

# Virtually prepared



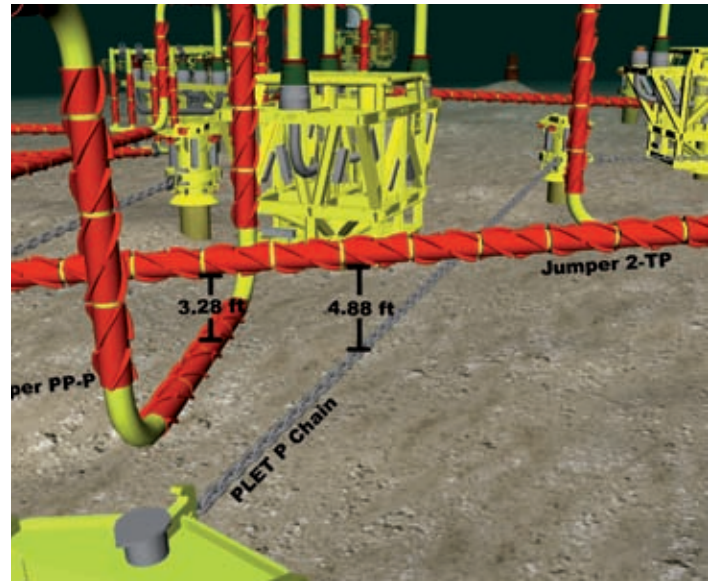
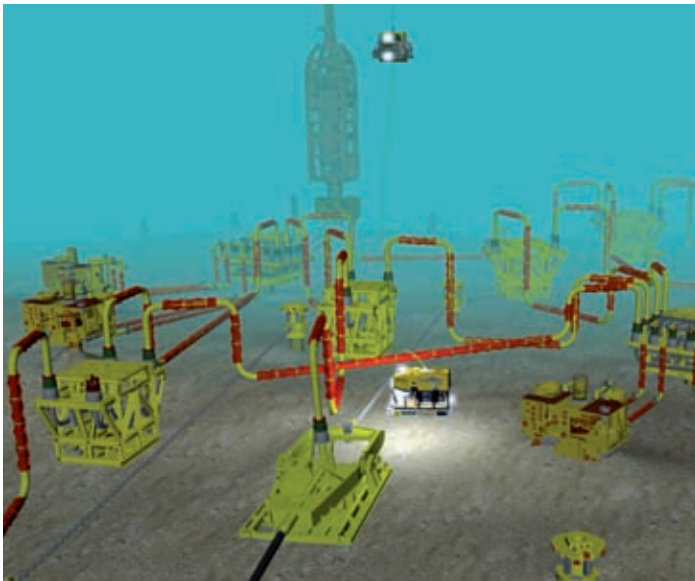


Preparing people in a simulated virtual world for their work in the real world has many advantages. *Malcolm Brown* learns more about BP's advances in creating 3D virtual environments, which are taking root across the company's businesses

**I**t could be a subsea engineer's worst nightmare. A heavy blowout preventer (BOP) is being moved near the sea floor from one subsea well to another between drilling operations, suspended from the drilling riser, when, inadvertently, it makes contact with a component of the subsea architecture on the seabed. Suddenly the BOP is behaving like a demolition contractor's wrecking ball. The damage could run into millions of dollars.

That sort of incident isn't likely to happen on John Hughes' watch. Several years ago, says Hughes, BP's subsea manager for installation and commissioning on the Atlantis oil field in the deepwater Gulf of Mexico, BP asked a software company to create a 3D model of part of the field's subsea architecture. It was to be used in a simulator for remotely operated vehicle (ROV) activities, enabling ROV operators to experience 'flying' these unmanned robots under the sea, just as airline pilots use flight simulators to practise landings and in-flight manoeuvres.

The Atlantis engineers were astonished by the vividness of the model. It was so realistic that >



**Simulation of the subsea architecture in the deepwater Atlantis field: 3DVE is used to review operational procedures, such as the movement of an ROV (lit in the centre of the image above) or a large BOP (in the background). It can also aid more detailed analysis, such as clash detection studies (above right) to confirm equipment accessibility**

**3D model of a BP retail store in the USA: Training store employees in the virtual environment has proved more effective than training in the real world**



› it soon became apparent that it had potential uses far beyond ROV simulations. It could be used, for example, for operations such as hazard identification.

'We'd have a simulated camera fly through the subsea equipment,' says Hughes, 'just to show what the seabed would look like if we were doing certain tasks, such as moving a BOP or other equipment. The 3D visualisation was a way for a group of people, sitting together, to review a task and help identify hazards associated with that work.'

The Atlantis subsea model is an example of a 3D virtual environment (3DVE) – a highly realistic immersive 3D representation of the real world. Anyone who has seen the latest 3D simulations of ski runs or motor races will know how quickly one becomes sucked into the virtual environment. A tumble on the virtual ski slope, for instance, feels so real that one's body reacts

accordingly. BP's 3DVEs are just the same, but the locations are different. The things being modelled in this instance aren't imaginary ski slopes or motor racing circuits, but refineries, offshore platforms and spreads of subsea equipment installed on the seabed in deep water.

