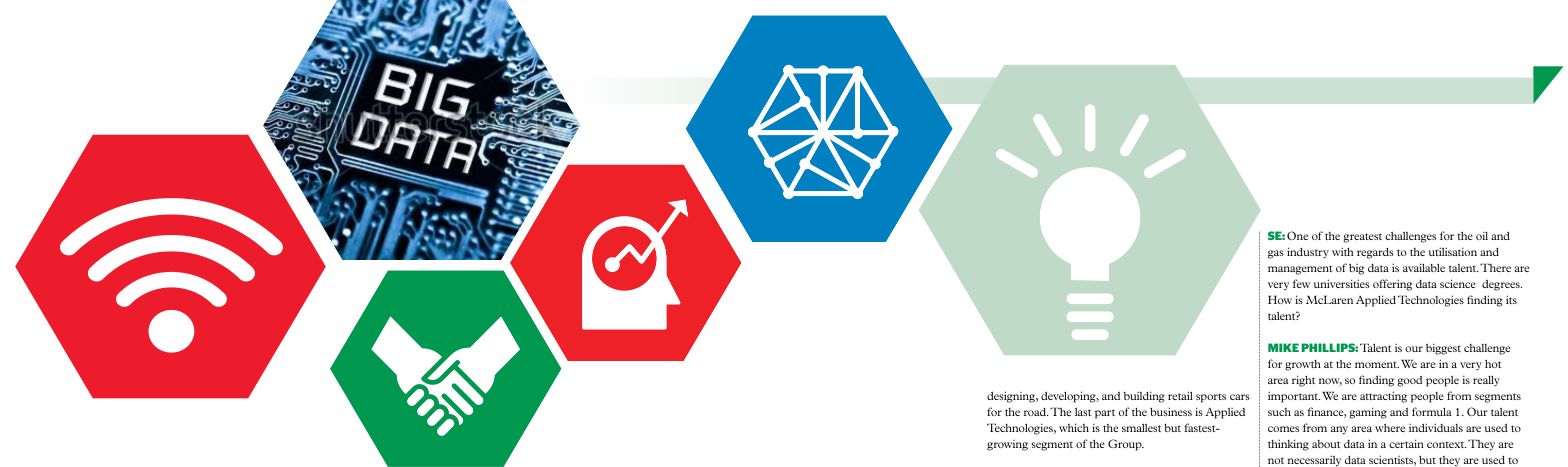
How our ideas have come to be adopted is clearly illustrated by our first venture into the world beyond

the racetrack and that was drug development. A major pharmaceutical came to us and said, "You guys did telemetry on race cars, can we do telemetry on people? Can we put sensors onto people so that when we're giving them drugs in a trial we can understand how they're reacting in real time? And that way we can speed up the way we develop drugs."

To develop a drug can take 10 years and a billion dollars, so if you can just take a few months out of that it's worth doing. We hadn't anticipated this scenario. It needs industry to come and say, hey guys, here's a real interesting challenge, can you solve it?

I think people have moved on from pure big data because it's too backward looking, and it's not actually much use in an operational sense. So companies are now looking at more real-time predictive analytics that they can use in the day in the operation to optimize performance. That's a much more interesting area.

For oil and gas in particular, faced with myriad financial and ecological concerns in a world of dwindling resources, the simulated modeling of their challenges and outcomes is the only real way ahead. 



Delivering Big Data Solutions from F1 into Oil & Gas Sector

Feature Interview with Mike Phillips, Head of Simulation Systems, McLaren Applied Technologies

The subject of crossover technology and, in particular, the area of big data, has been creeping more into our lives every day, whether personally or professionally. Within the oil and gas industry, the emergence of big data has become a critical solution for Enhanced Oil Recovery in mature fields. The goal for ADNOC R&D is to reach 70 percent recovery in Abu Dhabi's oil fields; many analysts expect that this will be difficult to achieve without a mature big data strategy.

Formula 1 has been working with big data for a very long time. Over the course of any Grand Prix weekend, a Formula 1 racing team will compute one billion pieces of data with around 200 individual sensors on each car. All of this data is processed in real-time to extract the required intelligence to feed back to the driver and make the car go faster.

INTERVIEWER, SEAN EVERS: The McLaren Group recently changed its name to the McLaren Technology Group, which currently has over three thousand employees, but yet only 600 of the 3,000 are involved in F1 racing. What do the other 2,400 people do each day?

