Manned Submersibles Return to Oil & Gas Work

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Stockton Rush | OceanGate, Inc.

As shallow-water reserves deplete, the offshore industry is making increasing investments in deepwater oil & gas production. "Shell is producing from 2,934m water depth in the US Gulf of Mexico and over the next five-years we expect total capital expenditure in water depths beyond 500m to total $223bn" said John Westwood of energy business consultants Douglas-Westwood. "In the years ahead, maintaining all this hardware is going to demand a considerable amount of subsea intervention."

Sub-sea intervention tools and technology will drive the economic viability for exploration and foster the next frontier of innovation and discovery. Currently the tools and requirements for intervention, monitoring and assessment are served by ROV, AUV and saturation diving operations with limited use of manned technology. The requirement for new options, new regulations and the ability to asses at depth is critical to securing intelligent data. Over the past few years, developments in material science and innovation in digital technology systems make the option for manned submersibles a viable option in sub-sea operations and intervention. Either as a stand alone option or in tandem with ROV and AUV systems expand overall capabilities.

ROV Challenges

It is widely accepted that for work class ROVs operating at greater than 3,000 meters the tethers and associated tether management systems have reached their practical limits. New technologies including more energy efficient thrusters, lights, sonars, cameras and as well as new dynamic positioning systems are helping to alleviate some of the historical issues with ever increasing power requirements and associated tether diameter increases. Recently launched observation class ROVs using fiber optic data transfer systems show promise to greatly reduce tether drag and tether management issues. However, these vehicles still need to deal with mid column debris and entangled tethers especially when operating in groups. It is unlikely that pure fiber optic control is the solution, but may have value in combination with other systems.

AUVs Issues

While excellent tools for large areas survey work or situations where the task and environment can be well defined AUVs have several limitations such as:

1. Lack of real time broadband communication – Without real time imaging and data transfer mission correction, active vehicle control and mission adaptation cannot occur.
2. Lack of active buoyancy control – AUVs tend to motor to dive and descend thus wasting energy and making resumption of searches at the last known point problematic.
3. Challenging launch and retrieval characteristics – As AUVs tend to be long sleek vehicles at sea recovery for recharging and data downloading can be especially difficult.
4. Tendency to get lost or go off course – A number of AUVs have "gone rouge" in past years or have been completely lost. These problems should be reduced as operational experience is increased.
5. Inherent inability to respond to the unknown. Programming the difference between bio

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fouling, debris encasement, or excessive corrosion or other unknown environmental variations is particularly challenging.

One approach to solving some ROV and AUV issues is the use of lightly tethered vehicles using thin fiber optic cables so that high data rates may be obtained and the vehicle may be actively controlled. In addition, a current industry goal is to create brilliant robots tied to data transmission networks that can assign tasks such as inspection, repair and maintenance jobs to robots that will be able to operate autonomously for brief, well defined, missions. While these approaches show promise, they are unproven and the advantages that they may present can be more directly solved by employing a manned submersible. Even if communications through water was at the level of terrestrial data rates, there would still be a place for a manned vehicle as you would always be attempting to recreate the work environment in a remote and disconnected place. Being on location, any equipment operator can sense the motion of the vehicle in real time, see the scene where the work is being conducted and have excellent depth perception related to the manipulator attached to the vehicle as well as the general environment. All the senses can be pulled into play without some complicated intermediate compilation, transmission and representation system.

Manned submersibles can address the limitations of both ROVs and AUVs and add capabilities impossible to achieve with the other systems. In particular manned subs:

1. Do not have tethers so all tether management issues go away.
2. Can respond to the unknown in real time.
3. Allow multiple stakeholders to be at the job site – Metallurgists, biologists, program managers and other disciplines can see the same environment and make collaborative decisions on location.
4. Draw media attention to causes of interest – Obtaining coverage of ROV operations can be challenging, however it has been shown that getting a network newsperson in a sub is straightforward and can be used to advance environmental or regulatory agendas.
5. Allow for situational awareness through full 3D viewing of the environment.

Deploying innovative and advanced technologies from other industries can expand capabilities on manned, ROVs and AUVs enhancing the data outputs and lower cost of operations. Those advances include:

- Individual fiber placed carbon fiber – This technology is used widely in the aerospace industry and allows for much better control of the fiber/resin matrix, is highly repeatable and allows for much more efficient structure than steel or titanium at a competitive production cost.
- Advanced sonar systems – High frequency sonar systems such as those from Teledyne BlueView dramatically increase the occasions where safe operation of manned subs as well as ROVs can occur. The ability to detect monofilament line and other entanglement hazards makes all submersible activities more safe and productive.
- High purity glass – The optical components industries have driven glass purity (both fused silica and borosilicate) to very high levels. It is now feasible to use glass as a structural component of a pressure vessel as its characteristics can be accurately modeled, controlled and tested.
- Real time hull monitoring – Strain and stress monitoring has been done for many years. In combination with embedded fiber optic and laser dimensional testing it is possible to monitor pressure vessel health and detect potential fatigue issues early thus making new material use acceptable.
- Batteries – Lithium polymer and lithium ion batteries are close to ABS and GL approval in manned vehicles and have been deployed on AUVs for some time. The batteries will allow longer mission times with greater speed and manipulation/sampling/work potential.

The need to develop and expand cross industry partnerships with aerospace, materials manufacturing and biochemistry to use out of the box solutions for sub-sea challenges will allow for a broad spectrum of tools and technology to tackle the challenges and requirements. Collaboration with specific experts in the field of carbon fiber manufacturing as well as ocean systems design, test and deployment, including the ability to collaborate with industry specific input into necessary accessories and mission profiles to insure best practices are adopted while deploying a new set of tools and technology. The key is to create a best of breed team strictly managed to be mission and total system cost focused and avoiding the mission creep and "not invented here mentalities" that often result in escalating costs and extended timelines.

Options like deep submersible systems similar to what OceanGate is now developing with the Applied Physics Laboratory at the University of Washington will allow a small vessel such as an ocean going tug or barge to tow the submersible and its launch and retrieval platform to a location; the submersible and its retrieval platform would then submerge, the sub disconnects and proceeds down, untethered, to the dive location to perform work. The surface vessel would not need to have dynamic positioning or complicated tether management.

Some specific applications that may be best served by this manned solution are:

- **Off well platform operations** – In situations where a work class ROV and/or drilling equipment is currently on site and performing work, but where a need arises for work near the site of this expensive flotilla of equipment, having a manned AUV that can be towed by a tender vessel several kilometers away, perform the work required, and then returned to the main vessel, would be of great value. This would eliminate the need to deploy a separate ship with added ROV systems and hardware.

- **Weather disruption – S**ignificant costs are incurred by industry when operations need to be curtailed due to actual or forecast tropical storms or hurricanes. A long duration manned vehicle could reduce some of this cost as the conditions deep on the seafloor will be largely unaffected by surface whether disturbances. A long duration manned submersible could continue work or inspection, repair and maintenance activities regardless of the surface weather environment.

While manned submersibles can fill some of the technological and real-time sampling gaps left by other deep-sea systems, all of these devices (ROVs, AUVs, HOVs) perform useful functions specific to their abilities. By working in concert, multiple platforms and forms of subsea technologies can provide complete data and access to the deepest points of the ocean.

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