2006 – Issue 3

Brazil oil & gas

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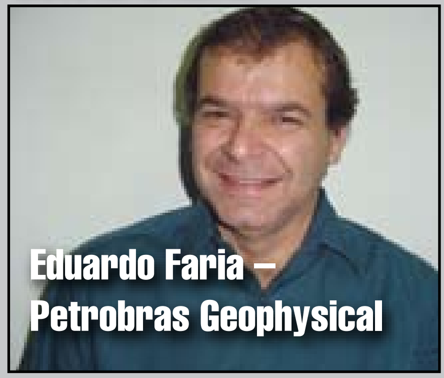
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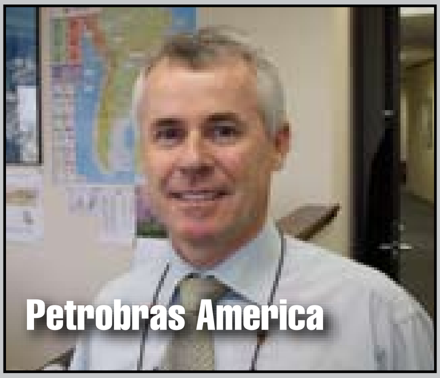
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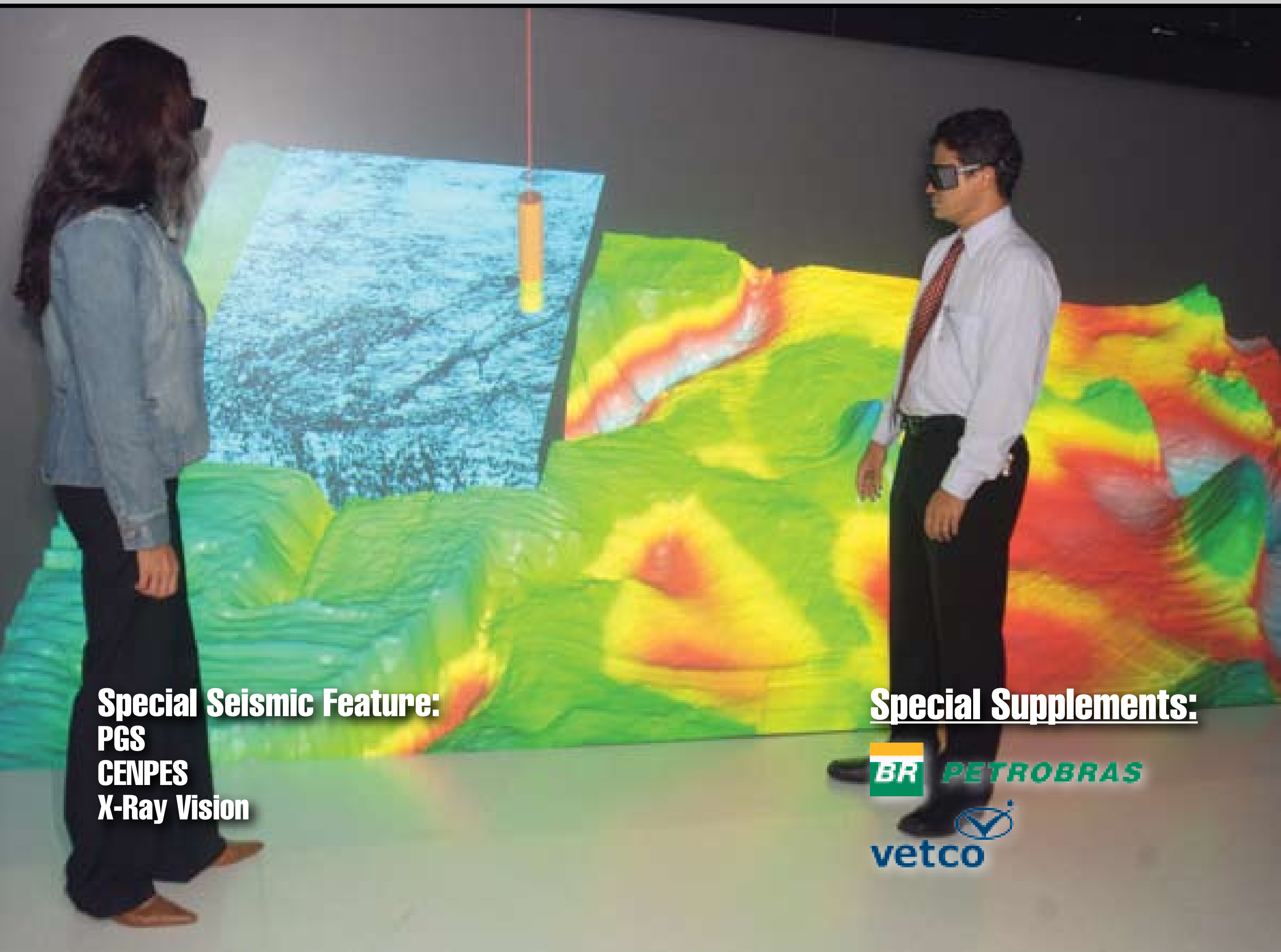

Special Seismic Feature:
PGS
CENPES
X-Ray Vision

Special Supplements:
PETROBRAS
vetco

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Petroleum Sample
Photo: Juarez Cavalcanti

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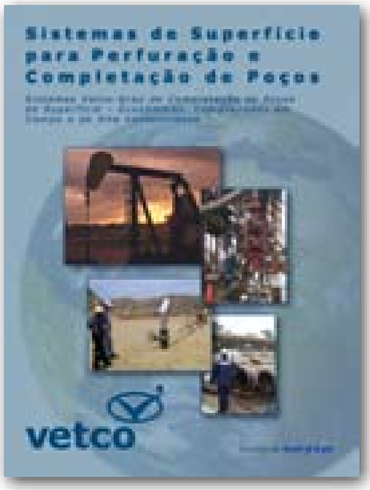
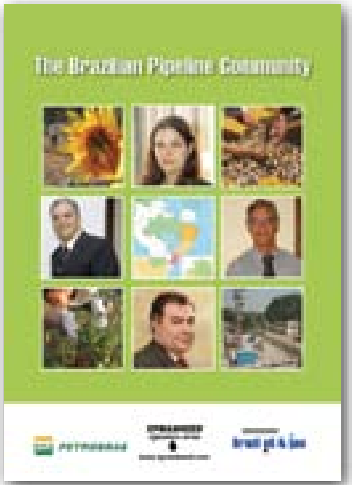
NOTE FROM THE CEO

Note from the CEO





It was a pleasure to be back in Rio de Janeiro for the official launch of BOG and see again so many old friends and colleagues. That meeting not only allowed us to meet again but also reinforced the mission of Brazil Oil and Gas.

I would like to thank all the people involved with Brazil Oil and Gas and those behind the scenes all of who have helped Brazil Oil and Gas. Especially, Marcelino Guedes, João Carlos Placido, Osmond Coelho Neto, Antonio Lage and Paulo Correia of Petrobras.

This 3rd issue coincides with Rio Oil and Gas where we will have an extended presence which includes a stand, circulation and the Brazil Oil and Gas Technology Prizes that will be awarded for innovative or money-saving technologies.

This issue's lead feature focuses on seismic with articles from Eduardo Faria, Petrobras Geophysical, PGS and X-Ray Vision an introduction to seismic technology.

Renato Bertani Petrobras USA President talks about his company's plans for the North American market.

Additionally there is also is a comparative analysis of differing models of oil and gas investment in Norway, Scotland and in Dubai, UAE.

We also have two special supplements offering solid technical contents for Petrobras and Vetco Gray. The latter is a unique technical reference document that is bilingual written in Portuguese and English. Look out for both.

This is the reason for BOG – to help spread accurate technical oil and gas information. There are some that will say there is no need for a technical magazine; there is no need to export technology. That the status quo is acceptable. That the internal market is sufficient. That existing pseudo-technical magazines are satisfactory.

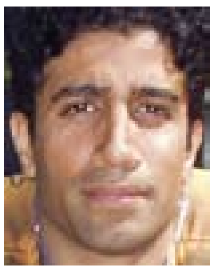
There is a need to export petroleum technology. And there is a need for a single source of technical material that focuses on Brazil but at the same time includes the wider international observers. This is a channel for companies both oil and service to share knowledge and communicate with the wider market.

Brazil Oil and Gas is not introverted; we do not look only into Brazil. Other magazines do that. We reach the international markets with local technology developments. That is EPRasheed and Brazil Oil and Gas.

Enjoy the magazine.

There is a need for a single source of technical material that focuses on Brazil but at the same time includes the wider international observers.

Founder EPRasheed and Brazil Oil and Gas



PETROBRAS AMERICA PRESIDENT INTERVIEW

Petrobras eyes US

Petrobras America President Renato Bertani spoke with Brazil Oil and Gas about his company's plans in the US.

By Wajid Rasheed

***Q: Brazil Oil and Gas** – Can you cover Petrobras' US Activities?*

A: Bertani – "Yes, Petrobras America is currently involved in 4 business areas. These are Upstream GOM, Trading, Procurement and Refining."

***Q: Brazil Oil and Gas** – Can you give us a breakdown of the E & P activities.*

A: Bertani – "To put things into perspective, over the last 4-5 years we have implemented a strategy which looked for specific core areas where we could apply two concepts. Firstly, our technology and expertise and secondly our creativity and new ideas. These elements are critical to success; we decided to not only look for frontier opportunities but also 'hard to access areas'; these included 4 core areas in the GOM (US Waters). But let us look at the tangible, our strong position in deepwaters. We are interested in the Eocene reservoirs in this area. The first 3 of 10 wells have been drilled – Cascade, Chinook and Saint Mal – in the shallow Upper Tertiary formations. The oil plays are found in 2000-3000m water depth. We are currently discussing the best ways of developing the reserves. One of the options is a phased development, FPSO similar to Brazil; FPSO could sail away in case of a hurricane and can reconnect after storms."

***Q: Brazil Oil and Gas** – What are Petrobras' US drilling plans?*

A: Bertani – "We are getting ready to drill 2 prospects – Andromeda and Orion where we are 100% operators. We may bring in partners on a 25% basis but no more because we believe in the area, we want to keep 75%. There are a further 10 prospects where we have options to drill.

In the 4th area, which is moderately well known, Garden Banks, there is high potential and it is attractive because of its existing infrastructure which is well developed and has access to markets. We are already developing Cottonwood which

Gulf for Growth

we have 80% along with Mariner Energy Inc. We have a Gas project consisting of 2 subsea tieback well completions to a host platform located in shallower waters. Our first gas is expected in the early part of 2007 from East Cameron Block 373 Platform."

***Q: Brazil Oil and Gas** – Petrobras is operating in the Heart of GOM. What can you tell us about this?*

***A: Bertani** –* "Liveoak has been drilled and we are awaiting results. We are drilling another prospect in April which means additional opportunities for drilling. Our goal is to concentrate in key areas, certain trends and certain plays where Petrobras is bound to be a significant player."

***Q: Brazil Oil and Gas** – What is Petrobras approach to risk diversification?*

***A: Bertani** –* "Spreading risk in the portfolio by building a portfolio through exploration and not acquisitions; spreading risk means testing different concepts. Concepts such as Early Production Systems (EPS) enable us to get a better idea of the reservoir/production profile before going into full production.

In the shallow waters and deep seas we have 12 prospects. At 10,000m depths the uncertainties are to do with reservoir quality while the drilling involves challenging HPHT conditions. The economics of the project are very attractive as the infrastructure exists and the market is buoyant. We also have an interest in Blackbeard in conjunction with Exxon Mobil who is the operator and Megamata which is located onshore about 150 miles from South West Houston."

***Q: Brazil Oil and Gas** – Petrobras' is an innovator-how has this been applied in the US?*

***A: Bertani** –* "In the western part of the GOM not a single well had been drilled for at least 10 years because the industry's general understanding was that there was no merit in the area. During the last 10 years several factors have changed these include technology, the market and now more information is available. These areas are Gas prone with most production coming from the very shallow formations and the Great White Shell development in deepwaters, but with nothing in between.

Seismic has generated interesting features; although these prospects were not properly tested. Petrobras has positioned itself through lease sales and acquired 80 blocks. For us

Graphic shows Petrobras holdings in US GOM

We are interested in the Eocene reservoirs in this area. The first 3 of 10 wells have been drilled – Cascade, Chinook and Saint Mal – in the shallow Upper Tertiary formations.

two key characteristics are repeatability and optionality. Prospects which have similar characteristics, are important because they allow geologists to make inferences from one area to the other.

This helps us to decide whether to drill more or not.

The concept of optionality is important too. Where we have 8 or 10 prospects, we can have the option to drill them and that limits the risk. We considered acquisitions and made aggressive offers but in the current market you have to pay full price."

***Q: Brazil Oil and Gas** – What is the role of Petrobras' know-how technology?*

A: Bertani – "Petrobras is using technologies and new ideas for building a successful portfolio; using deepwater knowledge, of course, but also geologic modeling from other international areas (ie Colombia and Ecuador). We have made 3 big discoveries in the deepwater GOM, we are diversified but not scattered. We have focused on core areas.

Western GOM is similar to successful tests offshore Brazil so we decided to go into the deep gas play, despite costs being very high because we see the potential there."

***Q: Brazil Oil and Gas** – What does the Trading involve?*

A: Bertani – "Petrobras Trading could be seen as another set of services for the group rather than a trading floor presence. It involves finding and developing markets for surplus production. Oscillations happen but this allows Petrobras to access production and optimize its production profile.

Increasing production of Marlin crude which has an API of 19-22° means that demand for Marlin to be processed in Brazilian refineries is set to go up as is Brazilian refining production but there is still a sufficient surplus of Marlin. We can sell and capture the best margins in the market.

Renato Bertani in his Houston Office

Market surveys, intelligence and transactions are done by Petrobras Brazil but Petrobras America is the broker. For certain products ie gasoline and fuel oil Petrobras America gains title and sells on.

Finding markets for Petrobras exports for Petrobras international such as Ecuador, Angola and Colombia."

***Q: Brazil Oil and Gas** – What are Petrobras America's Refining plans?*

A: Bertani – "Petrobras is starting a new business of refining and has completed the purchase of 50% of the Pasadena refinery. The current capacity of 100,000 bopd will be increased through substantial investments that will allow for a further 70,000 bopd and the addition of a coking unit.

There is the possibility of expansion and refining capacity could be expanded.

Petrobras continues looking to up and downstream which is linked to the strategy of the company. Within this context the US is a strategic market.

Between the period 2006-2010 we will invest US1.5 billion in the US.

We are still in the early days and are involved in establishing a business presence but there are strong economic benefits; there is a strategic position which will add volume to our presence in the largest market in the world."

Black blessing

By Wajid Rasheed

Dubai and Stavanger are synonymous with oil wealth. But these cities also subtly show that the black blessing has been managed responsibly; with a vision for the future. For these and other thriving cities, there are countless stories of squandered oil-wealth and cities that have ended up as ghost-towns. Yet, no single country's approach to the management of oil and gas has been perfect; it has been learnt.

What works in one country is not necessarily the solution in another. But parallels and lessons exist. We shall see how the forces and needs acting on the North Sea were very different to those of the Arabian Peninsula. Each country's profile is unique but what emerges is a common lesson – oil revenues 'rollercoaster' and are subject to depletion.

Dutch Disease

Due to the highly specialized requirements of the petroleum industry personnel and equipment are often imported. If you have a pressing deadline it is easy to think 'don't reinvent the wheel, import'. But this is dangerous. Firstly, capital flows become wholly dependent on cyclical oil and gas revenues. Secondly, the creation of local jobs and local infrastructure is limited as workers and equipment are 'outsourced'. The few jobs that are created are fringe industries and are very much dependent on the migrant workers and can easily vanish. Thirdly, excessive imports and the petroleum industry itself can inflate costs so that locals are excluded from housing, social and other activities. This is a double edged sword as the higher paying oil related activities push out other less lucrative activities. Without diversification these negative factors expose a country's dependence on oil wealth. When oil prices fall, the consequences can be disastrous – Norway and UK in the 1986 crash.

