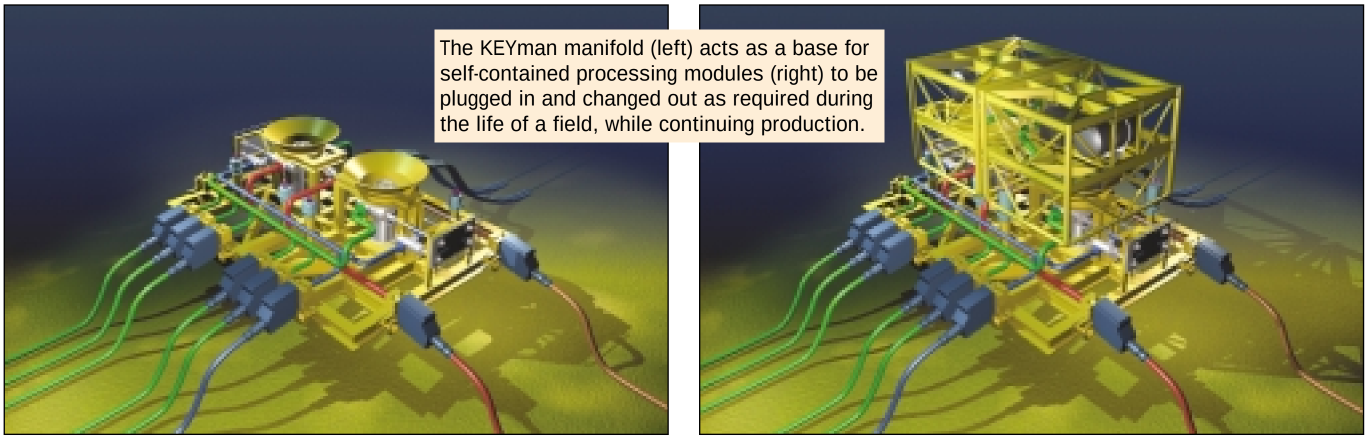


The KEYman manifold (left) acts as a base for self-contained processing modules (right) to be plugged in and changed out as required during the life of a field, while continuing production.

Primed for seabed plug-and-play

A modularised deepwater subsea processing system has drawn a step nearer thanks to recent backing from Shell. Terry Knott takes a closer look at system designer Alpha Thames and its approach to reducing the risks of working on the seabed.

For a small group of dedicated UK engineers armed with a good idea and unlimited supplies of self-belief, it has taken ten years of banging on the doors of the world's oil companies to achieve what could evolve into a breakthrough in subsea processing. Rebuffed on many occasions by the industry's notorious reluctance to be 'first' when it comes to gambling on unproven solutions, the committed founders of Alpha Thames could have been forgiven for throwing in the towel before now. But sometimes a good idea won't lie down. And persistence sometimes pays off.

The pay-off for Alpha Thames looks to have begun last month when Shell Technology Ventures announced it had entered into an agreement with the company, based in Upminster, Essex, to support a 15-month qualification programme of its products and technology for use in 3000m of water. Assistance will come from Shell International Exploration & Production in New Orleans, with the aim of proving the equipment and overall system to be 'catalogue ready' for potential use in Shell's operations, and by other offshore operators.

'This current collaboration between Shell and Alpha Thames fits very comfortably into Shell's overall Subsea to Beach global technology development programme (*OE* June 2002),' says Ian Ball, Shell's subsea to beach manager in New Orleans. 'We are in practice trying to act as a facilitator for early application of technologies that are emerging from the vendor community, to create win:win opportunities for all stakeholders. We have a globally dispersed team that is working closely with all vendors of emerging component technologies that can play a part within flexible subsea processing system configurations, with the object of addressing the wide spectrum of development needs that our assets have across the world. Our aim is to help the specialist vendors – all interested vendors – to spend their product development money wisely and efficiently, so as to be optimally aligned with the actual asset application opportunities.'