MIKE PHILLIPS: Our Chairman Ron Dennis recognised some years ago that Formula 1 is a fantastic sport and a great brand vehicle but in itself is a static business. There are only nineteen F1 races a season, with just two cars per team. This left very little potential from a business growth perspective. As a result, we began to diversify and invest in road cars which are now the largest part of the McLaren business.

Out of the 3,000 employees working within the McLaren Technology Group, 2,000 of them are

designing, developing, and building retail sports cars for the road. The last part of the business is Applied Technologies, which is the smallest but fastest-growing segment of the Group.

SE: McLaren's utilisation of data predates the jargon behind "Big Data". How did the awareness around this idea evolve and at what point did you realise that you could market this idea to other industries?

MIKE PHILLIPS: We have been doing this for many years in Formula 1. A car is just a big physics or mathematical model and it is relatively easy to construct. We use these models to design and develop the car. It is very expensive to build a car and test it so we first create simulations. Once you have an accurate model of the vehicle, you can then use data in real time to optimise the car throughout a race.

SE: One of the greatest challenges for the oil and gas industry with regards to the utilisation and management of big data is available talent. There are very few universities offering data science degrees. How is McLaren Applied Technologies finding its talent?

MIKE PHILLIPS: Talent is our biggest challenge for growth at the moment. We are in a very hot area right now, so finding good people is really important. We are attracting people from segments such as finance, gaming and formula 1. Our talent comes from any area where individuals are used to thinking about data in a certain context. They are not necessarily data scientists, but they are used to looking at large data sets and making sense of it.

SE: What is the synergy between big data and video gamers?

MIKE PHILLIPS: Data is useless unless you can consume it and turn it into intelligence. Part of that is the visualisation of data. Video game writers are very interested in the way that visualisation and the human interface works. In this perspective, they can have very useful insights.

SE: Do you think that 'Big Data' is just another piece of jargon? How do you define this term?



MIKE PHILLIPS: We don't talk about Big Data because for us it's not that interesting. If you think about it, Big Data means looking at and learning from large quantities of historic data. We are way more interested in looking towards the future. Predictive modeling can tell you what's going to happen next and how to act. That's where we are seeing interest in other markets. Data mining has its role but it is only a part of the story.

SE: When you say data mining, does that mean it is taking place in real-time?

MIKE PHILLIPS: Normal data mining is looking at big chunks of historic data to tell you what happened yesterday, last week, or last month. However, it is much more interesting to use little bits of historic data to build models and simulations to make future predictions. Doing this in real-time is the big game changer.

SE: You are coming from a space that has been applying this science for some time but yet for many others it's clearly unfamiliar. What has been the biggest challenge in terms of offering this as a consultancy service to other companies and sectors?

MIKE PHILLIPS: Our job is to deconstruct what looks like complicated data into a set of tools that are easy to use. The trick is to be able to identify the business challenge or key performance indicator that the company is trying to optimise. This could be a lot of things but the goal is to use data to create a tool that normal people can actually use. The tool is a complete waste of money if people can't use it. The human and technology interface experience is something that can't be ignored.

SE: In terms of the development and utilisation of data for greater efficiency, do you feel that institutions and companies will be able to build their own internal competence as time moves on rather than utilize third party providers?

MIKE PHILLIPS: More and more companies are building this capability. Even if they don't want to develop the tools in-house they still need to be an intelligent customer. They need to know what they're buying and what software companies are pitching to them every single day.

SE: As MacLaren continues to move into other sectors outside of Formula 1, such as healthcare, oil and gas, and transport, which one has been the most receptive towards McLaren Applied Technology's solutions?



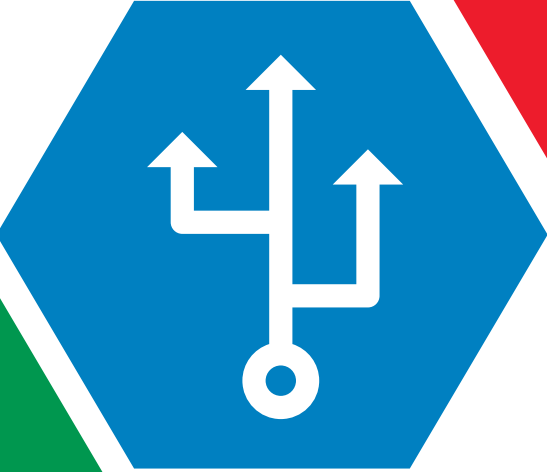
MIKE PHILLIPS: We first started in the pharmaceutical industry with drug development. Our client came to us and said “you do telemetry on race cars, is it possible to also do it on people?”