Within a century oil and gas have become the world's preferred energy source. Consequently, certain countries with the black blessing have benefited. This article looks at ways of making the blessing last.

Dubai's Palm-Jumeirah Island was created by using reclaimed sand from the sea. The landmark development in the shape of a palm tree typifies how oil wealth has been used to attract tourism.
Photo: Juergen Stumpe

Before Oil

When considering the North Sea – Stavanger, Norway, Aberdeen, UK and the Arabian Peninsula – Saudi Arabia and Dubai, UAE, it is revealing to see how these countries existed before oil.

Each of these countries had very different socio-economic profiles; healthcare, disposable income, education levels, transport links and indeed internal infrastructure were severely limited.

Undoubtedly, this shows that the black blessing has improved lives within the space of a single generation and has led to the creation of new industries.

Pilgrims

In the Saudi Arabian peninsula, oil was discovered in the 1930's. At that time, exploration contracts for oil were scorned; in scorching desert temperatures, exploration was for a more valued resource; water.

Saudi Arabia had already been guaranteed an annual source of revenue due to the Hajj – the pilgrimage Muslims made to the city of Mecca. However, the country's infrastructure was underdeveloped which led to a weaker bargaining position. When the first contracts were signed the Saudis received less than the equivalent of 5% royalties. With the discovery of oil and its' growing geo-political importance the Saudis' bargaining power increased.

Royalties grew to reflect this reaching 50%. Other stipulations such as the improvement of transportation and telecommunication links followed. By the 1970's the Saudis had started to buy-back the privatized oil company leading to the full ownership of Aramco and the country's estimated 262 billion barrels of oil.

In reality, National Oil policy has come full circle (see graphic overleaf). It has evolved from seeking maximum royalties to stipulating local capacity to full re-nationalization and now to partial privatization for Gas developments (see ttnrg 2 Bids

Oil and Gas wealth is not necessarily a trade off against the Environment. There are much wider considerations. Original art copyright ttnrg.

and blocks Section 1). To illustrate Saudi Aramco's local content, as of 2003 it had 53,954 employees, of which 86% or 46,365 were Saudi nationals. It has also signed gas exploration contracts with foreign oil companies.

Gold and Pearls

In the UAE – a union of seven Emirates – the situation was different. Dubai had long been a regional trading hub. It's souks were known worldwide for all manner of commodities, especially Gold and Arabian pearls. Dubai continued to profit from trading until the cultivation of artificial Pearls and world recession caught up in the 1930's.

The quality, size and quantity of artificial pearls could be controlled in such way that demand for them grew quickly. Commerce dropped in Dubai and it was no wonder that when news reached the ruling family in UAE and Dubai that oil exploration licenses were being sold in Saudi; negotiations followed.

With the fullness of time, this led to the discovery of reserves of approximately 100 million barrels of oil. Presently, Dubai has developed a policy of cluster economies which have resulted in flourishing financial services, tourism and IT sectors.

A tale of two cities

Before oil, Aberdeen and Stavanger were economically stable albeit sleepy fishing and maritime towns. During the early 1960s when gas was first discovered (oil came afterwards) in the Groenigen field in the Dutch Sector of the North Sea, Norway had high employment, a current account surplus and low inflation. From a socio-economic perspective, there was no pressing need to explore for, and develop oil and gas.

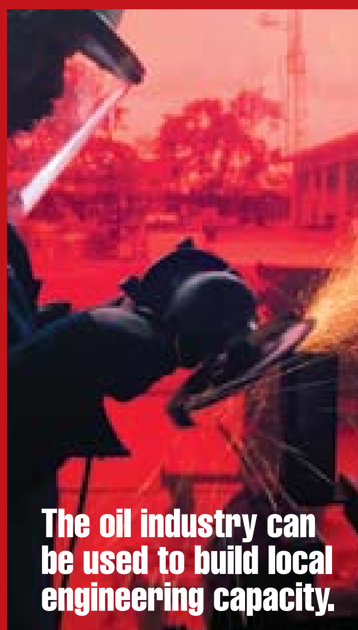
But with the 1973 Oil crisis and accompanying embargo geologists started scrambling for North Sea seismic. This instability in global geo-politics set the scene for the upper hand in negotiations with the international oil companies. When the Norwegians and Scots asked for rewards beyond taxes and royalties, the oilmen obliged.

Differences between the North Sea and Arabian Peninsula

The need to develop local knowledge was linked to the nightmarish operating conditions in Norway. In contrast, the Arabian Peninsula is an oilman's dream – punch a hole in the ground and chances are that oil will be struck. Therefore, from the very start these very different environments formed very different mindsets.

As noted earlier, oil is much easier to access oil in the Arabian Peninsula than in the North Sea. This led to a laissez-faire approach in the Arabian Peninsula. It seemed that all that was necessary was to sink a simple shallow vertical hole and a huge field would be found.

In contrast, Norwegian and British fields were located in the harsh North Sea; a dangerous environment where locating reservoirs was a costly, timely business. Here the application of technology made a vital difference. With good seismic, directional and



The oil industry can be used to build local engineering capacity.

real time data well construction costs could be halved. This was a compelling reason for the development of North Sea technology and the gradual introduction of terms such as the famous '50% local content' stipulation in exploration contracts.

Game-changing or incremental benefits?

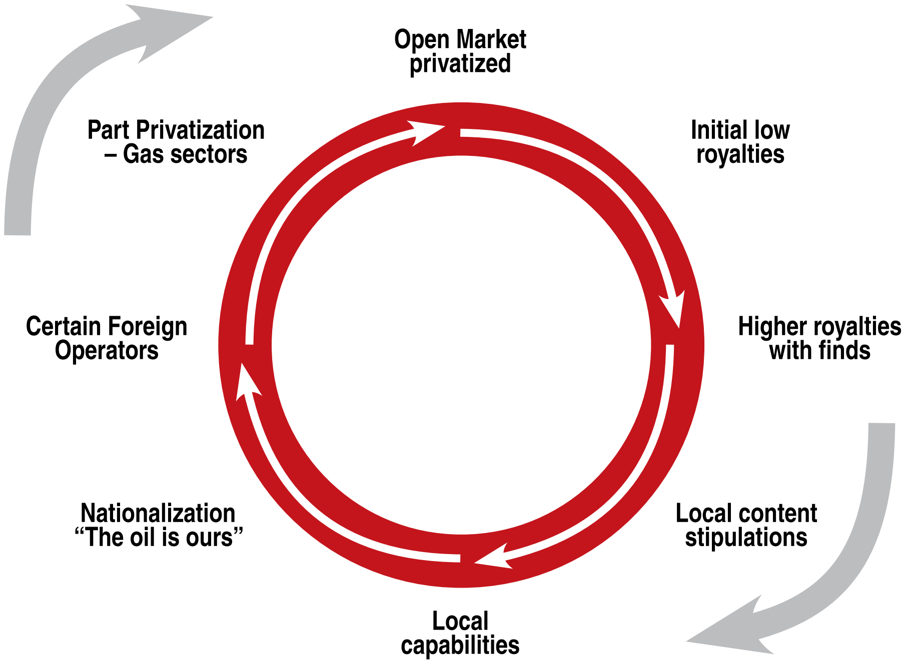
Technology of every type was necessary in offshore Norway and UK. The need for reducing risks and cutting costs was acute and technology could change the nature of the game – magically making uneconomic reserves profitable. In the Arabian Peninsula the benefits of offshore technology did not apply. While other onshore technologies could be applied their technical and financial gains were insufficient. An incremental gain in production or cost reduction was not compelling enough for such technology to be used in the Arabian Peninsula.

For example, North Sea offshore operations routinely cost in excess of $150,000 per day including rig rental and crew costs. By contrast, onshore operations in the Arabian Peninsula do not often exceed $50,000. Additionally, the profile of Arabian reservoirs ie their production rates and overall production size would be ten times the size of North Sea finds.

Therefore, policy makers in the Arabian Peninsula did not feel the same urgency to develop local content as did their North Sea counterparts. The Arabians were more interested in local participation in commerce and zero taxation so as to distribute revenues amongst private individuals.

Build locally

It is worth highlighting that prior to the early 60's, there was no oil and gas industry whatsoever in the North Sea. Yet, today the industry is a prime mover in the Scottish and UK economy.



Oil and Gas nationalization has come full circle from seeking high royalties to partial privatization.

How did this transformation occur within a generation?

Building local capabilities was always a 'must-have' for the North Sea. This created the backbone current oil and gas technology exports. Technologies were invented, tested and proven in the North Sea before being exported worldwide.

We have seen that until the mid 1960s, neither Norway nor the UK had an oil industry. But within years the chorus to create one was loud enough to be heard. In the early seventies this led to the preferential use of local goods and services at times reaching 90% as required by law. In the early 70's, the Norwegians created Statoil, the operational oil company and as policy maker the Norwegian Petroleum Directorate NPD, Accompanying this was a preferred policy for Norwegian goods and services coupled with clause of transfer of know-how and research cooperation.

The UK and Norway's success in achieving high local content is largely due to these policies which have encouraged partnerships between foreign and domestic companies and made research programs mandatory. Research has helped create smaller companies which have exported technology worldwide and grown. The University of Aberdeen Oil centre lists 175 small companies working in the oil and gas sector. These range from small independents to technology companies.

In terms of production Norway and the UK are very different, Norwegian oil and gas production has increased over the past decade to 3.1 million barrels per day. The UK's oil production has fallen by 30% over the same period to current levels of 2 million barrels per day. Yet, through demand for UK oilfield goods and services, the oil sector continues to generate substantial economic activity.

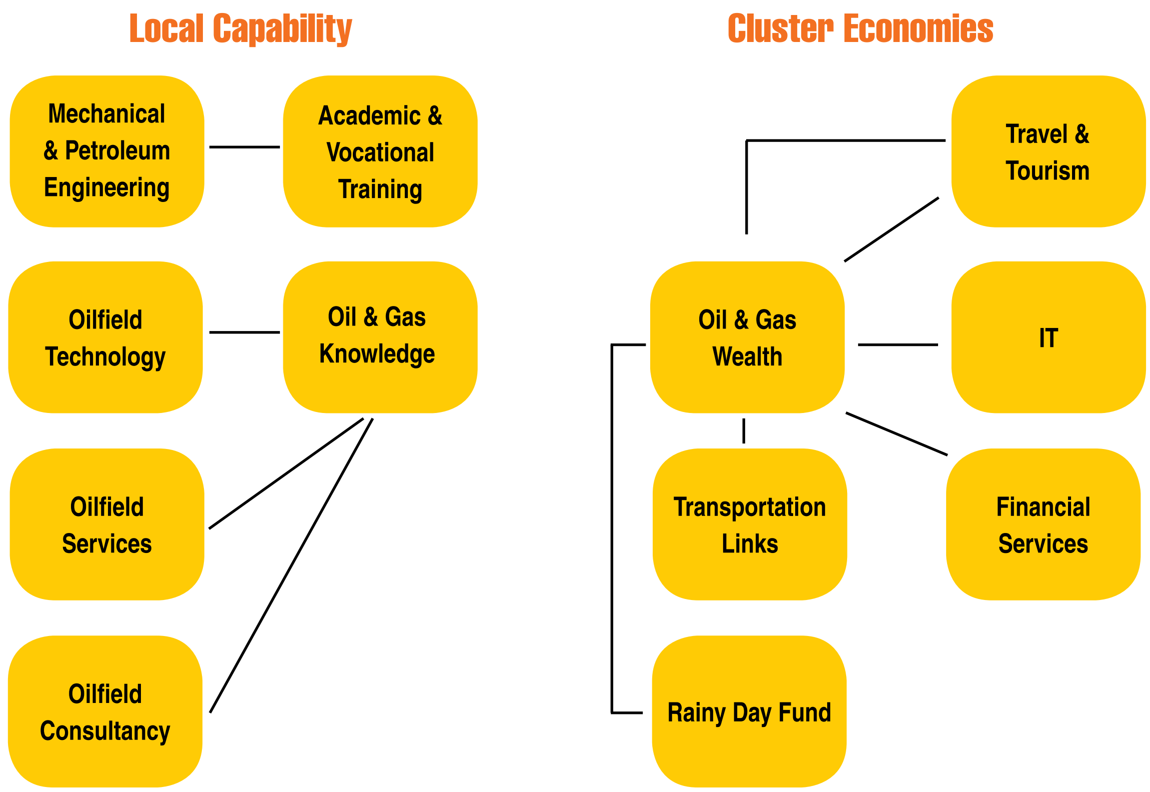


Diagram shows the relationship of Oil and Gas in economic sustainability.

Smaller independents have entered the UK sector but the oil and gas industry has developed far more due to the formation of mechanical and petroleum engineering, academic and vocational training and associated consultancy services.

Seeds of Knowledge

Licensing terms for oil contracts stipulated the transfer of skills and competence to Norwegian companies. Personnel from Norsk Hydro, Saga and Statoil received training in the IOC training programs and overseas postings.

The situation was slightly different for the UK as British Petroleum (BP) had already had international oil and gas exposure. In fact, this helped it discover and develop Forties the largest North Sea UK field.

These seeds grew into the commercial success of numerous oil technology companies that export goods and services worldwide.

Technology Greenhouses

Today there is a strong culture of oil and gas Research and Development; several test wells sites and research companies exist. Illustrating this is the Bridge of Don Test site in Aberdeen, Rogaland Research and its test well in Stavanger and SINTEF a company specializing in R & D.

As major oil companies shed R & D internally to appease cost considerations; more R & D has been taken up by the service companies. This is not to say that major oil companies do not use or test new technologies; they do so in low risk developments such as mature onshore operations. However, for the most part the development and ownership of proprietary oilfield technology no longer lies with oil companies.

There are some exceptions; the development of rotary-steerable systems to access complex well trajectories and expandable-casing for well construction. National oil companies are somewhat different as can be seen by Petrobras' R & D centre which has grown to support Petrobras' deepwater needs and has become a world leader in deepwater technologies. Norway and the UK have helped develop subsea technology and especially intelligent wells, real time operations management.

Cluster Economies

It is recognized that the Arabian Peninsula's economies have been highly dependent on oil; it accounted for more than 75 per cent of government revenues in the region. This made it crucial that the Peninsula diversify from oil dependence and open its' markets to attract foreign capital.

Various initiatives were undertaken in Dubai, for convenience they can be classed as cluster economies. Dubai began experimenting with cluster economies through the development of Dubai Internet City in 2000. This has grown to house over 5,500 knowledge workers today, while Dubai's Media City houses most of the global leading media companies. Dubai's financial markets have also grown. According to Chatham House Dubai market capitalization rose from US $14.3 billion in 2003 to US $28.6 billion in 2004.

The opening up of Dubai's real estate sector has also helped diversification. Between 2004 and 2010, investments in Dubai's real estate sector are set at US $50 billion. This is serving to support Dubai's tourism industry as it aims to increase the numbers of foreign tourists.

Dubai has first sought to consolidate the economy's major components of trade, transport, tourism and real estate sectors. Then to promote aspects of a 'new economy': IT and multimedia activities and e-commerce and capital intensive, high-tech manufacturing and services.

Rainy day fund

After an economic rollercoaster that saw Norway with the highest debt ratio ever attained by any developed country, the Norwegian Parliament established the Petroleum Fund in 1990. It receives net cash flow from the oil industry as well as profits from investments. The fund is designed to protect the economy should oil prices or activity in the mainland economy decline, and to help finance the needs of an increasingly elderly population and to cope with declining oil and gas revenues. The idea is to use 4% of the fund in the annual budget but in reality larger transfers are made.