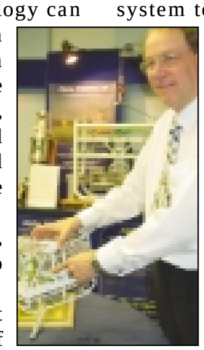
However, Ball acknowledges there can be a problem in convincing an asset to be the first to apply emerging technologies. To try to address this critical issue, Shell has evolved a system qualification programme, whereby an attractive new technology can be analysed well enough within a Shell context to convince a sceptical asset that the risks are well understood and managed, and, he adds, 'that the forward prize thus overrides the perceived under-performance risks of the prototype unit'.

In the deal with Alpha Thames, he sees the opportunity to demonstrate this in practice.

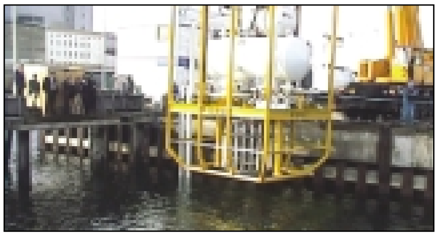
'Here we saw a bright entrepreneurial band of specialists with great embryo technology, which the industry as a whole had been keeping somewhat on the sidelines over the years,' says Ball. 'By working collaboratively with our colleagues in Shell Technology Ventures we were able to flange up an arrangement to bring the Alpha Thames resources right into the mainstream, for the potential benefit of the whole industry, and at the same time apply some of the company's venture capital to accelerate the qualification of Alpha Thames' unique all-electric modular plug-and-play approach. This will not detract in any way from our commitment to maintain close liaison with all interested vendors of related technologies, but it will accelerate availability of another valuable tool in the industry's subsea processing toolbox. Hopefully this will help convince the asset managers and the shareholders that this technology can really help them deliver on their challenging forward production targets.'

The unique approach he refers to is at the heart of the Alpha Thames philosophy for subsea field development, known as AlphaPrime. In essence this consists of a central processing unit, the AlphaCPU, located near to wells on the seabed. Each CPU consists of a standard manifold which supports at least two identical operating system modules, containing all the pumping, processing and control equipment needed for handling the reservoir fluids. All valves and controls are electric, rather than hydraulically operated.

'The key advantage here is that you can change out the modules to reconfigure the system to match reservoir performance as this changes with the life of field, while continuing production,' explains Alpha Thames' managing director, David Appleford (*pictured left*). 'By having two modules, for example separation modules each sized at 20,000b/d capacity, you can remove one of these and still keep the wells in production, while you replace it with a different module capable of a different duty already fully commissioned onshore.



'This is fundamentally different from the approach being proposed for other subsea processing solutions, which are trying to cope with through-life field conditions with a single set of components from day one. The inherent risks for the operator in this approach are high. We are offering a system of plug-and-play modules to enable field development to be made in



Trials of the AlphaCPU prototype in Malmö.

incremental steps as reservoir behaviour becomes apparent, improving NPV, capturing early production and increasing hydrocarbon recovery.'

While this appears to be a logical, commonsense approach to dealing with the changing nature of reservoirs, it has not been arrived at by accident. Although Alpha Thames has been working on the development of its modular system for ten years, Appleford points out that the subsea experience of both himself and his team goes back much further, in fact to the first subsea processing trials run by BP in the Zakum field offshore Abu Dhabi in 1970.

Using his skills as a special-purpose machinery designer, Appleford worked on the Shell Cormorant UMC in the 1970s for the Comex John Brown joint venture, where early advances were made in the repair and maintenance of subsea equipment, followed by stints at National Supply and RJ Brown, before setting up the engineering division of Goodfellow Associates. In 1989, with partner Alan Webb – an electrical power engineer who had worked on Zakum – he bought out the division and formed Alpha Thames.

'Our experience has come together to give a unique approach to subsea processing,' he notes. 'In our view, the actual processing of hydrocarbons has been largely proven, so we have shifted our focus on how the system goes together, the architecture. Rather than follow the industry tradition of seeing this as a collection of vessels, plumbing and structures on the seabed, like a factory, we see it through the eyes of machinery designers. Trying to maintain or repair individual parts of a factory in 3000m of water is no easy task. Our approach is that when modification or repair is needed, we will bring the whole system module back to shore to be worked on more effectively in benign conditions.'