They wanted to attach sensors to patients so they could understand how people react to drugs in real-time. This would help decrease the time it takes to develop drugs, which take years and billions of dollars. Cutting down this process by even just a few months was worth looking into. If that client had never come to us then we wouldn't have seen this opportunity.

The industries that rely on the performance of technology to be better than their competition have been the most receptive. For these industries, if you get it right it's really valuable and if you get it wrong it's catastrophic. The oil and gas sector is a great example. It has very high operating costs and non-productive time is a bad thing. Also, the environmental and reputational costs of getting something wrong are equally as important.

AUDIENCE QUESTION 1: We've been following the auto industry and are now utilising sensors to enhance drilling performance. However, we don't have the luxury of using telemetry. How can a company utilise what you do if they can't use a telemetry system?

MIKE PHILLIPS: In a telemetry system, a lot of the streaming data that we can look at from down well is either very poor quality or not enough data is being transmitted. The way we get through this is to use



historical data to fill in some of the knowledge gaps. Always have a hybrid model of historic mining with real-time data. It is a big challenge. Sensor failure is another issue that we are facing. Even if you have a sensor down well, the failure rate seems to be quite high.

AUDIENCE MEMBER 1: Our answer to the telemetry system is putting all the computer powers down-hole so we only need to communicate with what is being seen on the dashboard instead of sending everything up-hole. You can do most of the computing down-hole and only send command up-hole to the telemetry system.

MIKE PHILLIPS: That is exactly what we do in formula 1, because there are things such as trees and stands between the car and the garage. The data that we receive from the car is disrupted. We do a lot of the computing on board and send small data back. The trend now is actually small data not Big Data.

AUDIENCE QUESTION 2: It is very interesting that in Formula One cases you'll look more into predictive modeling as opposed to what we call historic matching. However, in the oil and gas sector, historic matching plays a vital role in creating a more robust predictive model. Maybe in your case it's not as important to get the data mining component as strong as you would if you were in the oil and gas industry.

Could you comment on this?

MIKE PHILLIPS: If we can build good physics models and simulations of the system or the product then we will always use that in preference to using historical data. Sometimes we use historical data to fill in the gaps and give contextual information but, if possible, we will always rely on the physics first. Furthermore, we must always bring the human element into this. If you ignore the way that humans interact with technology and consume information then you are missing a key aspect. We build data systems around this concept. These systems can learn how people make decisions and actually present information back differently based on the way that individuals have reacted to the data. [5](#)



Open Minds to Lead Oil & Gas Industry to Crossover Innovation with Other Industries

*Cross-fertilization of emerging technologies can
outperform oil industry niche R&D*

By Dr Wafik Beydoun, R&D Division Manager, ADNOC

Whether it may be key developments from the defense industry, or robotics or cyber security, many companies are discovering that they can benefit from breakthrough innovation originating in fields not obviously related to their own; they just need the openness to benefit from them.

How should we in the oil and gas industry change our current R&D practice and perspectives to embrace this cross-industry, cross-science innovation and benefit from it? One straightforward way is to create platforms between different industries to exchange knowledge. This would help identify where we share common challenges and interests with other industries.

The outcome of such an exchange/discussion could be simply classified in 3 categories:

(1) There is no interest in technological cross-exchange, so we each continue with our R&D business 'as usual' activities;

(2) There maybe new solutions from outside the industry that are ready, or nearly available, from which we can benefit – in this case little adaptation/development may be required before using it in our industry;

(3) There is no solution as such, but there is mutual interest to solve a joint challenge/need – we then actively seek a cross-industry R&D cooperation to work jointly on a solution.

In the past seven months, I have noticed real growth in the discussion of how such cross-industry opportunities can benefit our industry. We've seen an effervescence of ideas from different industries – For instance, in February 2015 during the major defense conference IDEX, I was part of a panel organized by TDC, where they were discussing how everyone could benefit from sharing cross-industry technology and development. It is encouraging to see these industries trying to get closer together and this type of cross fertilization is certainly the way ahead.