Too much local content?

Government departments provided incentives enabling operators and the private oil sector to identify technology needs and fill them. This led to a trial and error system where technologies were not always applicable. However, it is not so important to focus on any single research program that did not work because with the passage of time the local knowledge base and competence was created.

However, the preferential policy may have gone too far in some cases, leading to an introverted mindset. For example, in Norway in 1990 at least 80% new prospect content was domestic. The advantages were jobs and profits in Norway, but there was far too much dependence on the petroleum industry for Norwegian manufacturing while exports to markets in other oil producing countries were limited.

Undoubtedly, this shows that the black blessing has improved lives within the space of a single generation and has led to the creation of new industries. As we have seen there are many ways to make the blessing last.

Acknowledgements: Chatham House, The Royal Institute of International Affairs. NPD Norwegian Petroleum Directorate, Saudi Aramco and Dubai Media City, BP statistical review.

Marintek tested innovative Petrobras concepts to produce in ultradeep waters

Recent developments of oil fields in ultra-deep water, water depths of 2,000 meters and more, have pointed to the following scenarios: Use of large diameter steel catenary risers (SCRs), and the requirement for large storage capacity. FPSOs based on cylinder-like hulls with moonpool and with relatively shallow draft, will fit very well with these scenarios.

The MONOBR concept has been designed to minimize vertical and angular motions in waves. The dynamic behavior of this platform has been studied both by advanced numerical analysis and by model tests in regular, transient and irregular waves.

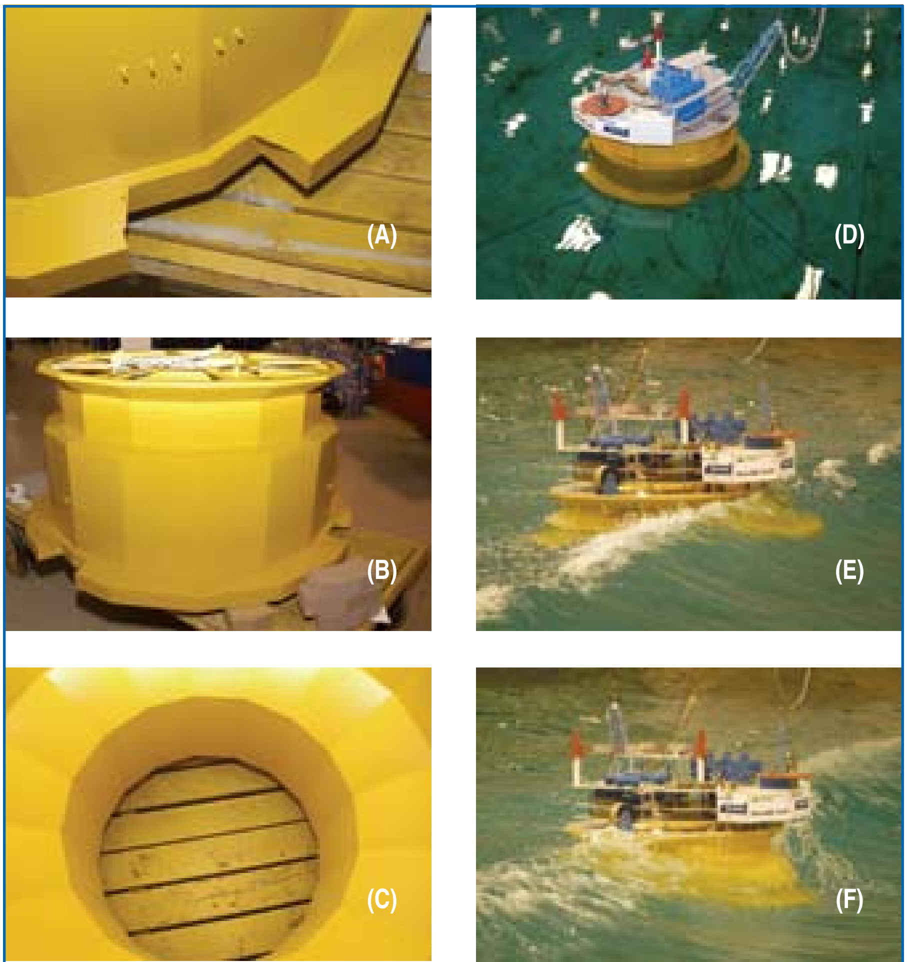
The last step of the conceptual design phase of the MONOBR for deep waters in Gulf of Mexico, was the model tests at MARINTEK. The tests were carried out with the complete model including mooring lines and risers in operational-, storm and hurricane conditions.

The results were very promising, indicating the MONOBR concept as a feasible FPSO for very harsh environments.

Marintek test facilities

The model tests were carried out in MARINTEK's Ocean Basin laboratory, which has 80 meters length, 50 meters width and 10 meters depth.

Multidirectional waves together with current and wind from various directions can be simulated.



(a) (b) and (c) Details of the MONOBR model; (d) MONOBR model in still water with all mooring and riser lines; (e) and (f) MONOBR in hurricane condition with waves of significant height of 17.50 meters and peak period of 16.3 seconds and current of 1.4 m/s associated with wind of 60 m/s.

Monobr

The present MONOBR is designed for 2500 m water depth, and for hurricane conditions in Gulf of Mexico.

The fully loaded displacement is 300,000 tonnes and the storage capacity is 800,000 barrels. The mooring system consists of 13 polyester mooring lines, and the riser system consists of 6 steel catenary risers (SCRs).

The model of the MONOBR was made to a scale ratio of 1:75. See photos above.

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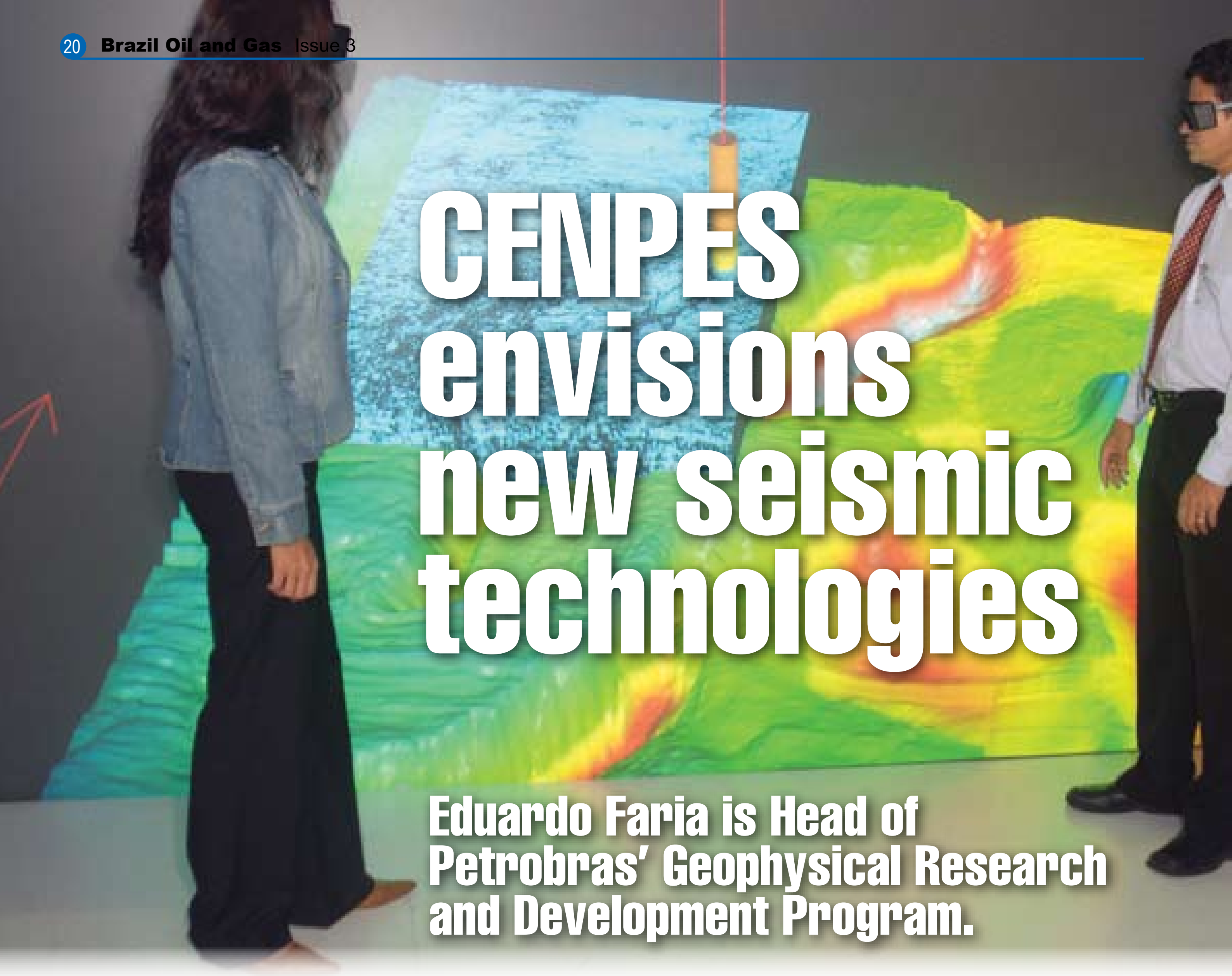


CENPES envisions new seismic technologies

Eduardo Faria is Head of Petrobras' Geophysical Research and Development Program.

By Wajid Rasheed

***Q: Brazil Oil and Gas** – What are the major upcoming seismic technology projects?*

A: Eduardo Faria – "Petrobras' R & D programs are based on overcoming a group of operational and geophysical challenges that Petrobras assets present. To this end there is a broad range of projects which includes imaging sub-salt migration phenomena and the modeling of seismic data. The prize is to access reservoirs but there are many obstacles. One of these obstacles is for example radial salt closure which prevents current seismic technology producing good quality images."

***Q: Brazil Oil and Gas** – What Sub-salt seismic applications exist in Brazil?*

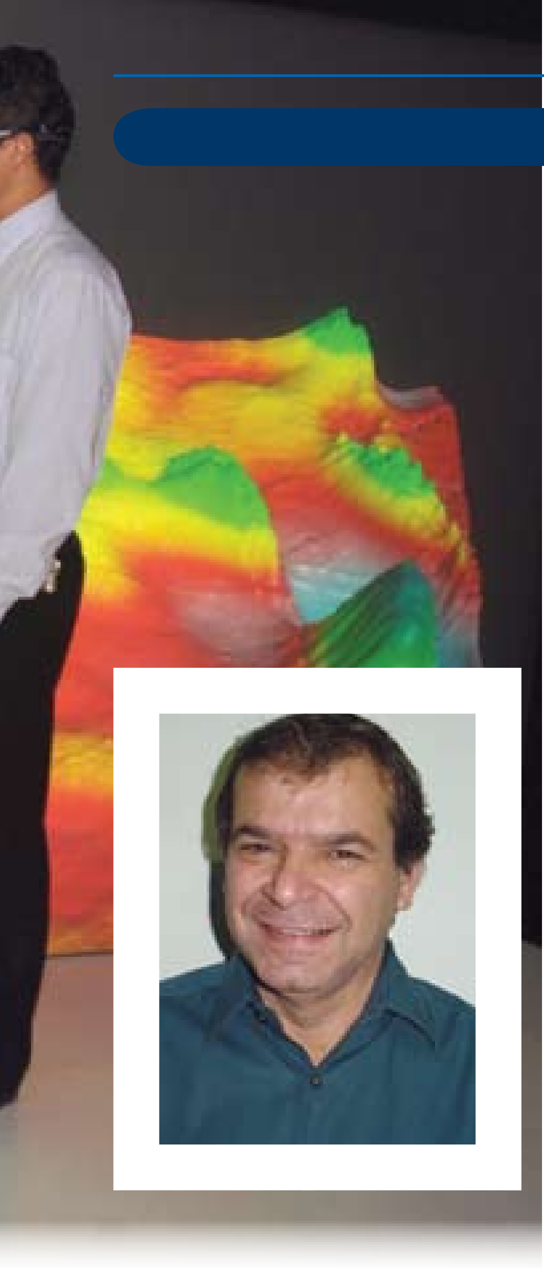
A: Eduardo Faria – "Today, Petrobras is exploring several frontier areas in the Santos and Campos Basin. These frontiers encompass deep subsalt reservoirs – this is a frontier that has very little characterization to date, yet that holds a very high potential of hydrocarbons plays. In terms of perspectives for Brazil we are looking for migration at 1000-2000m TVD depth. At depths beyond 2000m, the salt breaks up which causes further problems."

***Q: Brazil Oil and Gas** – What are the Petrophysical challenges associated with heavy oil?*

A: Eduardo Faria – "This is one of the biggest challenges that we face. Petrobras has an agreement with a university in Houston and in Colorado which covers a multi-client research and development project. This covers the issues of seismic attenuation and enhancing the extraction of field data."

***Q: Brazil Oil and Gas** – How does Seismic imaging help drill more 'wet'-holes?*

A: Eduardo Faria – "Seismic multi-component 3 and 4D technologies along with better seismic imaging helps drill more 'wet'-holes because it provides greater precision of the location and migration of hydrocarbons. Multi component involves larger volumes of data but it also enables the direct detection of hydrocarbons as well as reservoir geometries."



***Q: Brazil Oil and Gas** – What is the role of vertical seismic profiling (VSP) in exploratory and development drilling apps?*

A: Eduardo Faria – "VSP aids exploratory and development drilling by reducing risk and uncertainty. In this way, seismic has evolved from being an exploratory risk mitigating tool to a reservoir management tool with applications in mature fields.

In the future (the plan is to) implement – seabed permanent cables which take a lifecycle approach and includes taking repeat shots, overlaps and using permanent cables that use fibre-optics. This is because shear waves do not travel through water and therefore require seabed and solid media. VSP Multi Component are typically double the cost of regular P wave or marine."

***Q: Brazil Oil and Gas** – How has multi-component 3D, 4C, 4D, time lapse seismic developed?*

A: Eduardo Faria – "For example, last year Petrobras commissioned the industry's first 3D 4C in ultradeepwaters in the Roncador field where water depths are approximately 2000m. In this survey, cables stretching 4 miles were placed on the seabed and data was acquired under the PRAVAP mature fields (see Issue 1 Farid) where P waves were not applicable."

***Q: Brazil Oil and Gas** – What applications are there for Electro magnetic surveys?*

A: Eduardo Faria – "Magnetic seabed logging using controlled source electronic mechanism (CSEM) is interesting. There is an agreement to interprete and visualize this data as seabed logging allows physical qualities to be mapped with high resolution.

An artificial electro-magnetic source is used on the seabed in conjunction with recording instruments that register resultant magnetic fields. A low frequency signal is emitted by the source which penetrates formations to a given depth. The CSEM system is useful because it can help differentiate between hydrocarbons and water. This is because the CSEM propagates more effectively and is subject to less attenuation in higher resistivity layers which are precisely formations of interest; hydrocarbon bearing.

Seabed logging allows the physical qualities to be mapped in those areas with high resistivity allowing the accurate delineation of reservoirs. Although this is an auxiliary technique it offers great value in deep and ultra deep water applications.

The key is its combined use with wider seismic which enables better characterization and hence a better return on investment for exploratory and delineation projects.

Deeper prospects combined with the subsalt challenges are likely to increase demand for long offset data. The longer the offset between the source and the receiver, the deeper the survey.

Here we have to pay careful attention to environmental controls to minimize any impact and work within distance limits."

***Q: Brazil Oil and Gas** – What other new technologies are being developed?*

A: Eduardo Faria – "Petrobras is developing passive seismic where there is no man-made source. The source consists of harnessing naturally occurring sounds, of which there are two types – the first are micro-seismic events and the other is injecting CO_2 gas which is registered at surface. The origin of the source is not well established but is thought to be tidal based."