BP's information technology experts believe 3DVE could transform many of the company's operations. BP's chief technology office (CTO), part of the company's information technology and services organisation, has chosen 3DVE as its designated 'game changer' for 2009 – an emerging technology that if adopted across the group could make a substantial difference to performance. The rule of thumb is that a game changer should be capable of contributing at least an additional \$50 million a year to BP's bottom line.

### Model diversity

3D models aren't new. They have been part of computer aided design (CAD) for years. But CAD is mainly run on dedicated machines, and is used almost exclusively by specialists. 3DVE, by contrast, is a mass medium. It has grown from the convergence of several different things – the availability of high-speed broadband, improvements in high-end computer graphics, and advances in computer gaming software – which, taken together, mean that virtual worlds can be conjured up on any computer, 24 hours a day. It is a way of bringing 3D virtual worlds to everyone, whether on a high-spec desktop or a low-end laptop computer.

BP businesses have developed innovative 3DVE modules for a variety of very different applications – from training convenience store staff at BP's service station retail outlets in the USA, to refinery maintenance inspection in Australia.

The model used for the US convenience stores is based on a real store in suburban Los Angeles, says Brian Ralphs, a technology director in CTO who is leading the push to spread 3DVE throughout BP.

'The idea is that trainees are dropped into a

3D model of a convenience store via their computer, and can then conduct hands-on training activities as if they were in the real world.'

It works well. In fact it works better than taking people to real stores and training them by traditional methods like lectures, demonstrations and information packs. Studies have shown that knowledge retention by virtual-world trainees is 80 per cent better than that of groups who undertake traditional training in real convenience stores, says Ralphs. And it is quicker, typically shaving off several hours from the total training time.

Outside the classroom, engineers like Hughes in the Atlantis team are finding ever more inventive operational uses for the technology. His latest project will combine an existing drilling rig navigation system with a 3DVE package to ensure the safest possible movement of the mobile rig – and all the hardware suspended below it – between wells.

The mobile semisubmersible drilling rig working in the field, *Development Driller II (DDII)*, is a fifth-generation rig designed to work in complex deepwater developments, and is capable of much more than the traditional rig activities of drilling and completing wells. It is designed so that it can also install and remove major items of subsea equipment.

*DDII* already has a satellite-linked navigation system, which enables crew on the bridge to see exactly where they are, in horizontal terms, as they move the rig. Now, says Hughes, they are about to launch a system that will enable the crew to see where objects are located in the water column, in the vertical plane. The crew will have real-time 3D visualisation of what is happening near, or on, the seabed – some 2000m below.

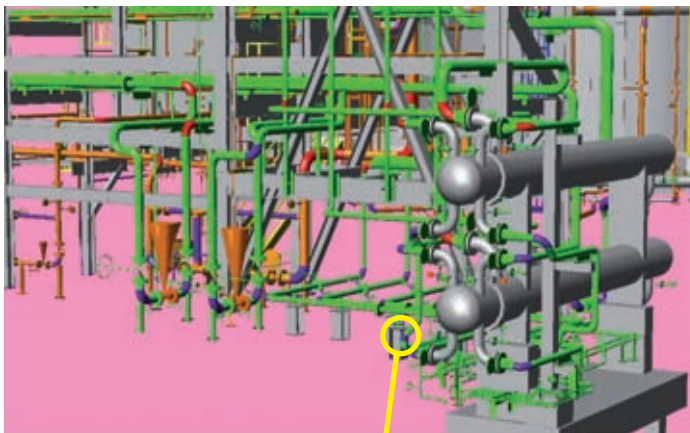
In future, one screen on the bridge will show the rig's movement in the horizontal plane, while a second screen will show, in real time, a 3DVE visualisation of what is going on at the seabed – how the rig is moving equipment around or over the subsea architecture. Eventually, says Hughes, they may add a third screen which shows the actual view from a strategically placed ROV.

### Effective inspection

Hughes' project is about as up-to-the-minute as you can get. Halfway across the world, at BP's Bulwer Island refinery in Australia, structural integrity superintendent Roger Griffiths is busy supervising the use of a 3D model whose genesis, remarkably, goes back nine years, long before most people had even heard of virtual environments.

The Bulwer Island piping inspection model, which was up and running in late 2000, was built on the back of the 3D model that had been used to design a completely new 'clean fuels' extension at the refinery. Griffiths realised he could adapt it to build a 3D interactive model that could be loaded on laptop computers and used on site by inspectors.

The business case was obvious. The cost of



Linking virtual and real worlds: Using a 3D model (top) to aid inspection surveys at BP's Bulwer Island refinery in Australia has enhanced safety and reduced inspection time. In this example, the 3D model helps the operator locate a specific pipe elbow for inspection, using an ultrasonic thickness meter

developing the inspection software was only about five per cent of the estimated cost to prepare the paper-based inspection sheets traditionally used by inspectors.