In the *Technology Review journal* (MIT publication) last year, they listed ten breakthrough technologies in 2014 including drones, smart phones, cyber-security, brain mapping - among many other ideas all across the technology landscape, all industries included. If we are open enough we can find ways to seek, work with and benefit from these breakthrough technologies that will considerably broaden our horizons and impact our industry (see red text on figure).

For instance, industrial drones are already used in oil and gas for surveying and monitoring our installations; cyber security is a crucial element of all



our systems. Development in these areas offer clear benefits to our operations and accelerate our own innovation.

The question is, are we really doing enough to understand and embrace these new technologies? Obviously, we strive to innovate in our own business, but we need to look outwards, to expand our circle of knowledge, to add another dimension to our outlook and to do this we need to look to other industries and to academia.

This is not a one-way process. Our own R&D has been extensively influential across the world and our encouragement for start-ups and feeder companies that benefit our industry is essential.

Integration between academia and industry will be the key to ensure that Abu Dhabi's emerging R&D ecosystem can deliver applied research. Governments tend to be continuous supporters of mature

technologies, but play other key roles as all-important regulators and as underwriters of risky projects.

But when it's time to move on from the mature technology, ready to deploy or at least develop new technology and thinking. That's when the industry should take over, working and integrating in a crucial partnership with academia, IOCs/NOCs and the service sector.

Technologies that increase Oil Recovery are obviously one of our main priorities at ADNOC. If you look at IOR/EOR technologies that are primed for development, we see that we will be addressing issues involving chemical engineering, nanotechnology, material sciences, sensors, automation and robotics. And these are exactly the type of spheres of expertise where we can learn so much from other industries, perhaps even from areas that we would not normally recognize any common

ground. What is the most significant contribution that international energy companies partnering with ADNOC can make to help put the UAE in the world top-10 for R&D? Simply, it is to locate and/or help develop mission critical research labs in Abu Dhabi that support their global operations; also to incubate, mentor and partner with young, local innovation entrepreneurs.

We have already started seeing these kinds of startups, at least in the defense industry in Abu Dhabi. I think the next wave will be an automatic spread of startups in the oil and gas industry, providing services, new tools and new technologies. I don't see any difficulty in funding, if they propose sound projects, and we are already seeing ideas turn into reality. As this movement gathers momentum, it will propagate across other industries. It's a win-win situation. 

CROSSOVER TECHNOLOGIES

“How Can Innovation from Other Industries Play a Key Role in Enhancing Performance in the Energy Sector?”

FEATURED PANEL SPEAKERS:



William Coates,
Senior Vice President Technology & Marketing, Schlumberger



Mike Phillips,
Head of Simulation Systems, McLaren Applied Technologies



Alain Guenot,
Senior Vice President, Total E&P UAE



Dr. Thomas Hochstettler,
President, The Petroleum Institute



Dr. Arif Sultan Al Hammadi,
Executive Vice President, Khalifa University



Moderator:
Sean Evers, Managing Partner, Gulf Intelligence

SEAN EVARS (SE): Mr. Coates, How much of a potential disruption do you think Big Data presents to the oil and gas industry in the sense that it has become such a critical area for the industry that is in the hands of somebody else?

WILLIAM COATES: I think there are two things. First, big data has been a problem in oil and gas, especially in the seismic domain, for decades. In Schlumberger, we have a computing infrastructure in Houston which is the second or third largest cluster of super computers in the world, working through seismic information. The whole industry has been involved in not just big data, but enormous data, for a long time. So, I don't think it's a new subject.

I think the application of it in predictive modeling that is what is new. I know in Schlumberger we're now taking and gathering a lot of data from the tools to try to predict maintenance windows to keep things from happening downhole. I think most of the larger companies in the industry have a reasonably talented and technical workforce, and I think these things are mission critical or differentiating and so they will keep those in-house.

SE: In terms of cyber security versus big data strategy, in the analogy of the horse before the cart, which should be deployed first?

WILLIAM COATES: I think today that this data security, cyber security, if you cannot ensure that first, you won't move forward. We are in a privileged position to hold much of the oil and gas data in the world inside the walls of Schlumberger and we can never, I would say, compromise the perimeter of that and never would take the risk of doing so.

SE: Dr. Thomas Hochstettler, as you look to the future with unknown disruptive technologies such as big data on the horizon, should you be still teaching petroleum engineering?