***Q: Brazil Oil and Gas** – What is the role of seismic visualization?*

A: Eduardo Faria – "Petrobras has visualization rooms in all its operational sites and in other locations where engineers can 'see' reservoirs. The development of visualization tools has been conducted in conjunction with the Catholic University (PUC). This has allowed us to image 'harder to see' reservoirs such as thin layers which can be missed by conventional seismic. With 4D time based seismic it is also possible to view migration as two time lagged surveys, say a year apart, which will show how hydrocarbons have moved."

4D Acquisition strategies for reservoir monitoring projects

Four dimensional (4D) monitoring by time-lapse seismic used to optimize the management of producing reservoirs will reduce well costs and improve recovery.

Andrew Long, PGS Marine Geophysical

Introduction

By the availability of timely information, accurate reservoir models can be constructed, and smart, controllable wells can be planned (Calvert, 2005). Reservoir monitoring begins with a baseline survey, preferably acquired before any production of hydrocarbons has begun.

A monitor survey is later acquired after production has begun, and a physical change in the reservoir state has occurred. Successive monitor surveys are then acquired throughout the lifetime of reservoir production.

The frequency of monitor surveys is dependent upon the rate of change in reservoir state as production progresses and the cost-benefit model for 4D seismic in the specific reservoir location. In the least case, the difference between successive surveys will spatially correspond to changes in reservoir state, but no quantitative information can be extracted.

These observations will provide insight into reservoir connectivity, compartmentalization and flow barriers. It may then be possible to identify reservoir locations of bypassed pay and help plan the location of injector and producing wells. In the best case, quantitative inversion of elastic seismic properties and production data can be used to measure and differentiate between changes in pressure and saturation.

History matching and reservoir prediction will thus be improved. Such ambitions are only achievable with a combination of very good seismic data and a reservoir state that elastically deforms in response to small amounts of production. In some cases, subtle geomechanical deformation interpreted from high resolution seismic data may help constrain the production model of the reservoir.

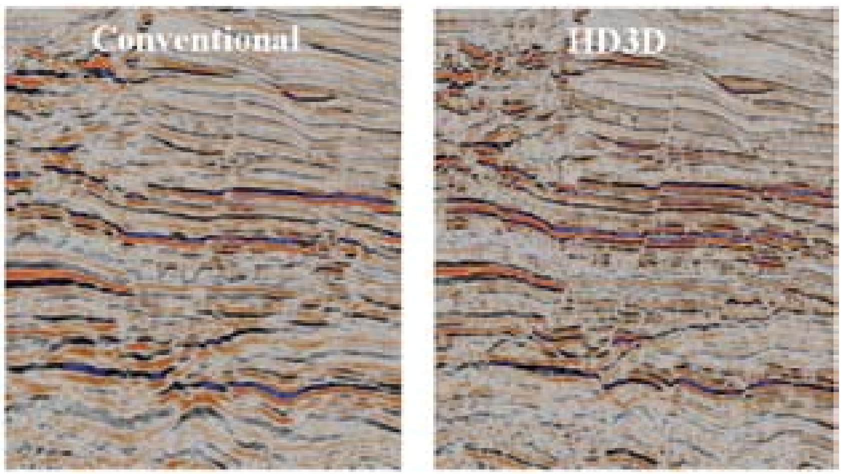


Figure 1 - Outstanding resolution and quality yielded by HD3D acquisition and processing in complex geology compared to conventional towed streamer. Tight 3D spatial sampling (small bins) and high 3D trace density gives increased resolution, imaging of faults and increased high frequency content.

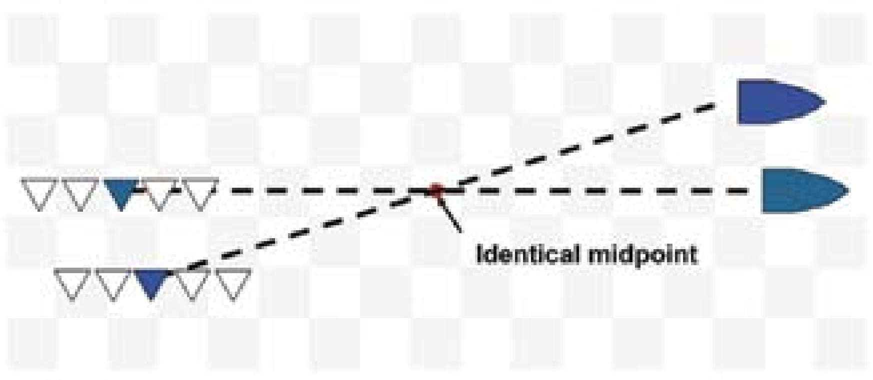


Figure 2 - Demonstration of how source-receiver azimuth will be different for a given CMP location when the shot position is not repeated. This principle applies for all source-receiver offsets. If the azimuth is different the 4D signal will probably reveal an artefact due to the non-repeatable acquisition at that CMP location.

The Optimum 4D Acquisition Strategy

Eiken et al. (2003) demonstrate that dense streamer towing complemented by accurate data regularisation can reduce the NRMS repeatability error to about 6%, which corresponds to the minimum theoretical 4D threshold in ideal conditions as described by Calvert (2005).

Correspondingly, Widmaier et al. (2003) describe a 4D acquisition strategy that has become a standard component of international 4D tender documents. The strategy is based upon high density 3D (HD3D) principles yielding high quality data (Fig. 1), which is very robust, and is easily modified for specific reservoir challenges and survey locations. The generic name is 'HD3D-4D acquisition'.

It is easily demonstrated that if the location of a given shot is repeated between successive surveys, then the repetition of all source-receiver azimuths will guarantee that receiver positions are also repeated (Fig. 2). This criterion is specified because source-receiver azimuth differences are particularly easy to QC during acquisition and processing.

Furthermore, azimuth matching is used during CMP binning in the 4D processing stage. Differences in azimuth imply different ray paths through the overburden and different illumination of the target, and can therefore lead to degradation of the 4D repeatability.

Large differences in source-receiver azimuths between the baseline and monitor surveys may obscure the 4D signal. Streamer overlap is a robust method to maximize the repeatability of azimuths at sail line boundaries, whilst simultaneously reducing primary infill requirements (Fig. 3). Streamer overlap will provide a surplus of CMP traces in a broad zone along each sail line boundary. Typical overlap configurations are one or two streamers, e.g. 10 or 12 streamers on an eight streamer pre-plot.

The surplus of traces in the overlap zone improves azimuth repeatability, and can also be used prior to CMP binning to optimize cross-line processing operations such as 3D interpolation, 3D regularization and 3D surface related multiple elimination (3D SRME).

The cost of streamer overlap is small compared to conventional streamer acquisition when a high capacity vessel is available for acquisition.

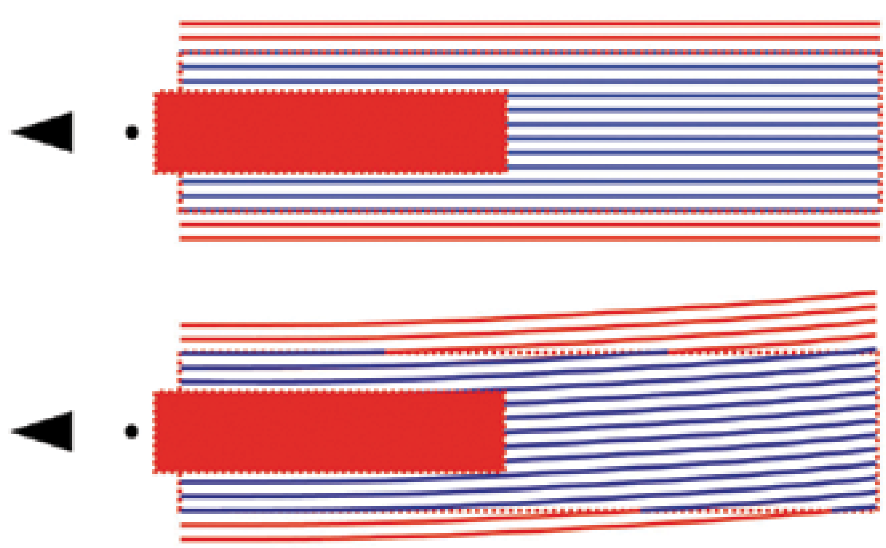


Figure 3 - Comparison of CMP binning with and without streamer overlap. The 'live' area of CMP bins populated during acquisition is highlighted in solid red. For zero feathering the 'excess' overlap streamers are plotted in red also. Streamer feathering allows the overlap streamers to contribute to CMP binning, as seen in the lower part of the figure.

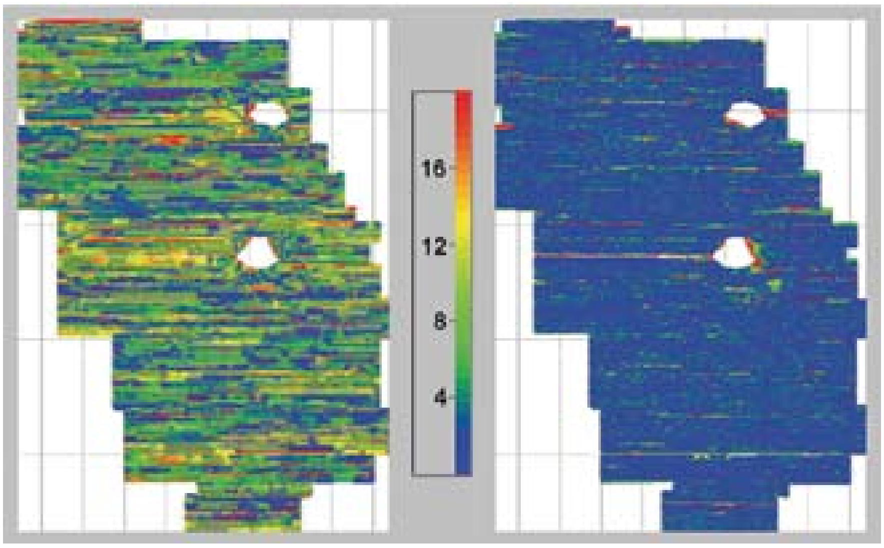


Figure 4 - 4D source-receiver azimuth difference plots between two sets of successive surveys. The colour maps display azimuth differences from 0 (blue) to 20 (red) degrees. The comparison on the left is the 1998 vs. 2001 surveys (streamer overlap, but no shot point repetition in the monitor survey), and the comparison on the right is the 2001 vs. 2004 surveys (shot point repetition + HD3D-4D in the second monitor survey). The HD3D-4D strategy robustly repeats source-receiver azimuths within two or three degrees.

Data courtesy of Shell E&P.

HD3D-4D Seismic Example

The seismic survey conducted over Shell's Draugen field in 2004 is a milestone in 4D acquisition with respect to repeatability. A conventional 3D survey was acquired in 1998 using four streamers at 75 m separation, and this served as the baseline survey.

The first monitor survey was then acquired in 2001 using the 'American Explorer' towing six streamers at 75 m separation over a four streamer pre-plot (i.e. the same nominal sail line separation). The 2001 survey did not attempt to repeat the shot positions of the 1998 survey, but resulted instead in an ideal 4D baseline survey with overlapping coverage and close to zero infill.

The second monitor survey was acquired in 2004 using the 'Ramform Valiant' towing an overlap configuration with 10 streamers at 37.5 m separation. The 2001 shot point locations were repeated as accurately as possible.

The denser streamer separation deployed in 2004 by the 'Ramform Valiant' combined with overlap shooting and shot point repetition has resulted in a much improved match to the source-receiver azimuths of the 2001 survey than the previous 4D survey (Fig. 4).

Conclusions

We recommend the following acquisition strategy as being ideal for highly repeatable 4D acquisition:

- the vessel is steered for repeating shot positions and sailing direction for all lines;
- acquisition with streamer overlap configurations, i.e. additional outer streamers are towed without increasing the sail line separation. In other words, the vessel is steered disregarding the outer 'overlap' streamers. This gives over-sampling of the surface fold, making it possible to select matching source-receiver azimuths during processing of the seismic data, notably at the sail line seams, and;
- dense streamer separation to optimize both data repeatability and data resolution.

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X-Ray Vision – Seismic

X-rays enable Doctors to 'see' inside the body and locate injuries without using a scalpel. Similarly, seismic enables Scientists to 'see' inside the earth and locate hydrocarbons without using a drill-bit.

By Wajid Rasheed

An acoustic means of investigating the earth, seismic is used by Oil companies to locate and characterize hydrocarbon accumulations within their acreage. Shooting seismic is the first step in reducing the risk accompanying oil and gas exploration. It enables the Geophysical and Geological team (G & G) to 'look' deep into the Oil company's acreage and interpret the type, fluid content and geometry of rocks contained therein.

In this way hundreds of square kilometers with vertical depths reaching 6 kilometers, or more, can be characterized without incurring the time, financial and environmental costs of drilling several dry holes. With diligence they will find bright spots – the industry term for a potential hydrocarbon reservoir. Bright spots will often form the basis of top drilling prospects. In this way, seismic allows the rapid and effective characterization of vast surface areas and pinpointing reservoir location and properties.

Sound Waves

Shooting seismic essentially relies on a 'source' that emits sound waves ranging from 1 to 100 hertz, and a 'geophone' that records the reflected waves as they 'bounce' back from different rock formations. This data is mapped by powerful computers using thousands of processors to yield 'processed' seismic information. This information forms 'seismic' sections which usually represent 10km depths of the earth at a time.

The G & G team pores over these sections gaining knowledge of formation thicknesses, locations, beds, dipping planes and, the all important, oil and gas reservoir. Coupled with advanced visualization software, it is possible to 'walk through the earth' – a reference to viewing the distribution of rock layers (stratigraphy See Issue 1) according to depth and properties.

Pay-per-view

As we have seen (Issue 2 Bids and Blocks) leases can be on state or privately owned land. In either case, seismic cannot be shot without a permit. There is a rising scale of regulatory demands associated with seismic activity which follows the general rule; offshore seismic (shooting water bottoms) permits are more stringent than those onshore. And those locations within nature reserves will have even more demanding permitting criteria.

In all cases, an Environmental Impact Assessment (EIA) will be undertaken by the Oil company and submitted to the appropriate environmental regulatory authority for approval. To conduct seismic a fee is usually paid to the landowner. Prices are determined by adjacent finds, the degree of exclusivity, regulatory burden, general market forces and whether the acreage is in private or state owned.

Needle in a haystack

Licensed acreage refers to areas where an oil company or group of oil companies has obtained exclusive rights to explore for, develop and produce hydrocarbons. But actually finding oil and gas is very difficult and depends on the location and size of blocks – which is a measurement of licensed acreage differing in size depending on location.

Offshore Northwest Europe block sizes vary between 300 to 500 km^2. Gulf of Mexico blocks are typically 23.3 km^2 or 9 square miles. Block size will also add complexity and cost. Typically, offshore Gulf of Mexico blocks are 9 square miles in size. Offshore North Sea block sizes vary between 230 square miles and 460 square miles. Blocks in new exploratory frontiers can be much larger – exemplifying this are Brazilian exploratory blocks which can be 2000 square miles.

Locating reserves in such a large area is no mean feat.

Other challenges

Waves, whales and winds are just some of the challenges facing seismic program. Others include sea-currents, sea-traffic, minimizing environmental impact and technical challenges associated with the seismic process itself. These technical challenges are related to receiving clear signals and reducing background noise which can distort seismic data, Accurate seismic saves oil companies millions of dollars that would otherwise be spent in drilling dry holes and reduces the environmental impact that drilling has.