'We developed the model instead of drafting those field sheets,' says Griffiths. 'The model development saved well over A\$200,000. We now save similar amounts every time we do a project, big or small, on a refinery unit that has been modelled.'

They also save the considerable expense of maintaining and using the paper system. With the paper system, every design change requires the field sheet to be updated, and then the updated sheet is printed and physically filed in the library.

'With the new system no further update is necessary beyond what is required to design the modification, so the costs are in effect zero. And we no longer need to produce photocopied sheets for each inspection.'

Today, Bulwer Island inspectors go on site not with books of inspection sheets under their arms, but with miniature touch-screen laptops and an ultrasonic thickness meter. Corrosion

can occur in many areas of a refinery, and an inspection programme to monitor the remaining wall thickness of piping and pressure vessels is essential for safe and reliable operation. The model that appears on the laptop screen uses colour coding to distinguish the pipes that have to be inspected from those already done or waiting, and the precise locations for inspection.

The inspector locates the pipe he is to inspect, both in the field and on the screen, touches the point of inspection on the screen, and then on the real equipment uses a probe attached to the ultrasonic meter to take thickness readings which are automatically transferred to the laptop (see graphic above). Back in the

3D virtual environment technology has been designated as a game-changer by BP

office the results are downloaded into a corrosion control program used to manage piping and pressure vessel thickness data. A major outcome is that inspection surveys are conducted in less than half the time, and there are many other advantages, notably in enhanced safety. The system can also assist in inspecting steelwork and supports, in weld quality management and many other areas. ➤



3DVE technology is helping BP personnel prepare for working onboard the forthcoming Angola PSVM floating production platform. In this abridged example, an operator practises pigging for internal pipe cleaning.

1. The operator approaches the selected pig launcher, with the software identifying the equipment item to be worked on. The pig, shown in black to the left, is suspended from the crane boom. The instructions for the operation come up on the screen after the operator selects the correct valve, and text confirmation of the operation is received.

2. He loosens and removes the clamps around the pig launcher door, then opens it, ready to insert the pig.

3. The crane lines up the pig in front of the launcher, and then the operator pushes the pig in and rods it through. (Pig shown in launcher.)

4. The operator turns to the control panel, to close and seal the launcher door, set the pipeline route and launch the pig. Full instructions on how to do this can be accessed by the operator at any time by pushing the blue button seen on the screen.

5. The pig's progress is shown on the screen on the right. In the real world, it can take 24 hours for the pig to travel around its pipeline route – this period is shortened for 3DVE training and the pig arrives at the selected receiver after about a minute.



## ► Floating operations

Griffiths and his colleagues at Bulwer used an existing 3D model – a virtual 3D model that imaged the new, clean fuels plant in fine detail – and adapted it to build an inspection tool. Something similar is happening offshore Angola, where BP's 3DVE specialists are providing 3D virtual environments derived from CAD drawings for a floating production, storage and offloading (FPSO) vessel, now under construction, which will be at the heart of the Angola PSVM development in 2000m of water in offshore Block 31.

So far, says Blaine Tookey, technology consultant in the CTO, the team has developed a partial FPSO model which contains accurate 3D portrayals of the control room, accommodation block and the turret – the complex structure which moors the vessel and enables the FPSO to move around with the prevailing weather. The model was created to check out the control room design and help familiarise staff with the accommodation area

of the vessel. But the Angola 3DVE project plans to go much further – 3DVE training scenarios for two 'low frequency/high risk activities' have been built, one demonstrating pigging for internal pipe cleaning, and the other for crew mustering and lifeboat launching.

'We brainstormed with the operational readiness team for Angola,' says Tookey, 'and identified operations like these as primary areas for 3DVE to help them. We are now exploring other critical procedures, for example hooking up the risers between seabed and the FPSO.'

Simulating low frequency/high risk operations is also being implemented by BP's safety and operations group which runs the company's Operator Essentials programme. During the programme, first level leaders, such as supervisors, are put through exercises aimed at testing their leadership skills in unusual situations. Until recently, says Ralphs, this has been done using printed material, e-learning modules, workshops and meetings.

Now the supervisors can be confronted with life-like 3DVE scenarios. One example of this focuses on the safe operation of a slug catcher in the pipeline system of the Atlantic LNG (liquefied natural gas) plant in Trinidad, in which BP is the major partner. Operators are faced with a range of simulated faults or issues on the slug catcher and associated equipment in 3DVE, and have to think on their feet on how to resolve them safely.

As with many of the other 3DVE projects being developed by BP, this allows people to apply and test their knowledge without affecting site integrity, and without endangering either themselves or the plant.

The list of 3DVE applications across BP's businesses is expanding quickly, both in terms of their numbers and in their variety.

'It's a very powerful way to work,' concludes Tookey. 'With the ingenuity that exists in BP, one can believe that in five years' time these tools will be an integral part of the entire business process.' ■

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