DR. THOMAS HOCHSTETTLER: Absolutely! We need to continue to teach petroleum engineering. Big data, data analytics, the use of data and computing downhole, as was recently mentioned, is becoming a more important part of what we do. We offer degrees at the Petroleum Institute only in fields that relate directly to the oil and gas industry in Abu Dhabi, such as increasing enhanced oil recovery techniques.

The issue about the future is something that concerns us deeply and especially every time we make a hiring decision, we ask ourselves if we are going to hire in the field of electrical engineering, computer science etc. are we going to move forward in that area? I think the answer has to be "yes."



There are many technologies that we teach that have nothing directly to do one would think on the face of it with petroleum engineering and data. Big Data is one of them; nanotechnology is another one; robotics is another one. We have fields, we have our supporters, funders in ADNOC and in the OPCOs and our international supporters, Total, BP, and so on. They all know exactly what they require in terms of the technology and skills that our students must have when they graduate, in terms of the research that we're doing. So when you talk about doing petroleum engineering, all of those things are now part of petroleum engineering.

So I think it's very important that we keep our eye on the future and what are the skill sets and what are those areas of research into which we need to be moving.

SE: Does Total, or the oil and gas industry in general, proactively seek sufficient crossover technology tools from other toolkits, from other industries?

ALAIN GUENOT: Obviously this is the solution we're seeking! We have been doing this for a while because cross fertilization is something which is absolutely necessary. But we still believe it is essential to build the ability to deliver bespoke R&D locally for local solutions rather than being exclusively dependent on off-the-shelf technology optimization.



At Total we have what we call "prospective labs," which are established for short periods of time, two years, where we have people going out and interacting with the whole industry on many topics including nanotechnology, big data and robotics, topics which we find strategic for our development and for our evolution. We give the opportunity for young innovators to incubate in our labs to develop their ideas. So that's something which is an integral part of our activity and maybe we'll be lucky to bring that to an industrial project.

SE: From Your experience moving into the oil and gas sector from F1 car racing, what have you recognized as a common hurdle to overcome in order bring big data solutions to the sector?

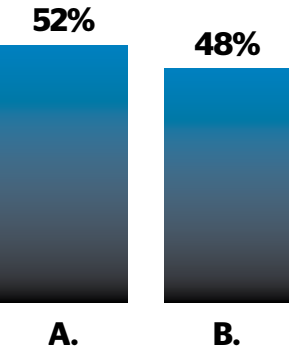
MIKE PHILLIPS: Good data! I think it's easy to be good at Big Data analytics when there's plenty of data around to look at, but when the data is poor or unreliable, or the physics or the engineering is not clearly understood, it is difficult. At the same time, plenty of data around something that's actually poorly understood is almost useless.

I think it's a very difficult problem to crack in the oil and gas industry. The environmental conditions down-well are very, very challenging in a way that perhaps in other industries, like telecoms, it is relatively easy and simple to get really good data and look really clever.

SE: Let's look at the first survey question and answer.

Q1 As the technological challenges of the energy industry are mounting, crossover technologies from other sectors such as aerospace, automotive and even medicine are making their way into the oil and gas sector, providing new solutions and applications that in turn help drive efficiencies, boost productivity and optimize performance
- Leveraging tools from others tool kits is proving to be a very effective low-cost replacement for R&D?

A. Agree
B. Disagree



WILLIAM COATES: I voted B and disagreed with the thesis. We have an ongoing collaboration with McLaren, we've got one going with Porsche, we've got one with Boeing and we've got one with Google. And we're doing that because the one thing I think any company has to realize is that you can't have all the great ideas. We spend more than a billion dollars a year in R&D and it's a very good investment we think. And at the same time we try to go and find other good ideas elsewhere to supplement that. Not a lot of them work. And I would never say that it's low cost.

Everything we do in this area is tens of millions of dollars when you're looking at solutions that you have to scale, because the issue that we have as a big company is that everything we do has to scale in some way. Scaling on a global basis any product is never low cost and it's never cheap and it's fraught with risk of commercialization issues and IP issues. I think crossover tech is a very effective way of broadening your knowledge and taking advantage of all the smart minds around the place, but the low cost and the idea that you can replace your R&D with that I think is also a fallacy.