Environmental Regulations

Regulations governing seismic are comparable in most oil and gas provinces and are based on wider environmental protection laws. The application for consent to conduct seismic or permit is issued after EIA which will consider various factors including disturbance to animal life. The regulations will limit acoustic and other disturbance to animals. In the case of shooting water bottoms, the animals most sensitive to disturbance are cetaceans (marine mammals) such as whales and dolphins.

Marine Mammal Observers (MMOs) must also be trained on implementing guidelines and procedure and are employed solely to minimize disturbance to cetaceans during seismic activity. For sensitive marine areas, the MMO must also be an experienced cetacean biologist or similar. Often, surveys are required to be conducted during summer months and during daylight, stopping if there is poor visibility such as fog or storm weather.

Regulations provide that at least 30 minutes before a seismic source is activated, operators should carefully observe from a high observation platform for any cetaceans within a 1,600 ft zone of the vessel.

Hydrophones and other specialized equipment may provide further indications of submerged animals and such equipment is to be used in particularly sensitive areas.

If cetaceans are present, then seismic sources cannot be activated until the animals have moved away. Generally, this is after at least a 20 minute waiting period. Except for sensitive areas, all seismic surveys using a source size of more than 180 cubic inches must follow a slow ramp up procedure. In other

Marine Mammal Observers (MMOs) must also be trained on implementing guidelines and procedure and are employed solely to minimize disturbance to cetaceans during seismic activity.

words, irrespective of whether marine mammals have been sighted – acoustic activity should be increased slowly. This can include starting with the smallest airgun and slowly building up. Space does not permit examination of other restrictions and procedures but suffice to say that seismic activity is controlled and an extensive written report must be sent to the authorities after the survey.

Surface tow

In 'shooting water bottoms', the most common source is an air gun, which releases compressed air into the water, thereby generating an acoustic shock wave which travels to the seabed and beyond. Seismic sources are towed behind the seismic vessel slightly beneath the surface of the water.

A streamer is towed behind the vessel on the surface of the sea picking up reflected sound waves. Usually, a streamer contains hundreds of pressure sensitive hydrophones in a near buoyant cable that can be 5 kilometers or more in length.

A geophone is a type of seismic receiver placed on land or on the seabed that records seismic waves by registering the minute movements of particles. In offshore operations, Geophones are configured to record both Pressure waves (PW) and Shear waves (SW). This is because sound travels through liquids (the sea) as pressure waves while it travels as Shear wave through solids (the earth below the seabed).

Brown and Green fields

Seismic has evolved greatly over the years and has applications in mature fields as well as the Exploratory phases of oilfield development. The industry uses the terms brown and green fields respectively to describe the age of the field. In fact, seismic provides tremendous value during the production of an oilfield and as mature fields have started to decline. This is because as with all technology, seismic is subject to constant improvement. Therefore, seismic shot 20 or 10 years ago would have had limited 'vision' and likely only located 'shallow' reservoirs. Opportunities exist to find deeper reservoirs in mature fields which were characterized by 2 D (2 Dimensional) early less sophisticated seismic. This can be seen in the new frontiers or deep gas play which is being explored in the Gulf of Mexico (Both Mexican and US waters) and in the Columbus Basin.

Deeper reservoirs or those located below salt would have been overlooked as previously seismic was not capable of penetrating beneath shallow reservoirs nor below formations containing thick layers of salt. Hand in hand with seismic advances have been drilling technology firsts such as overcoming directional control and drilling torque problems of drilling 10km depths.

For deeper or sub-salt seismic, two seismic vessels are run together with both shooting simultaneously and using long streamers. Global Positioning Systems are used to keep the two vessels at a known distance and this maintains the required distance between the source and streamer to accurately measure seismic reflections from deep and sub-salt formations.

"Shooting seismic" is crucial to reducing oil and gas exploration risk because it enables geophysicists and geologists (G & G team) to visualize deep inside the earth and locate accumulations without the cost and impact of drilling.

4D

Time lapse or 4D seismic accompanies the lifecycle of an oil and gas asset providing valuable seismic information on the asset as it matures. This also has tremendous value in shaping decisions as to the peaking of production rates and decline curve. Usually, a cost – benefit analysis is conducted which measures costs and attributes the value gained. This exercise can be difficult as they value gained may often be indirect. 4D seismic is used mainly to better manage reservoir production across the lifecycle of a field. Due to the increasing number of brown fields worldwide applications of 4D seismic have increased substantially. However, as seismic is a recent technology there are relatively few processes available to evaluate it.

bpTT's 4D Seismic Application

By virtue of its acreage in the Columbus Basin, bp TT owns various gas reservoirs in the Greater Cassia Complex, located offshore Trinidad and Tobago. Greater Cassia comprises brown and Greenfield developments including Amherstia, Immortelle Parang, Kapok, Cannonball and Cassia.

This required consideration of expensive 4D OBC (Ocean Bottom Cable) seismic acquisition options. Additional benefits from 4D seismic for monitoring dynamic reservoir performance could be foreseen with a permanent installation.

Here bp TT developed several research programs to refine decisions regarding which 4D acquisition option was the best solution.

In 2004, bpTT faced the challenge of valuing a number of seismic survey options over the Greater Cassia Complex in the Columbus basin, Trinidad. In Southern Greater Cassia several Tcf (Trillion Cubic feet) of gas reserves are located under shallow gas reservoirs, which often blur seismic visualization. Development of these reserves is complicated by the presence of 27 stacked reservoirs with reserves trapped in over 100 separate segments.

bpTT had to identify and value the style of survey required to improve seismic visualization over the southern half of the Complex affected by shallow gas imaging problems and value the benefits that 4D seismic could offer for reservoir management and future well placement. The main focus of this work is to present the process and the decision tree methodology used in the value assessment study as well as to present the main results from the study. The integration of these results with other elements helped support decisions for a seismic strategy for the 'Life of the Cassia Complex'.

"Raw Seismic Data" means acoustic reflections that have not been analyzed, processed, or interpreted.

Processed Seismic Information means geological and geophysical data that have been analyzed, processed, or interpreted to yield seismic sections".

New riser development– a free standing hybrid riser for deep waters

Francisco E. Roveri – Petrobras Research & Development Center – CENPES/Subsea Technology Group

Introduction

Petrobras is considering the single-line FSHR (Free Standing Hybrid Riser) design as an option for large diameter export risers in deep waters. This large bore specification combined with the deep water site put this application outside the present feasibility range of solutions such as flexile pipes and steel catenary risers (SCRs). Both these solutions present high top tension loads for installation and operation. The lateral buckling failure mode in flexible pipes and the fatigue damage in the touch down zone (TDZ) of SCRs are further design limitations currently only solved by the use of heavier pipes which further compromise hangoff loads in a negative design spiral.

The FSHR system has a reduced dynamic response, as a result of significant motion decoupling between the Floating Production Unit (FPU) and the vertical portion of the FSHR system and its vessel interface loads are small when compared with SCRs or flexible pipe solutions. Therefore it is an attractive alternative solution for this kind of application. There are further cost savings associated with this concept due to the added advantage of having the riser in place prior to the installation of the FPU.

The hybrid riser concept, which combines rigid (steel) pipes with flexible pipes has been utilized by the offshore industry since the 80's. The Riser Tower first installed by Placid Oil at Gulf of Mexico in Green Canyon 29 was refurbished and re-utilized by Enserch. More recently, the concept underwent some changes for application at Girassol field in Angola, where three towers were installed by Total. The Riser Towers at Girassol field are positioned with an offset with regard to the FPU, whereas at GC29 the vertical portion of the riser was installed by the semi-submersible FPU and was located underneath the derrick.

Five water and gas injection monobore FSHRs (10 to 12-inch) have recently been installed in West Africa offshore Angola, at Kizomba field in about 1200 meters water depth. The design of these risers has some key differences to one of the concepts presented in this paper, each of which offers different design and operational advantages. Riser towers are being developed for installation in the Greater Plutonio and Rosa fields in Angola.

Petrobras has been studying the hybrid riser concept for some years. In 1989 a feasibility study was developed for Marlim field, Campos Basin, for a configuration similar to the one utilized by Placid. After a long period, it was only in the year 2000 that this alternative was considered for conceptual studies at Albacora Leste field, in 1290 meters water depth, for the P50 turret moored FPSO. Two alternatives were considered for comparison: a Steel Lazy Wave Riser (SLWR) and one concept combining rigid and flexible pipes. In 2003 Petrobras contracted the conceptual study development of the Riser Tower solution for the starboard side 8-inch production lines of the P52 semi-submersible platform. Two towers were considered, each one comprising seven production lines and one spare line. In 2003 Petrobras also contracted the feasibility studies of an export oil FSHR to be connected to a semi-submersible platform in water depths of 1250 and 1800 meters.

System Description

The FSHR design may have a number of variants. Two configurations are presented hereinafter, the main difference being the interface between the Buoyancy Can (BC), the vertical pipe and the flexible jumper.

Configuration A

The configuration described below is considered for an oil export riser to be installed from a MODU (Mobile Offshore Drilling Unit), due to the availability of such vessels already under contract at Campos Basin.

The FSHR consists of a single near vertical steel pipe connected to a foundation system at the mud line region. The standard riser joints are 18-inch OD x 5/8-inch wall thickness X65 material. The riser is tensioned by means of a BC, which is mechanically connected to the top of the vertical pipe. The vertical pipe shall be kept always in tension in order to maintain the FSHR stable for all the load cases. The BC is 36.5 m long x 5.5 m diameter. It has 16 compartments and the maximum upthrust is about 570 Te. The BC is located 175 meters below the sea level, therefore beyond the zone of influence of wave and high current.

The FSHR goes from the hangoff slot at FPU to the Pipeline End Termination (PLET) located near the riser base. The lower end of the vertical part interfaces with a stress joint. Below the stress joint there is the offtake spool, which connects to the foundation by means of a hydraulic connector. A rigid base jumper connects the mandrels located at the offtake spool and PLET, providing the link between the FSHR and the pipeline. The foundation pile will be drilled and grouted and may typically be offset from the FPU by more than 200 meters.

The riser pipe passes through an inner 36-inch OD stem within the BC, and is guided within the stem by centralizers. Where the riser pipe is subject to high bending loads such as the keel ball centralizer on the BC, taper joints are used to reduce the stress in the riser pipe. The BC is secured to the riser pipe at the top of the BC by means of a bolted connection.

At the top of the free-standing riser is the gooseneck assembly. This assembly consists primarily of the gooseneck and an ROV actuated hydraulic connector which allows the gooseneck and flexible jumper to be installed separately from the vertical section of the riser. Attached to the gooseneck is the flexible jumper. The flexible jumper connects the free-standing section of the riser system to the vessel, and includes bend stiffeners to ensure that the range of rotations experienced at the end connections do not damage the jumper due to low radius of curvature. The flexible jumper has enough compliance such that the vessel motions and offsets are substantially decoupled from the vertical portion of the FSHR system, and consequently the wave-induced dynamic response of the free standing riser is low.

Configuration B

The position of the gooseneck in relation to the BC is the main difference between the West African and Configuration A designs. In the earlier design, the gooseneck is positioned below the BC and the vertical riser is tensioned by the can via a flexible linkage or chain.

This arrangement simplifies the interface between the BC and vertical riser, and allows pre-assembly of the flexible jumper to the gooseneck before deployment of the vertical riser. However, in the event of flexible jumper replacement or repair, an elaborate jumper disconnection system needs to be employed below the BC.

Positioning the gooseneck at the top of the BC allows for independent installation of vertical riser and flexible jumper. A flexible pipe installation vessel can install the flexible jumper

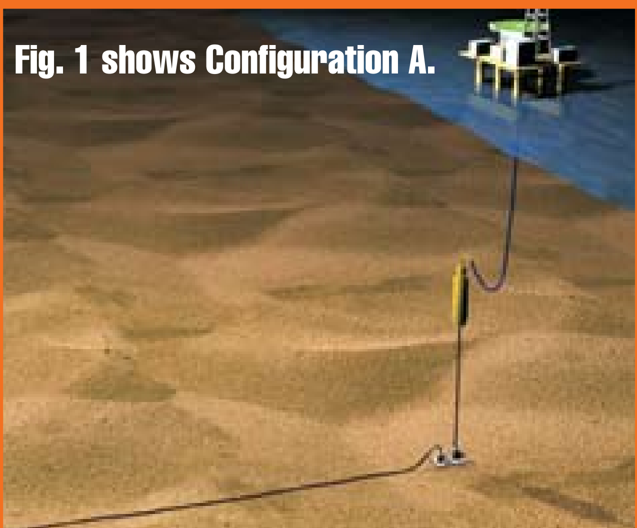

Fig. 1 shows Configuration A.

Fig. 2 presents Configuration B.

Petrobras is considering the singleline FSHR (Free Standing Hybrid Riser) design as an option for large diameter export risers in deep waters.

ROVERI

at a time of convenience. This minimizes the risk of damage to the flexible jumper during installation as the procedure is similar to that of a shallow water flexible riser with the first end at the top of the BC. This design also facilitates and minimizes the time for flexible jumper retrieval in case of damage, in service, to any of its components such as stiffener, end-fittings or pipe outer sheath.

On the other hand, it is necessary to have a continual vertical riser string right through the centre of the BC to provide a connection hub for the flexible jumper at the top. This arrangement introduces interfaces between the riser string and BC which have to be carefully analyzed and engineered. In addition, installation analysis has also to be conducted to assess the loads on the riser string during deployment through the BC. Other differences are the foundation type (suction piles x drilled and grouted pile) and bottom interface (flexjoint x tapered stress joint).

Configuration B presents the gooseneck positioned below the BC. The vertical riser is tensioned by the BC via a flexible linkage or chain and the hub is in offset with regard to the vertical section of the FSHR. This allows the flexible jumper to be installed in a similar way as Configuration A, therefore overcoming some disadvantages of this configuration and previous designs.

Installation

Installation procedure of Configuration A is defined such that the FSHR can be installed using a MODU. The procedure requires the BC to be transported to the work site separately from the riser, then positioned beneath the drilling rig. The riser is installed by continually joining and running the riser through the BC. Once fully assembled, the entire riser is then lowered to the seabed using drill collars and connected to the foundation.

For Configuration B, the installation shall be performed by a specialized vessel (e.g. having a high capacity crane and J-lay capability). The riser is run by continually welding the 50-meter quadjoints. After deployment of the vertical segments, it will be connected to the BC by a segment of chain and the assembly will be deployed for connecting the lower extremity to the foundation. The BC is de-watered by means of ports located on the side of each compartment. Each compartment features an inlet and an outlet port. During de-watering nitrogen is injected into the can at pressure and the BC compartment is slightly overpressurized with regard to the water pressure outside.

Design Issues

The design of an FSHR typically involves an upfront global analysis of the system to optimize the riser configuration. Parameters to be varied are (a) offset from the production platform, (b) depth of BC, (c) flexible jumper length, (d) net upthrust provided by the BC and (e) FSHR azimuth. Clearance may be an issue and interference with adjacent risers or mooring lines drives the choice of the system layout.

The FSHR comprises special components, such as taper joints, gooseneck, offtake spool and rigid base jumper, for which detailing will be required. In addition, the riser string components shall be able to withstand both the installation and in-place loads. The FSHR benefits from the fact that the overall system design is robust and relatively insensitive to a number of parameters. Therefore, a relatively conservative design approach may be adopted for the upfront global riser design, with allowances for parameter sensitivities and design changes during design completion. The system is designed and analyzed in accordance to API RP 2RD for 25 years design life.

The VIV (both due to long term and storm currents) response of an FSHR generates fatigue damage that is low along the majority of the riser length, but high at the two ends of the vertical section of the system. The critical region for VIV damage tends to occur in the riser string just below the BC interface for Configuration A. Shear7 was utilized for assessment of fatigue damage due to VIV. The use of strakes may be necessary given the uncertainties associated to VIV. VIM of the BC may induce significant motions on the riser system.