Development of Alpha Thames' now-patented components began with the invention in 1993 of an underwater connection system for horizontal rigid flowlines (CUSP), which received backing from Deminex, Babcock and the European Union (EU).

Work then moved on to developing a range of electrical components, notably a wet-mateable electrical connector and subsea valve actuators.

In 1996, needing more cash to fund the development programme, Alpha Thames sold a major stake in the company to Swedish submarine-builder Kockums.

'The tie-up with Kockums has been a good match for us,' says Appleford. 'Their approach of building completely integrated, standalone modules for submarines and supertankers is based on the same philosophy as our own.'

With the components of the subsea system now ready, the time had come to build and test a prototype system, ultimately leading to successful trials of a 20,000b/d two-phase separation module in September 1999 at Kockums' quayside facility in Malmö. The trials, conducted under the Aesop joint industry project, demonstrated that a system module, designed for 1000m of water, could be taken from the dockside, installed onto the manifold and commissioned in 20 minutes. The JIP was supported by British Borneo, Conoco, Shell, Statoil and the EU.

But in the background, ownership of Alpha Thames was undergoing change, as the company sought further backing from the oil industry. This came in the shape of small independent Hardy Oil & Gas, which took a significant equity stake in the company in 1998 alongside Kockums, with Hardy believing the subsea system would give it leverage to become a partner in larger field developments. The plan was to target the subsea system first at one of Hardy's prospects in India, the PY3 field, but Hardy itself was bought by British Borneo before this could be actioned. British Borneo then ran into financial trouble when it was hit by field development problems in the Gulf of Mexico, leading to its purchase by Agip. Meanwhile Kockums' owner, Celsius, was taken over by Saab. Negotiations followed between Saab and Agip over the latter's inherited stake in the subsea company, and by early 2001, Kockums had become sole owner of Alpha Thames under parent company Saab.

'We were hit by two major changes at once, which saw funds previously committed for Alpha Thames being moved elsewhere,' Appleford recounts. 'But the outcome is a very stable platform with Saab as owner.'

With the stable platform achieved in early 2001, the task now was to try to win the support of the oil companies, for which Alpha Thames focused on operators of all sizes in the US market.

'In this respect our time with Hardy did us a tremendous favour,' says Appleford. 'We had learned to think more from an oil company's perspective rather than that of a contractor. And we were offering a completely integrated subsea processing system, acting like the engineering division of an oil company.'

Despite these perceived advantages, finding a backer to commit to a full-blown AlphaPrime greenfield development continued to elude the company, leading it to step back from pushing the complete field development concept at the industry in one go.

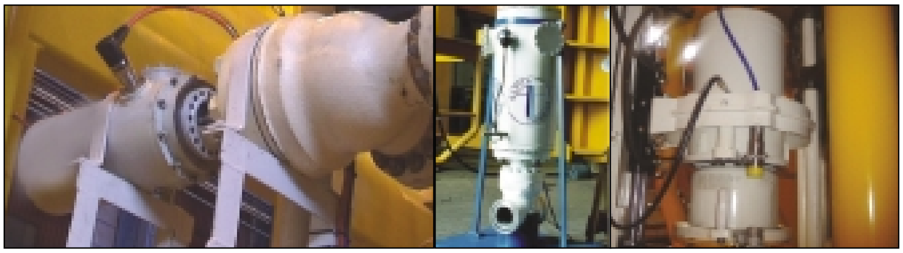
Instead Alpha Thames began concentrating on the advantages of its modular AlphaCPU and associated electrical components, which it believes set the system apart from competitors' designs. The company's strategy is to market complete integrated systems and not individual components.