MIKE PHILLIPS: The word "replacement" doesn't work for me. You need a range of solutions, some of them can be fundamental research, some can be from academia, and some are going to be technology transfers from other industries.

ALAIN GUENOT: I agree with the thesis of the survey question – we can find very low cost replacement tools from other industries.

For example in the oil&gas industry we produce a lot of water. All over the world when you produce one barrel of oil you also produce 3 barrels of water at the same time, and this will be the key question in the Abu Dhabi fields in the years to come, before the use of enhanced oil recovery. And we need to deal with this water; we need to re-inject this water back into the ground.

But before re-injecting this water we need to treat and process it, and we used to use very heavy expensive industrial equipment for this purpose. But we now found a low cost solution which has been developed in the food industry: A ceramic membrane. It's very simple: the oilywater is forced into the pipe; the clean water is seeping through the porous ceramic material and is used for re injection; and the concentrated water is disposed of. And it is a very effective and sustainable system.

This is now going into pilot and we will save



millions of dollars in research and development -- it was off-the-shelf and we took it.

DR. THOMAS HOCHSTETTLER: But that is just one example. It's great when you can take something off the shelf. But basically, in the complex fields that we're dealing with here and the kind of challenges that we're confronting in this part of the world and elsewhere, I think we would have serious problems if we didn't have a solid basis of R&D delivering bespoke solutions for the particular needs of the region.

ALAIN GUENOT: Please, it doesn't mean that we don't have any R&D, yeah? Simply, we should not forget that we have a lot of good solutions on the shelf and that we should use them.

DR. THOMAS HOCHSTETTLER: Understood.

DR. ARIF SULTAN AL HAMMADI: I voted "disagree," because I read the word "replacement" and I don't think anything can replace research and development in certain areas.

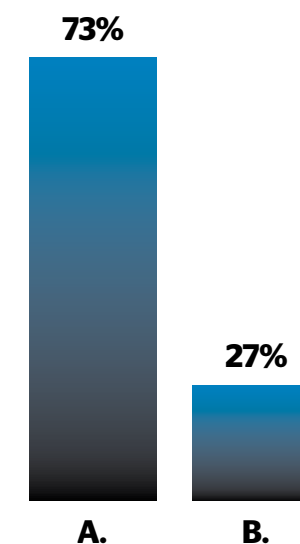
Every sector is going to concentrate on its own interest, but at the end of the day it's the sharing of the ideas that matter. Today in Khalifa University we have an aerospace center where we are working on material science. I'm sure that this research will also benefit the oil industry here in the UAE somehow if we collaborate and talk.

DR. THOMAS HOCHSTETTLER: I think there's a very important role for government to play, and the government of the UAE is stepping up and is funding research. The best example of public-private partnership is between Mubadala and MIT, namely Masdar. The Masdar Institute is dedicated to environmental research; it's a cross-disciplinary, crossover platform for different technologies to come together. None of the degrees that come out of Masdar are discipline based, they're all interdisciplinary.

SE: Let's take the second Survey question.

Q2 Big Data, Internet of Things/ Everything, Automation, cyber security etc are infiltrating all industries, and in so doing making the ICT backbone the most critical operational architecture in many sectors, including oil and gas – this ICT tsunami coming from silicon valley should propel the oil & gas industry to accelerate its proactive pursuit of crossover technologies as the hardware, software, processes and skills deployed are essentially the same?

A. Agree
B. Disagree



WILLIAM COATES: I thought I was going to be controversial and be the only person who disagreed, but I'm glad some other people joined me.

I think ICT is incredibly important, incredibly powerful, there's no doubt about that, but you know, for better or for worse, we operate in the very physical world, we deal with a physical commodity that we have to extract it from the earth, and while ICT information is a very important piece of it, the quality of the people is much more important than anything else.

SE: In that question there is an assumption that the ICT backbone is emerging as the most critical operational architecture, is that a wrong or correct assumption?

WILLIAM COATES: I think the connectedness of any company or industry is vitally important, and

companies that can deal with moving data around and keeping everybody on the same page have an advantage. So that ICT architecture is incredibly important, but it is not the only thing necessary for success. And that architecture is only as smart as the people who use it is my main point.

The backbone and the ability to move information is only an enabler to a much richer discussion.

SE: The question is about compelling industry to proactively go out and seek these solutions that are available in other tool boxes?