The fatigue damage the system may undergo during installation shall be limited such as to leave most of the allowable damage to be spent when the riser is in-place. Considering a safety factor of 10, the minimum required system fatigue life is 250 years, which is fulfilled for the in-place condition. The in-place analyses have assessed the damage due to first and second order motions and due to VIV and VIM. The acceptance criterion establishes that the four sources of damage be added and that the resulting fatigue life be above 250 years. For Configuration A, most part of the damage is due to VIV, followed by first order motions. The damage due to second order motions is negligible. The total fatigue damage shall consider both installation and in-place phases.

Conclusions

In the FSHR design concept, the location of the BC below high current and wave zone, and the use of the flexible jumper to significantly decouple vessel motions from the vertical riser greatly reduce the system dynamic response, resulting in a robust riser design particularly suited to deep water applications. The design is relatively insensitive to severe environmental loading and non-heave optimized host vessels when compared to SCRs and flexible risers. The robustness allows the riser to be conservatively analyzed, and allowances for design changes and uncertainties to be included upfront in the design process, thus giving greater confidence in the overall system design.

For engineering, procurement and construction (EPC) contractors not having a suitable vessel, or unable to mobilize their vessels to install the FSHR, the ability to use a MODU as the installation vessel could prove to be an attractive alternative.

It can be said that the FSHR concept extends the reach of deep water riser feasibility as it avoids the main technical problems faced by other solutions, and arguably, it may be among the few proven riser concepts feasible for deep water large bore applications.

TECHNICAL PROFILE **SPONSORED BY WEATHERFORD**

RiserCap Rotating Control Head System

Fabricio Clemente, Weatherford.

Following the Brazilian deepwater tendency, Weatherford offers a RiserCap system designed to replace conventional slip-joint/diverter/bell-nipple system used for floating drilling rig applications (drill ships or semi-submersibles). The RiserCap is installed on the top of the marine riser in floating rigs with subsea BOPs and uses a specialized Rotating Control Head (RCH) based system for improved well control, spills containment minimizing environment impacts and personnel exposure.

RiserCap system can provide additional isolation during different drilling circumstances: sour gas drilling; handling sweet gas-cut drilling fluid, aerated fluid drilling, gas drilling operations and also allows you to RIH casing strings with your annulus casing/openhole closed by a rubber element.

During drilling operations, it provides a continuous high pressure-capable mechanical seal for the annulus riser/drillpipe. Mud returns to the rig through flexible hoses with sufficient length to accommodate heave movement and in number and sizes correctly designed to accommodate return rates and attend all operational needs.

RiserCap vs Conventional Slip-Joint System

As the slip-joint system has been used for years in the oil industry, it is already widely accepted as a standard system and limitation and maintenance procedures are already well understood. Using the RiserCap system you must add a few operational procedures like remove the bearing assembly to change the rubber element.

When working with diverters, usually their working pressure is rated to 500 psi but it is the telescopic joint packer which will determine the system's working pressure. Using RiserCap you may lock closed the slip joint and the seals fully energized or the telescopic joint can be eliminated from the system allowing the pressure limitation to be the burst and collapse rating of the marine riser.

Typical RiserCap Installation.

Some limitations of the conventional slip-joint system are: pressure sealing system must be hydraulic activated and is subjected to wear and failure, and if an influx of gas gets into the riser it must be detected and then the diverter closed in order to prevent gas release at the rig floor.

Working in a rig equipped with a RiserCap system allows the use of a pressurized mud return system and is compatible with other emerging drilling technologies like underbalanced drilling. It should also be more reliable than slip-joint system because it is easier and faster to change seals or perform any maintenance. If any influx of gas comes undetected into the riser it would be contained even without human intervention or activation required with conventional diverter system.

When the bearing assembly is not in place, you have different accessories that can also be used for operations optimization like: drilling nipple, casing stripping assembly, test plug, logging adapter and others.

This system had already been successfully used in Brazil with Petrobras for an underbalanced drilling operation and in a mud cap drilling operation conducted for Shell in Malaysia and others.

Conclusions

RiserCap technology when correctly applied could be a significant improvement over the conventional slip-joint technology. Its use provides a continuous contained mud return system allowing to keep drilling with gas influx into the wellbore and to rotate the drillstring while displacing gas from the annulus minimizing risks of stuck pipe. Like any new technology it takes field trials and time to be implemented and recognized as an improvement for the oil industry, but RiserCap has a great potential to become a new standard for deepwater drilling from floating rigs with subsea BOPs.

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e-Drilling;

Advanced Real Time Drilling Modelling, Optimization, Diagnosis and Visualization

Rolv Rommetveit, SINTEF Petroleum Research

A new generation real time simulation and visualization system designed to integrate all participants involved will enable enhanced collaboration of all drilling and well activities in a global environment.

e-Drilling will provide the technology elements to realize real time modelling, supervision, optimization, diagnostics, visualization, and control of the drilling process from a remote drilling expert center. These technology elements are:

- An advanced and fast integrated drilling simulator which is capable to model the different drilling sub-processes dynamically, and also the interaction between these sub-processes in real time
- Data Quality Module DQM
- Real time supervision methodology for the drilling process using time based drilling data as well as drilling models / the integrated drilling simulator
- Methodology for diagnosis of the drilling state and conditions
- Advisory technology for more optimal drilling
- A Virtual Wellbore, with advanced visualization of the downhole process
- Data flow and computer infrastructure

Data Quality Module

Correct processing and interpretation of the data that are acquired in the drilling process is essential for safe as well as reliable interpretation. Today, measured data are often disturbed by physical effects that can lead to faulty interpretation. By systematic modeling of physical effects that influence the measured values, improved drilling data will be obtained for important drilling parameters. In addition to the error correction, algorithms will also be developed for identification of the proper state of the drilling process (drilling, tripping, circulation, making connection or reaming).

Advanced filtering techniques are required to extract as much information as possible from drilling data.

This module will therefore address:

- Calculation of important physical parameters from available raw data, e.g. calculation of hook load and surface torque,

- Determination of drilling status, e.g. whether bit is on or off bottom and whether drillstring is in slips,
- Detection and handling of sensor failure,
- Correction of systematic errors and noise,
- Removal of erroneous or misleading data that are not handled otherwise.

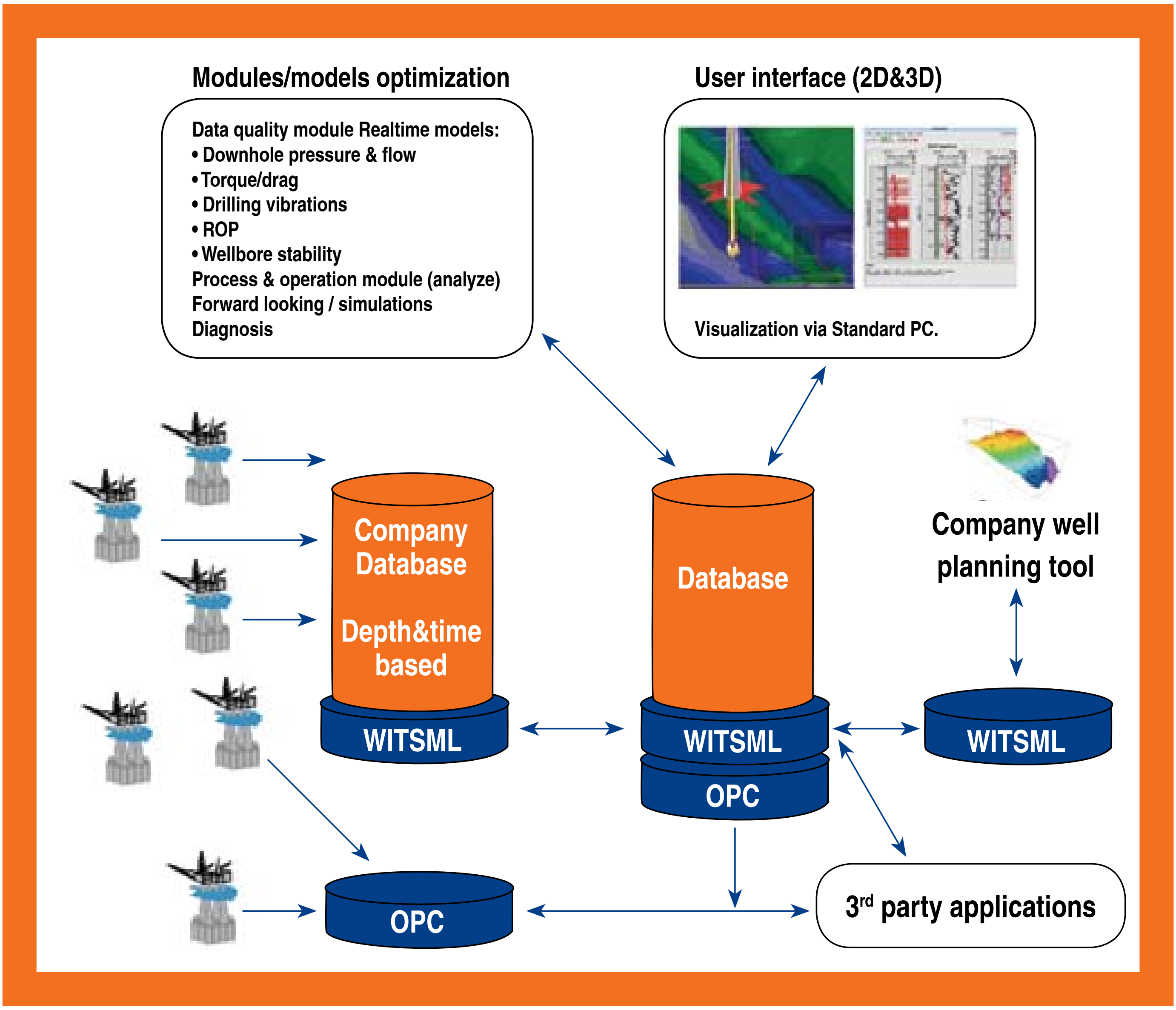
Downhole pressure and flow

An advanced transient flow and temperature model has been built. The model can handle calculation of:

- Pressure/ECD, temperature, and pit volume vs. time while drilling and circulating, including flow of cuttings. Detailed modeling of formation of cuttings bed is beyond current scope, but the model will warn when significant bed formation is expected.
- Detailed modeling of formation of cutting beds is beyond the scope of the technology currently, transient well pressure and flow vs. time during surge and swab.
- ESD and temperature vs. time during static periods, e.g. flow tests.
- Transient pressure and flow vs. time while resuming circulation after static periods.

The model will be calibrated to incorporate effects of slowly drifting model parameters, but still give warnings when relatively rapid significant changes relative to model prediction are observed. The model has been used in design, procedure

Fig.1: Typical e-Drilling infrastructure.



development and also for real time optimization and follow-up of critical operations.

Torque/drag

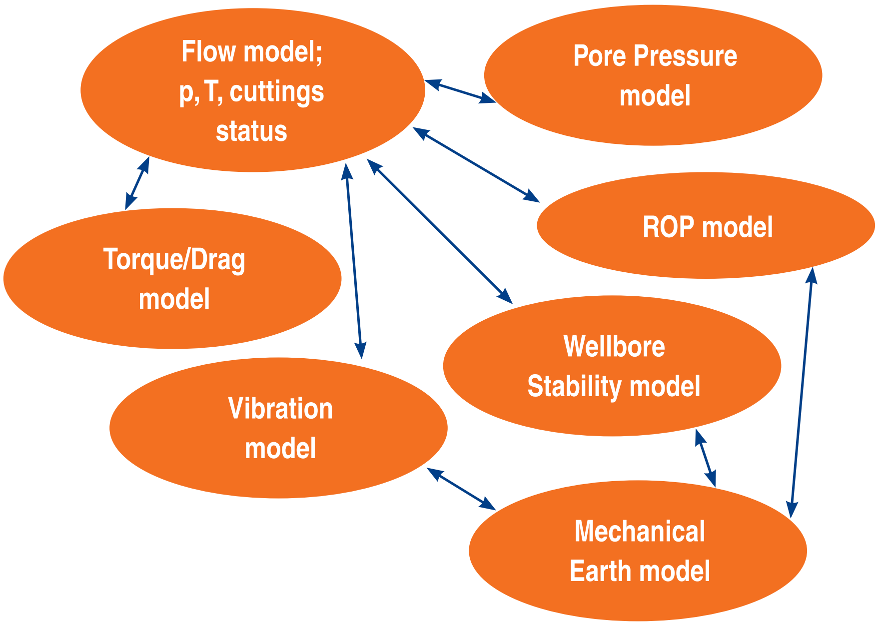
An advanced torque/drag model has been built. The model will be applied for the calculation types:

- Calculate WOB with input of hook load or vice versa. Automatic calibration when rotating off bottom can be used.
- Calculate bit torque with input of surface torque or vice versa.
- Back-calculation of friction factor with input of measured surface and bottom hole weights or torques. Friction factor can be monitored with warnings issued on unexpected changes.
- Bit depth correction due to string elasticity. More accurate bit depth will increase value of LWD.
- Initial calibration of rig specific parameters, such as model parameters for force/torque transfer from top drive system to string.

Benefits are realized through

- Comparing measured hook load with calculations while tripping, and warn if unexpected deviations occur. Compare with earlier trips to identify expected effects like dog-legs.
- Comparing measured and calculated hook load and torque during connection tests, which typically involves pick up, rotating off bottom, and slack off. Trends in data and calculations are used to obtain early indications on poor hole cleaning.

Fig.2: Sketch of how different sub-models interact in the Integrated Drilling Simulator.



- Comparing measured torque and ROP while drilling with calculated results to get early indications on poor hole cleaning. Both the torque/drag model and the bit/ROP model will be involved.

Drilling vibrations

Algorithms are implemented to help detect drillstring vibrational problems. When such problems are detected, solutions will be recommended. Recommendations might include active damping, such as the algorithm developed to cure stick-slip motion of the drillstring, or passive adjustments to the drilling parameters weight on bit or rotary speed. The algorithms can also be used in planning a wellpath and BHA design to help avoid drilling vibrations.

ROP

While drilling a well, the rate of penetration will vary. Some of this variation is due to variations in the formation parameters and some is due to variation in the drilling parameters. The important formation parameters are the compressive strength and the formation pressure. Drilling parameters include a description of the bit, the weight on bit, the rotary speed, the borehole pressure, the mud flow rate and viscosity. Analysis of these variations, intentional or incidental, can give more information on conditions downhole than is generally assumed possible. Time-based logging data is a prerequisite for this analysis.

The analysis of the ROP will be performed simultaneously with analysis of (1) torque on bit/weight on bit relationship, (2) torque and drag analysis, (3) monitoring of hole cleaning, and (4) well pressure, but the main focus will be on ROP.

Wellbore stability

Considerable expertise exist in well bore stability. Existing models are expanded to estimate the probability of well bore instability based on formation description and the temperature and pressure history along the well path.

Pore Pressure

The multi-purpose geo-pressure modeling tool PRESSIM includes all processes relevant to pressure generation and dissipation.

Process & operation module

The integrated drilling simulator will be driven by the drilling data, and computed results will be compared with measured values to generate an initial diagnosis. Trend curves of measured drilling parameters versus calculated will be used to visualize the drilling history. The process and operational related modules will use results from the basic process models to discover upcoming problems as early as possible, and to further analyze the drilling data when problems are suspected. These will run in the background and give input to the active process and operational related modules during the various drilling phases.

Diagnosis

Various specific process and operational related modules will be built on top of the basic process models for interpretation and diagnosis purposes.

Forward Looking

Automatic forward-looking is performed by the calibrated models by projecting the drilling process a given time period ahead.