'The subsea tradition of using hydraulically operated valves requires a lot of support equipment,' he notes. 'For each valve you need a 4-port control valve, and for choke operation, a gearbox, plus a system pump and solenoids, and all equipment must conform to strict material standards under NACE. We say we don't need all these bits, just an electric motor and actuator. We have developed pressure balanced actuators driven by brushless, permanent magnet motors. This arrangement provides maximum torque immediately, faster reaction time and better accuracy of control. Electrical controls also enable wells to be at longer step-out distances, as these are not subject to the same restrictions that hydraulic power imposes.'

Under the Shell programme, Alpha Thames will build electrically operated actuators for operation in 3000m of water, testing these in hyperbaric chambers in European facilities. Initially developed and tested for the Aesop JIP, the company's REAct linear actuator for fail-safe operation of isolation valves on christmas trees, flowlines and manifolds, and PROAct linear actuator for precise and fast operation of chokes and control valves, will be put through their paces.

Also under test will be ELEx, a subsea, wet-mateable high voltage connector, rated to deliver 11,000V. Wet-mateable connectors, through which power is supplied to the subsea modules, are somewhat notorious for failing subsea – Zakum suffered from such failures and other more recent connector failures have occurred. Noting that a critical problem appears to be the ingress of water and subsequent breakdown of insulating materials, such as oil or dielectric fluids, inside the connector, Alpha Thames has developed its ELEx connector – invented by Alan Webb – based on 'creating an air bubble on the seabed'.

When the male and female halves of the connector are mated subsea, the device will initially contain seawater at ambient pressure. A fluid exchange system built into the module is then activated, driven by a small pump. As seawater is sucked out of the connector, it is replaced by a cleaning fluid which cleans the electrical contacts; this is subsequently replaced with a dry inert gas such as nitrogen at one atmosphere. This environment maintains the electrical contacts under conditions which are well understood, avoiding unpredictable problems which may arise due to long-term degradation of other fluids. The chamber is also continuously monitored for water ingress due to possible weeping past the seals, forewarning of any potential failure.



Electrical components: PROAct, REAct and ELEx.

Should this occur the water can be removed by the fluid exchange system, by remote control.

Appleford points out that the AlphaCPU design deliberately keeps all electric switchgear components contained within the removable modules, rather than in the manifold on the seabed – switchgear failures on the seabed can bring an entire subsea system to a stop. In a field development involving multiple subsea wells tied back to a host installation through a conventional power cable, the modules would be interconnected to form a ring main connected to the host. This would allow a module to be removed without interrupting power supply to the others.

This modular philosophy underpins the patented concept of the CPU – all components which move or do work are kept in the retrievable system modules. The CPU will be designed in detail under the qualification programme, consisting of two main elements: the manifold and the system modules.

The manifold, known as KEYman, is a departure from conventional manifolds in that it does not contain hydraulics or control pods, but only pipework and isolation valves which allow flowlines – flexible or rigid – from subsea wells to be tied in. The ‘dumb’ KEYman, typically measuring 10m by 8m, sits on a single seabed pile or support base, and houses two industry standard wellhead-type connectors, to which the system modules are attached when installed.

The system modules, with a 4m by 5m footprint, 5m high and weighing 35-80t depending on their duty, are mounted on top of the manifold in a single operation – connecting electrical power is the only other installation step needed before operations can begin.

In the first phase of production, when reservoir pressure drive may be high and separation not needed, the modules can be designed to act as simple bypasses to let fluids flow straight through the manifold to the host facility – Alpha Thames has a proprietary module design, FlowCAP, for this purpose, which helps capture early oil at minimum capex. As produced fluids change, the FlowCAPs may be changed out for other modules, for example, metering, two or three-phase separation, multiphase pumping, or water injection.

‘For the first time, an operator would have complete control over the way the reservoir is handled subsea, throughout the life of field,’ Appleford asserts. ‘And as technology advances and new devices come along, these can be built into the system modules and applied to an existing field for low risk testing. The system is therefore future-proof in this respect.’

When it comes to actual processing of the fluids in separators, he points out that in subsea situations operators are not seeking ‘perfect processing’ as they do on platform topsides. Instead he sees the system as providing a means to overcome a transport problem. As such, he believes it may be possible in time to avoid putting large separator vessels providing several minutes of residence time on the seabed, opting instead for dynamic compact separation devices such as cyclones.