ALAIN GUENOT: Well, the reason I voted against the question is that I tend to share the view that those tools are simply a means to achieve something. We also need to look at the fundamentals of our own industry, and to use our own unique tools. I'm not against the fact that we have to go to big data and so on, but there are also many other things that we should not forget from our own industry.

SE: In the context of the technology revolution, there is a belief that you need to be changing faster internally than things are changing externally – from your experience is the oil and gas industry changing fast enough?

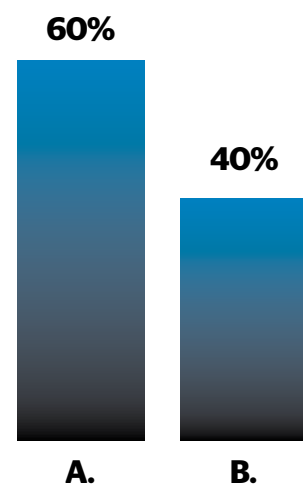
MIKE PHILLIPS: Yes, I think it is. When I think about technology, I don't think it's all the solution, but it may give you opportunities to do things in different ways. As we see a drive towards more remote locations for oil extraction, towards automated wells, even to completely unmanned installations -- how are you going to do that? What technology enables you to go in that direction?

If I look back at all the really cool and interesting projects we've been involved in over the last few years, a big proportion of them have come from conferences like this one, where me or one of my colleagues is giving a talk about Formula 1 or about some other subject and it has triggered a light bulb moment for someone in the audience – "Those guys can help us sort out this problem that we've been wrestling with. . ." Because that guy, he's not thinking "I've got a problem to solve, shall I go check with F1 or the guys in the food industry," he hasn't got time. But if someone presents a solution in front of him, he's going to jump at it. So it's that connection, I think, we're missing more points of connection between industries.

Q3 When looking for suitable crossover technologies,

should the oil and gas industry prioritize adopting innovations aimed at improving safety and security over others given rising concerns about cyber security in particular?

A. Yes
B. No



SE: Can we bring up the next question on prioritizing crossover technologies?

SE: In terms of prioritizing, do you go seeking specific solutions to certain problems?

ALAIN GUENOT: Yes, if you're talking about prioritization, we can't go chasing everywhere. So, we need to be selective.

SE: Bill, you mentioned earlier about the absolute priority needed for security around the data that you hold, does the premise of the survey question then seem appropriate for you?

WILLIAM COATES: No, I think the question is quite particular and it says prioritizing safety and security over everything else? And, you know, that in the context of Schlumberger, security means right now something very different than what we might be discussing here, because physical security is a problem that the industry has today in spades that it didn't have 10 years ago. And when you look at where we operate, whether it's in certain countries in the Middle East or North Africa, we spend an enormous amount of money on security that we never had to speak before.

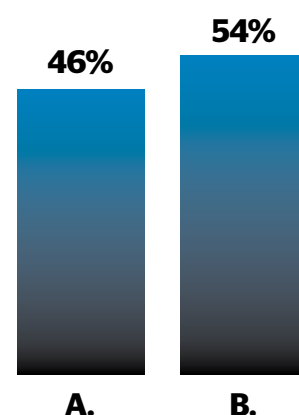
I actually think oil and gas is a very sophisticated industry and I think we are actually quite well up the learning curve on most of these technologies, and most companies are actually very advanced in cyber security. I don't think that we're laggards or slow followers in that domain at all. And I don't think we talk about that very often or give ourselves very much credit, because we deal with a business that touches the lives of every single person on this planet and cyber security is just one of the many things that we deal with.



SE: Let's go to the next question on connecting the oil industry capital Houston with Silicon Valley.

Q4 It is time for major IOCs and NOCs to open innovation centers in Silicon Valley to tap into the best ICT engineering talent pools to build up a true 21st century workforce?

A. Agree
B. Disagree



MIKE PHILLIPS: Yes, we're shamelessly hedging off that. We are opening an office in San Francisco. Silicon Valley doesn't have all the answers, but it's an interesting place to be as it has a different perspective on life.

I would definitely agree with the idea of Silicon Valley as a very successful innovation model, that other industries could learn pieces from. The oil and gas industry—and I'm very new to it so forgive me—is quite risk-averse. The question that quite often comes back is: "show us your solution and show where it's been proven to work in the past," rather than: "that sounds interesting, let's take a



risk." It's a quite conservative industry to kind of initiate new things. Whereas, you know, California is well known for putting money into projects, expecting them to fail and being completely okay with that. That could be some learning.