Results

This system will enable decision makers to have better insight into the status of the well and formation surrounding the well and thus make better and quicker decisions. This is of particular importance when problems or unusual situations arise and experts are called in to make decisions. They will quickly be able to grasp the situation and make the correct decision.

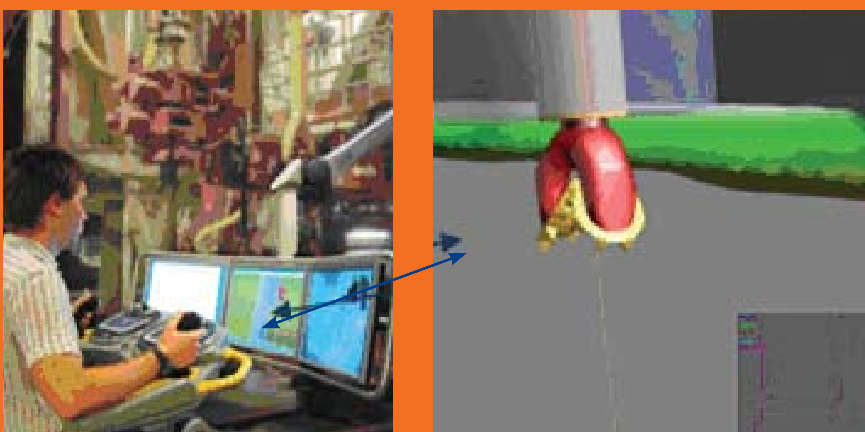
Conclusion

By combining, in real-time; simulation and drilling analysis, interfacing; and 3D visualization you will get a system that all involved personnel can use as their common working tool.

This tool will easily reflect what is going on now and also give the user access to historical data (playback scenarios) for experience exchange and training.

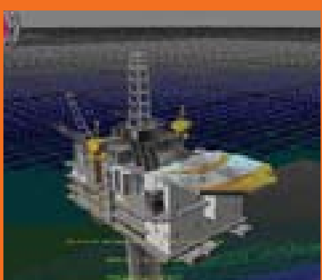
The overall result is a more cost effective and safer drilling and well construction operation.

Fig.3: Screen shots from the virtual wellbore 3D visualization tool.

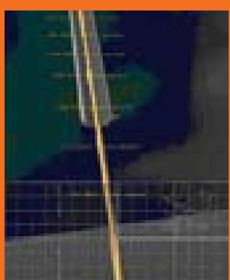


Drillers view with focus on bit movement in the well.

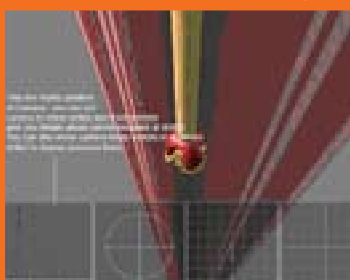
Visualization of wash-out, tight spots and cutting bed.



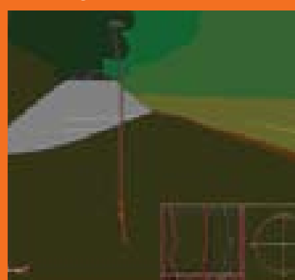
Realtime modeling (installation).



Casing shoe.



Realtime view of ECD model data with PWD data from MWD tool.



Geological layers.

Liquid Pipelines and Terminals

By Marcelino Guedes, Director Petrobras Transporte

Transpetro is present in the whole of Brazil, through the operation of 44 terminals and a pipeline network of around 7,000 km of oil pipelines, operating from the north of the country in the Amazon region – pipelines ORSOL I and II and terminals in Coari, Manaus and Belém – to the extreme south – Rio Grande Terminal. With an infrastructure of around 500 storage tanks for oil and oil products, in addition to 80 globes for LPG, Transpetro has the installed capacity to store approximately 10 million m^3 and transport around 53 million m^3/month of oil and oil products, in addition to handling around 4,600 shipping operations per year. Complementing the infrastructure of these terminals, Transpetro owns two multiple buoy mooring systems and five mono-buoys, with the objective of unloading in locations where the coastal conditions do not allow the mooring of ships.

Operational Safety

Transpetro maintains the consistent policy of improving the safety of its operations. In the Pipeline Integrity

Program (PIP) alone, US$ 630 million have been invested – with the result being a reduction in the volume of leaks to the order of 93%. PIP, which is destined to ensure perfect functioning of the installations and reliability of operations, has been continuously revised and has gained new monitoring tools.

In 2005, the Terminal Integrity Program (TIP) began to be implemented. This will establish a series of technical projects with the objective of achieving excellence in the safety and integrity of the installations and infrastructure of the units. The integrity programs for pipelines (PIP) and terminals (PIT), which include stabilization of the slopes, renovation of piers and storage tanks are being enhanced by the training of the workforce.

The National Operational Control Center (NOCC) ensures the standard of safety for the operational control of the pipeline network throughout Brazil. From there, the technicians accompany remotely and in real time the operations in the pipelines. NOCC is equipped with computers and the leading edge technology. Supported by the Supervisory Control and Data Acquisition (SCADA) software, the operators receive immediate detailed information about what is happening in the pipelines and monitor the levels of flow, pressure, temperature and density of the oil and the gas. At the least sign of any abnormality, the system allows for telecommand interventions such as the switching on or off of pumps, or the opening or closing of valves in any stretch.

Pipelines and terminals, just like all of the Transpetro installations, comply with norms that go beyond the regulatory demands, having the voluntary certifications for the Integrated Management of Quality, Health, Safety and the Environment (QSMS) – ISO 9001 (quality), ISO 14001 (environment) and OHSAS 18001 (international norm for occupational safety) – being evaluated by international certifying agencies.

CREs – Transpetro Management – 34
CDAs – Petrobras Management – 9
Advanced CDA Bases – 6

Within the projects aimed at increasing the operational safety of the pipelines, is the Program for the Greater São Paulo Outflow Logistics Reformulation. The project, with investment of around US$ 1 billion, establishes the substitution of the existing pipeline network installed in the metropolitan region of São Paulo, with an external network. The objectives are to provide the network with the capacity for the growing movement of oil, oil products and other products, and reduce the safety risks provoked by the heavy urban concentration in the pipelines rights of way in Greater São Paulo.

In addition to all the care taken with operational safety, Transpetro maintains an infrastructure to respond to emergencies that includes a Center for Emergency Pipeline Repairs (CREDUTO) in Guarulhos – São Paulo, and 49 Emergency Response Centers (CREs and CDAs) spread around the country, with equipment and teams trained for a rapid response to any accident with a possible impact on the environment.

New Projects

The increase in the price of oil and the growth in demand for fuels with less impact on global warming have led to the search for biofuels. In Brazil, the Transpetro Program for Ethanol Logistics gained impetus due to the Brazilian experience with alcohol technology, and the perspective that by 2014 demand for ethanol will reach 25 million m³ in the domestic market and 5.5 million m³ abroad. Transpetro is preparing to increase its capacity of fuel ethanol outflow from the present 1.2 million m³ per year to 9.4 million m³ per year in 2015, with investments in exclusive pipelines and tankage in the Southeast, the South and the Northeast of Brazil amounting to US$ 532 million. The principal investments are as follows:

- Ethanol pipeline Paulínia-Guararema: exclusive pipeline for ethanol with the capacity for eight million m³ per year. The investment is US$ 154 million.

- Ethanol pipeline Uberaba-Ribeirão Preto-Paulínia: capacity to transport four million m³ per year. The investment is US$ 100 million.

- Tietê-Paraná Waterway: capacity for transporting four million m³ of ethanol per year from the west of São Paulo, Mato Grosso and Goiás to Paulínia and take the same quantity of diesel oil and gasoline from Paulínia back to these regions. The investment is US$ 236 million.

- Ethanol pipeline Guararema-São Sebastião: capacity for four million m³ per year. The investment is still being evaluated.

- Construction of three more tanks at the Maceió Terminal, increasing the capacity from 400,000 m³ per year to 700,000 m³ per year. The investment is US$ 4 million.

- Paranaguá Terminal: adaptation of an existing tank, construction of two additional tanks and a platform for tanker trucks with the enlargement of the wagon platform to increase the capacity from 400,000 m³ per year to 700,000 m³ per year. The investment is US$ 4 million.

The highlight among the new projects for oil pipelines is the study for the implantation of a pipeline of around 1,400 km between the REPAR Refinery in Araucária and the cities of Londrina, Campo Grande and Cuiabá, with the objective of reducing the logistics cost of transporting oil products to the central-west region, meeting the growing demand generated by the expansion of agribusiness in that area.

The increasing demand for natural gas in Brazil, whose estimated annual growth is around 14% per year to 2010, taken together with the necessity to diversify the sources of supplying this fuel, have led to the anticipation of projects for water-based terminals with the capacity to receive, vaporize and dispatch natural gas. For this purpose, projects are being developed for the implantation of terminals capable of receiving ships carrying Liquefied Natural Gas (LNG) initially in Ilha D'Água – Rio de Janeiro, in the southeast of Brazil and in PECEM – Ceará, in the northeast.

Graphic shows Schematic of Pipelines

ADVERTISEMENT TIGER TANKS TRINIDAD UNLIMITED

Casing Drilling Technology

Jorge Sanguino, TESCO Corporation, João Carlos Ribeiro Plácido, Petrobras

This process developed by TESCO eliminates the conventional drillstring by using the casing string to transmit mechanical and hydraulic energy to the bit. Statistics on safety have demonstrated that drillpipe and conventional casing handling are major cause of accidents associated to drilling a well. The Casing Drilling® process requires fewer people on the rig floor and less pipe handling than conventional rotary drilling, resulting in a safer drilling process. It also eliminates unscheduled events that result from tripping the drill string, such as swabbing, formation sloughing and swelling.

Retrofitting an existing rig with Casing Drilling® equipment is easy to do and does not interfere with its use for conventional drilling. As a dual-purpose rig, it can be used on a wider range of wells, increasing contract opportunities. For long term projects, Casing Drilling® fit per purpose rigs can be manufactured, resulting in smaller and lighter rigs due to the use of Range III masts, no setback required, less fuel use, and less loads to move, consequently less horsepower is needed, resulting in a less environmental impact process and hence less capital investment.

The main reasons to use this technique are to reduce trip time, eliminate well conditioning time before running casing into the well, overcome troublesome formations with well instability and loss circulation problems, and improve well control.

A pilot hole is drilled using a conventional bit and an underreamer enlarges the well diameter. The BHA is attached to a DLA (Drill Lock Assembly), which connects the BHA to a profile nipple immediately above the casing shoe joint. The BHA can be tripped with wireline, coiled tubing or drill pipe. When the BHA is run into the well, spring-loaded dogs in the DLA stop the tool at the proper depth to lock it to the profile nipple. The locking process is accomplished by shifting a sleeve downward to positively extend lock dogs into recesses in the profile nipple.

Any type of BHA can be used, depending on the operation. For vertical wells, the BHA may consist of a pilot bit, stabilizers, and underreamer. For directional wells, the BHA would include a downhole motor and MWD (or LWD). A casing connection must have adequate torque capacity to withstand drilling loads. A torque ring increases casing torque connection capacity.

The experience Casing Drilling® system in Brazil consists of three tests, which covered a wide range of complexity, from very simple vertical wells to high angle directional wells.

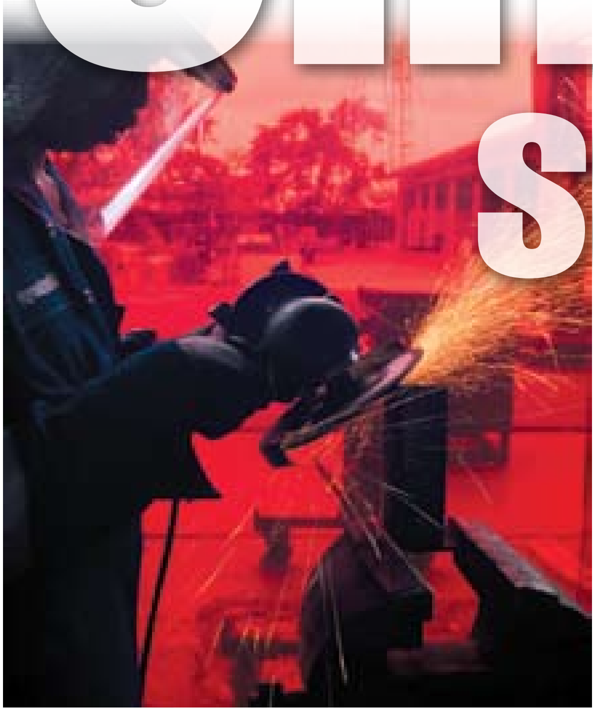
The first Casing Drilling® test in Brazil was conducted by Petrobras in the Pilar field on June 2003. Casing Drilling® was used to drill and case the 13-3/8” and 9-5/8” intervals. The 9-5/8” casing was used to directionally drill to 30 degrees.

The second Casing Drilling® test was conducted, also in 2003, in the offshore Curimã field, Northeast of Brazil, using a jack-up rig. The test objective was to drill in the 13-3/8” surface casing to overcome the troublesome fractured limestone formation. When drilled conventionally, this zone experiences total loss circulation, impairing the casing running operation. The technique Casing Drilling® presented potential for drilling loss circulation zones, in fractured limestone formation.

In the third test, in November 2004, a 9-5/8” directional Casing Drilling® system was used to drill through a troublesome section in an onshore Petrobras well, also in Northeast Brazil. Previous attempts to drill horizontal wells in the Aracas field were unsuccessful in penetrating through the over pressured Taua shale to set casing in the under pressured Agua Grande pay zone. Mud weights adequate to keep this shale from collapsing caused massive lost circulation at the top of the Agua Grande. Sliding mode required the casing to be “rocked” in order to slide effectively. This test demonstrated that 9-5/8” casing can be used to drill directional wells with adequate directional control and competitive drilling rate.

After all these tests, the Casing Drilling® system has shown great potential to overcome troublesome zones. After these trials, it was observed some points could be improved. The system was modified and tested in USA by Conoco Phillips. The tool is being prepared to be sent back to Brazil, where a new test will be performed this year in an onshore field located in the Northeast of Brazil.

Oilfield services



Many types of oil and gas contracts exist. In this article, we consider the process of selecting and contracting oilfield service companies.

By Wajid Rasheed

It is worth distinguishing oil and gas operating contracts from service and supply contracts. Already we have seen how operating contracts provide a framework for paying hydrocarbon production royalties (Issue 2 Bids and Blocks). Now we can consider how service contracts enable the supply of equipment and technical services that are necessary for hydrocarbon production.

Outsourcing

Traditionally, oil companies whether IOC, NOC or independents have always out-sourced certain oilfield activities-such as rig supply or facilities engineering. As the industry consolidated in the 80's and 90's, the volume of outsourcing increased as new definitions of *non-core* activities were applied to a greater number of activities and disciplines.

Major oil and gas disciplines are classed as:

- Facilities (Platforms)
- Drilling and completions
- Production
- Reservoir Engineering
- HSE
- Management Systems (IT and Accounting)
- Project Management
- Project Economics/Financing

Nowadays, non-core activities are defined differently according to the discipline and oil-company in question. However, the common thread that emerges is that all disciplines will have at least some outsourced elements. This means that any given oil company will have service providers in many different areas of activity.

The extent of actual outsourcing depends very much on the culture of the oil-company, the degree to which a task is defined as core and its accompanying level of commercial sensitivity.

Core activities

For example, facilities engineering is an area that is traditionally outsourced. But certain oil companies may consider Production or Drilling and Completions as non-core. In this case, an oil company representative will manage the activity but the actual engineering is conducted by a lead service company and a number of sub-contractors. Other oil companies may consider disciplines such as Reservoir Management as core, or as sensitive and therefore not wish to outsource the service.