‘Using dynamic separation devices is made possible with our system because of the fast-acting electric control valves we have. Sensors enable us to detect whether the fluids exiting the cyclone are liquid or gas and the valves can be quickly activated to make sure the right product is going into the right line.’

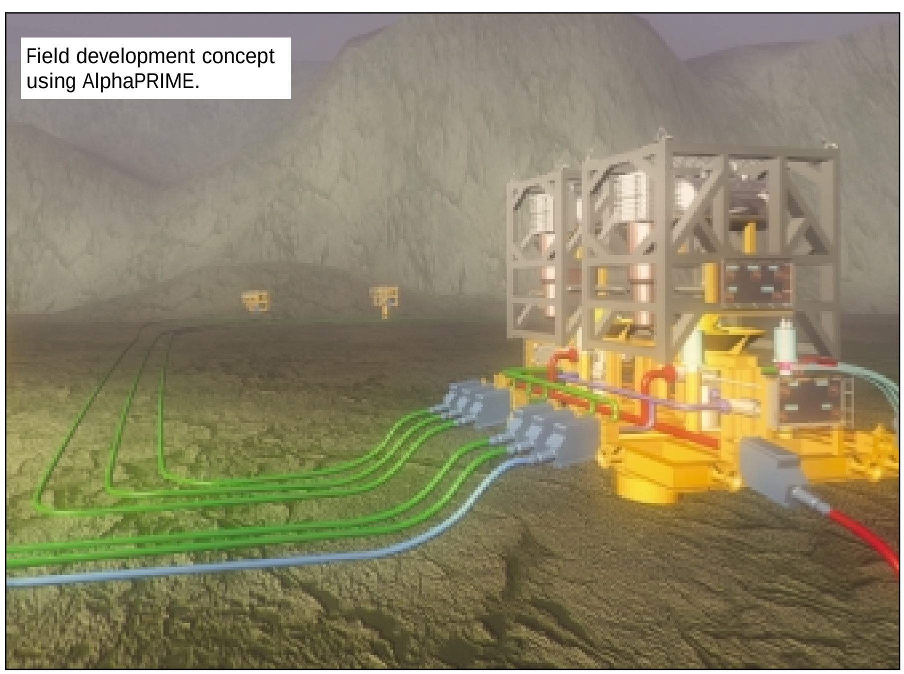
Removing an entire module brings other advantages, claims Alpha Thames. Replacement modules can be fully tested onshore and ‘burnt in’, so that their component parts have entered the stable operation phase normally achieved between starting up and finally beginning to wear out. And should a module have to be pulled due to equipment failure, having the complete system to work on back at the beach enables not only the immediate symptom to be repaired, but also the root cause established and rectified. All too often in conventional subsea systems, a single failed component is retrieved and replaced, only to find that the problem is more complex and other parts have to be pulled out in turn until the cause is located, a potentially costly offshore exercise.

He likens the AlphaPrime approach to a desktop computer setup, where the subsea wells act as chips, the CPU is the processor, and the keyboard is akin to the host facility, controlling operations. In this context he foresees the advent of ‘smart’ subsea systems, where the changeout of components is recognised by the system and operating parameters are automatically adjusted to suit.

With over 30 patents granted or applied for, Alpha Thames has been no slouch in the new ideas department over the years. But back in the present however, the task facing the company now is to make good on its decade-long campaign for recognition and backing, and prove its subsea system can deliver on its many attractive promises.

‘We are looking at a specific field for the Shell work as a generic design case, but this may not be the first field to install an Alpha Thames system,’ Appleford says openly. ‘We are talking to many other operators about deepwater projects in the Gulf of Mexico, West Africa and Brazil, and are not tied exclusively to Shell. Most likely the first application will be a retrofit of an AlphaCPU. We hope to see one in operation by 2005.’

If that prediction comes true, persistence and good ideas will have finally paid off. OE



Field development concept using AlphaPRIME.