SE: Alain, what are your thoughts on the idea of Silicon Valley as a physical place or a model for the oil and gas industry to learn from?

ALAIN GUENOT: It's obviously a good idea. We have seven or eight research centers all over the world. The people and companies which are open in an organized way are also the ones who're going to win access to the best people and technologies.

WILLIAM COATES: I have to agree because we actually just opened a research center in Palo Alto a few months ago. We have research and engineering centers all over the world and you're always looking to find pools of talent, and there is clearly something interesting and innovative that's been going on in Silicon Valley that it's worth tapping into. We used to have a center in Palo Alto that we closed in 1998 and we're just reopening it now because we really think there is something to try to discover there. Now how it's going to work out, we don't know, but we have our eyes open and we're hopeful to find something interesting out of it.

AUDIENCE MEMBER SRIKANTH: You attract talent when you can create an open ecosystem. So its openness which attracts talent and this is no more the unique privilege of Silicon Valley or Houston. In fact, data science has become global; its geographic center is agnostic. I will take an example from genomics. One hundred thousand people are collectively working every day towards a very, very high order of innovation in genomics and they are spread throughout the world. There is no single center. There's no Silicon Valley of genomics. It could've started in Manchester University, it could've started in UPenn, but now it's everywhere. Almost 50 to 100 petabytes of data is accessed by a hundred thousand people who believe that there is an open playing field on which they could go ahead and innovate. Upwards of 10 million research documents are accessible to these people. So ultimately this is what attracts talent.

MIKE PHILLIPS: What's the venture capital environment like in the Gulf, I mean in terms of people putting money into great ideas coming out of universities in the way that Silicon Valley does?

DR. ARIF SULTAN AL HAMMADI: I think it is unfair to compare between here and the Silicon Valley.

I would say we have to look at the demography



of the region or the country, the number of UAE nationals is one million. We don't have the US model in attracting the talent like the way it's done in Silicon Valley. I would say we have to be different in what we do here than what they do in the US. I like the US model, I like Silicon Valley, and I think it's the right way for innovation. However, here, as a country, we are still building the basics of education. In terms of the Petroleum Institute, it just started a PhD program and at Khalifa University we have just 40 students in PhD. We should build on what exists today. We have an oil industry, a petrochemical industry, there's lots of development that can be done in what we have today. And we should keep investing in new industries and emerging technologies such as aerospace and biotech.

SE: Is there any piece of the Silicon Valley model that you could identify that would be useful to look at and say we should do a bit more of that here in the Gulf?

AUDIENCE MEMBER - ROBIN MCGOWAN, CTO, PEAK WELL SYSTEMS: I think one of the things to look at is what actually predated the current Silicon Valley model. There were some companies at the time that worked on a kind of open innovation type model and they were primarily engaged with connecting by networking, by connecting people with ideas to the people with the problems and then bringing in the money. This

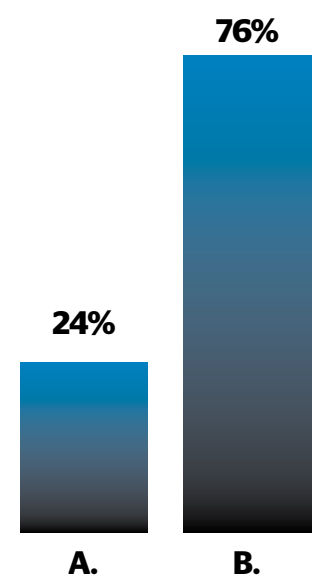
happened before venture capitalists then decided to integrate on a model of, well, now there's enough ideas out there, I can make a whole business out of doing just the money bit. So right here we have to focus on that integrated approach and focus on the essential element to innovation which is the people, and connecting people with different ideas. We're talking about crossover technology, crossover happens through people. And that's the fundamental piece.

SE: Let's go to the final question of the survey and the session, which looks a little bit into the future. 

Q5 Twenty years from now none of today's energy industry giants will be leading the sector as big data and analytics heavyweights such as Google will be, assigning IOCs to contractor roles

- A likely scenario?

- A. Yes, this change is inevitable
- B. No, oil majors will adopt new technologies, not be swallowed by them





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