Process of selection

Despite the oil and gas industry being highly globalised, most of the factors that influence the selection of contractors are locally based. These include variations from nation to nation, operator type, the extent of goodwill between companies, technical innovation and price.

The actual selection of contractors is a complex process that requires oil companies to appoint a project manager or other executives acting as a tender board in order to prepare a contracting strategy.

This document will cover the pre-qualification of tenderers, a finalized bidders list, finalized technical & commercial specifications, the preparation and issuing of a tender document, bid clarification, issuing of clarifications and addendii to tenderers, preparing company estimates, the evaluation of technical and commercial bids, presentations to the project manager or tender board, presentations to the Ministry that deals with Oil & Gas leases, the awarding of contracts, start up (mobilization), a contract management database, runlife target & calculations, budget calculations and management of the contract. Corporate governance and ethical standards are often also included.

National factors

Many service companies can trace their origins to as far back as 50 years ago, and in some cases, as much as a century. During this time these companies will have built up strong positions in technological niches and market locations. These positions will be based on local applications, relationships, investment and management philosophy.

Variations in market presence occur due to political situations, governmental policy and trading regulations between countries. Therefore, certain service companies will be stronger in certain markets, enjoying a leadership position while in other geographic areas they will have only a skeletal presence. In this way, the service sector tends to balance itself out globally with the larger companies tending to consolidate their market share in certain areas while being weaker in others.

For example, this occurs with giant service companies such as Baker Hughes, Schlumberger and Halliburton. One or more of these service companies may have a large market share in Latin America and the North Sea while having a reduced presence in the Middle East. By the same token, the other service company's operations will reflect the opposite: it will have a stronger presence in the Middle East and a lower presence in other areas.

Operator Type

Large International Oil Companies (IOC) such as Shell and BP will always tend to favour centralized service agreements due to the high number of operating assets these companies hold. A central procurement contract offers global supply and pricing advantages which will have been negotiated by a head or regional office with bulk volumes in mind. Many such contracts exist and are aptly named such as the *Big Lever or Enhanced Supplier Contract or Preferred Contractor*. The oil companies will also appoint local focal points which enable the contracts and services to be managed more effectively and in accordance with local needs.

For certain products that can be bought in bulk such as casing, bits and drilling fluids this provides certainty of business on both sides. Independents may also develop global preferred service agreements but due to a much smaller number of operating assets, their contracts will be less centralized and will tend toward establishing contact with major service companies on location.

Typically, IOCs will employ a global focal point or a project or technology leader with responsibility for contracting strategy and direction, each region or major asset will also have a local specialist or focal point. This local specialist will have a local service company counterpart. Other staff will include service personnel seconded to the oil company's local offices.

National Oil Companies

National Oil Companies are more likely to contract long term services and develop partnerships with service companies. NOC's despite their perception to the contrary provide many of the most lucrative service contracts.

The perception is that "the lowest price wins" philosophy is predominant. This maybe applicable in some cases but in general the NOC's often offer long term fixed revenue contracts, something that IOC's rarely offer.

Goodwill

This concept covers global relationships that permit the exchange of technology, knowledge and operational know-how. These relationships exist at many levels; some oil companies use bulk-buying contracts to supply international operations, there maybe JIPs (Joint Industry Projects), technology cooperation agreements, relationships at various levels within oil companies and their service company counterparts and relationships with specialized small companies.

Technology Innovation

Small companies may not achieve large economies of scale but at the same time they do not have large overheads. Because they can act rapidly, they often can beat the giants when it comes to developing new technology. True, operators develop technology in-house, through joint industry projects and with best-in-class companies.

For example, Shell and Petrobras respectively are involved in the monobore and the Procap 3000 initiatives – two examples of technology cascading downward. Underlying the monobore (a vision of drilling and casing a single-diameter well from top to bottom) is the creation of two businesses to develop the downhole tools, tubes and market for expandables. Procap 3000 – a range of exploration and production technologies – is paving the way in ultra-deepwater development.

Drilling contractors have introduced simultaneous drilling and completion of two wells by way of the dual-derrick system. Additionally, the billion-dollar think tanks and research and development facilities that major service companies own are continually creating new technologies.

So how do small companies compete against this backdrop? And how do they succeed without the benefit of marketing channels or the influence of larger service companies?

Small companies can distinguish themselves by providing a service that includes applications analysis, technical recommendations and rigsite support through end-of-well reporting.

And if they can maintain market leadership, they will attract the attention of operators interested in new technology. Certain oil companies, select market leaders in what they deem essential technology and work with those leaders to develop technology. (Tough luck if you're not No. 1.)

A typical oilfield services contract

Nature and Obligations of Contractor & Company

- Parties
- Obligations & Conditions
- Performance Standards
- Personnel
- Safety / Environmental
- Procurement of Goods and Materials
- Subsurface Conditions
- Force Majeure

Liability and Risk Control

- Risk and Liability Clauses
- Performance Standards
- Corporate and Personal Guarantees
- Letters of Indemnity
- Warranties

Insurance

- Insurance Obligations
- Coverage
- Claims

Non-Disclosure or Confidentiality Agreement

- Acquisition and Control of Proprietary Information
- Patent Rights
- Technology Licensing

Pricing

- Payment schedule
- Dayrate, operational, LIH

Audits

- Auditing Procedures
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SELECTION OF CONTRACTORS

Service integration

Tangled Thicket – Integration?

Traditionally the oil company appoints a lead service contractor which may or may not be responsible for naming a drilling unit provider. The complexity of the drilling unit required will also affect whether this decision is made by the lead contractor or oil-company. Drilling units will vary according to offshore and onshore needs; drillship, semi-sub or land rig.

Subsequently, specialist contractors in each activity of each discipline are selected. Because very few companies can provide all the required services, the concept of integrated contracting became commonplace. An integrated contractor or contracting alliance allows for each party to calculate their share of the development cost and price. These calculations are then used as performance targets, with the gain or pain of reaching the target or not being shared.

But for operators fed up with the tangled thicket of contracts and contractors, the easiest course may lie in integrating outsourced services. This certainly reduces some of the complexity and numbers of service providers by providing a single point of contact.

However, the appropriateness of integration depends very much on the location and nature of the project; the right approach for a development in China probably is inappropriate for Brazil. While US Gulf of Mexico contracting differs greatly from Mexican, Gulf of Mexico practices. Equally UK North Sea contracting differs greatly from Norwegian North Sea practices.

Critics would argue that integration tends to discourage small-company services, as the main service provider will fulfill most technology requirements in-house. Only where technology is unavailable can a small company enter the project, filling a gap that no other business can. Integrated services often mean small companies are required to meet wide-ranging legal or other tender requirements, many of which are applicable only to the major service provider. While safety is non-negotiable, it seems unfair to insist on the same levels of insurance liability for two different scopes of services. This asks small companies to bear more project risk without an accompanying increase in the reward.

Price – Market Cycles

Market cycles affect pricing more than any other aspect. In terms of tender strategy, an operator may use price competition as a way of controlling costs. In a down market, demand falls while the need to maintain utilization remains. Here price-beating where the lowest price wins maybe adopted by the service company to retain work. In an up market, demand is increased with greater demands on utilization. Therefore price competition is counter-productive as companies will simply tend not to provide services or equipment as they are diverted to the highest paying markets.

Performance pricing

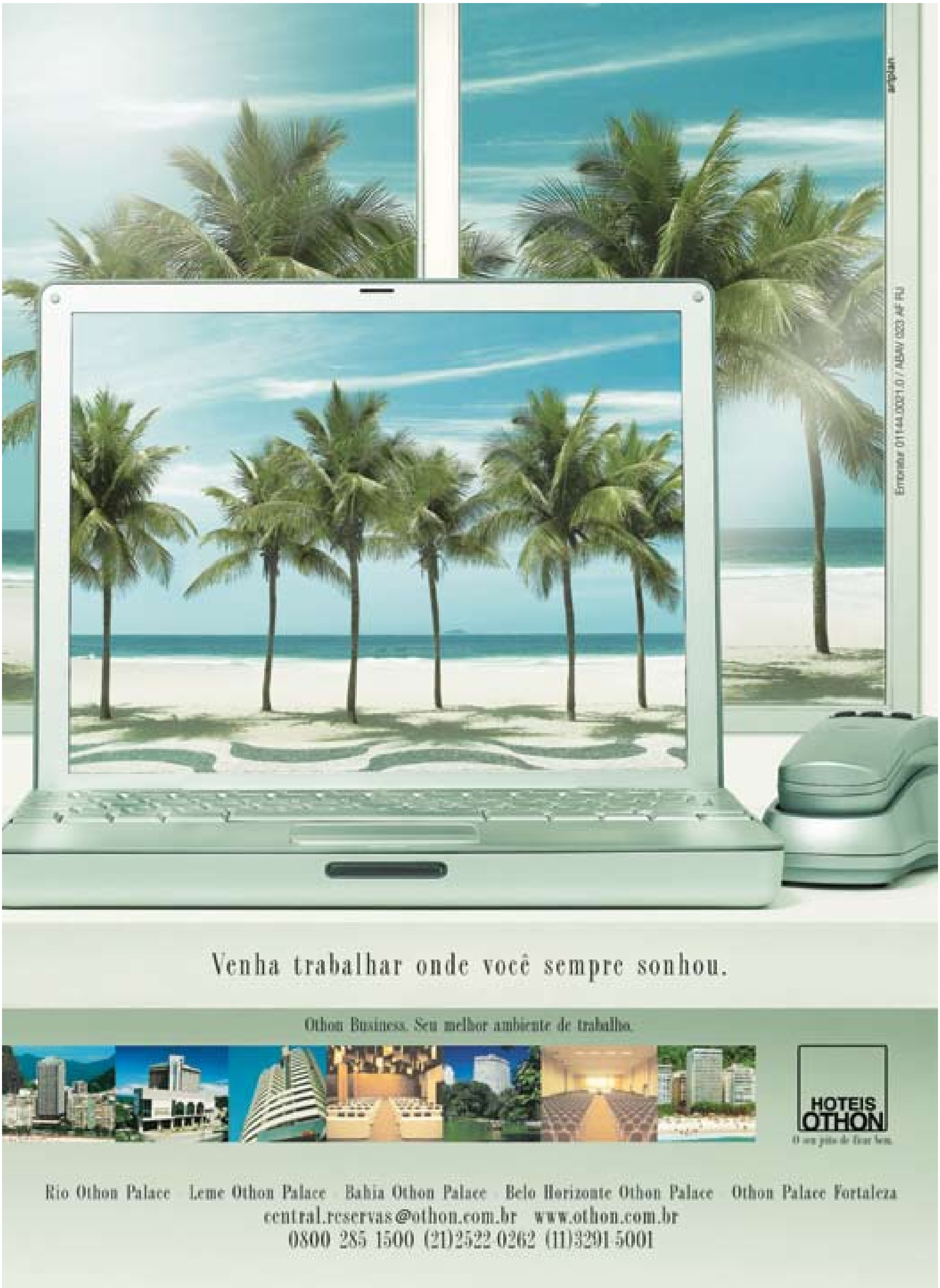
Performance pricing

How to reward so many different service companies? Perhaps this is where value or performance pricing can help. The operator and small company set a performance target and price the work accordingly. If the contractor overachieves, it receives a proportion of the gain.

Conversely, if the company underachieves, it invoices less than the original price. It is self-evident that operators and small companies need to work more closely in developing cost-lowering technology. Increasingly, drilling engineers are becoming project managers rather than specialized engineers. So it lies with the service provider to effectively market service benefits to the operator. This is where small companies trip up.

Without established marketing channels, small companies regularly miss out on opportunities. Operators can help by focusing a small company's resources on specific projects where applications are plentiful. Cynics would argue operators are not inthe business of making small companies richer. But this misses the point. Sign-posting a project helps accelerate product development and operator savings. To that end, small companies must improve their marketing to demonstrate service benefits.

They also must develop partnerships with operators and be service-oriented rather than supply-oriented. Operators need to keep on the lookout for small companies, invest in their technology and encourage integrated service providers to use their services. And last but not least, all must reassess how the reward is spread across the hydrocarbon machine.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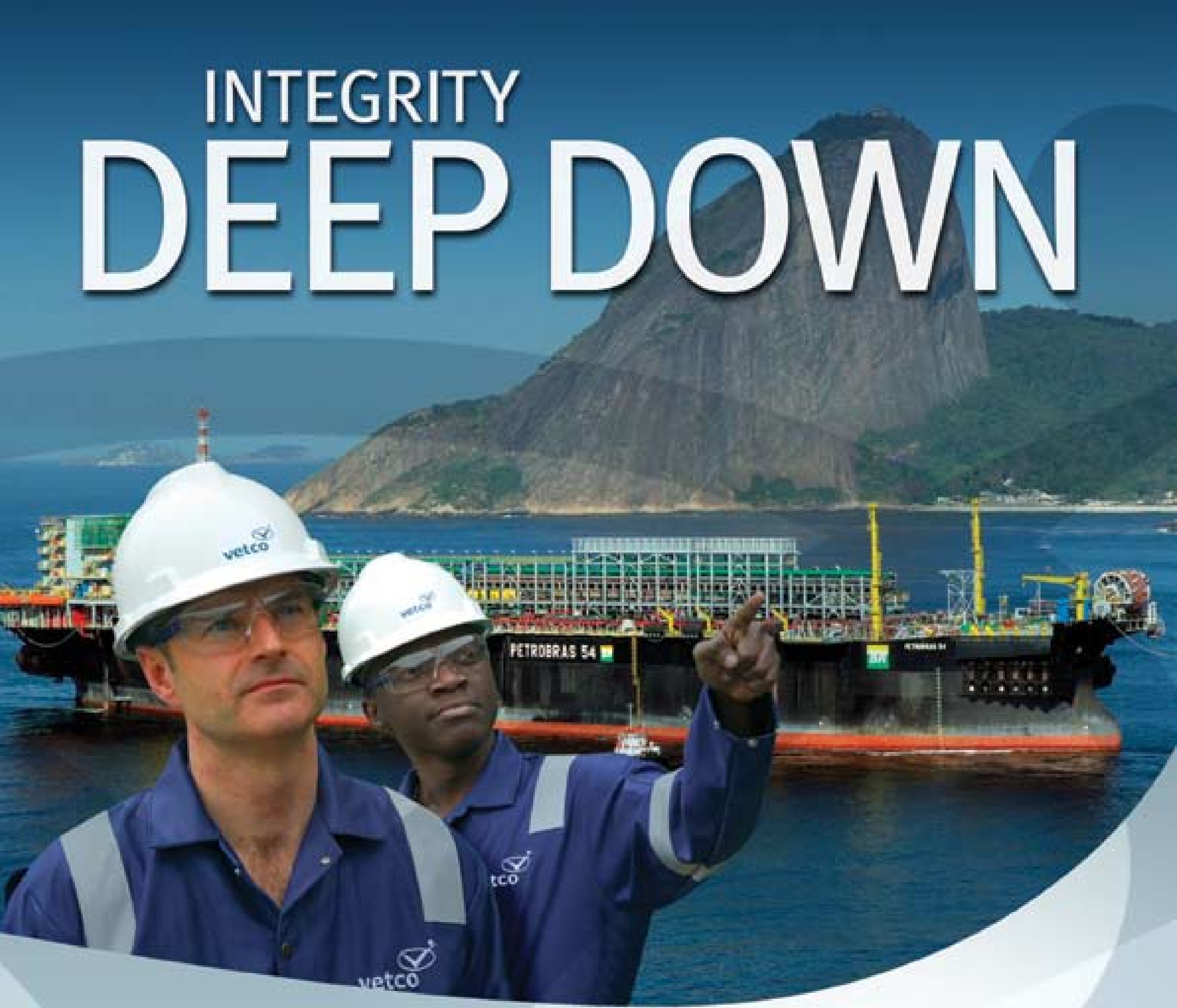
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