A Statement from the Deep Submergence Science Committee to the Ocean Commission

by Patricia Fryer

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Commission members, ladies and gentlemen,

Thank you for the opportunity to speak to you today. My name is Patricia Fryer, I am a senior research scientist in Marine Geology at the University of Hawaii. As we consider future efforts toward understanding coral reef ecology, fisheries management, geochemical cycling that affects ocean/atmosphere interactions, resource management, and protection from hazards along our coastlines, we should bear in mind the methodologies by which US scientists push the frontiers of knowledge forward in these areas.

I am currently serving as chair of the Deep Submergence Science Committee of UNOLS. The committee provides scientific liaison between the research community and the National Deep Submergence Facility (NDSF) operator at the Woods Hole Oceanographic Institution. The NDSF operates the US deep submersible *Alvin*, and several remotely operated vehicles. The Deep Submergence Science Committee is concerned about maintaining strong support on the parts of the three funding agencies, ONR, NOAA and NSF, for continued development of US capabilities in occupied submersible technology. The *Alvin* has the most impressive record of successful submergence science operation in the world. However, a portion of the scientific community sees remotely operated vehicles (ROVs) as eventual replacements for occupied submersibles in the oceans and has voiced the opinion that efforts to enhance submergence capabilities should be focused in that direction, rather than toward improving existing capabilities with occupied submersibles. DESSC strongly supports the efforts of the NDSF to design a replacement for the *Alvin* submersible in the very near future. DESSC contends that whereas both are needed, there are aspects of submergence science that can be best carried out with on-site human presence in an occupied vehicle.

There are six critical areas in which occupied submersibles far exceed the capabilities of ROVs, engagement of the operator, visibility from the vehicle, maneuverability, unobtrusiveness, reliability, and the capacity for education, outreach and recruitment.

Engagement
Anyone who has dived in a submersible knows what this means. When you are in the submersible you are conscious of every sensation and you are focused the whole time. To achieve this same level of engagement of the human consciousness one would require nothing short of complete virtual presence. We can’t do that with ROVs yet. Indeed the whole idea behind achieving virtual reality is to simulate the human presence in order to

gain the level of engagement one gets from actually being there. Science time at sea is expensive and a fully engaged researcher is more effective.

Visibility

The difference in perception gained from looking out the porthole of a submersible with the human eye *in situ* vs that from looking at video monitors is the same as your view of this room right now vs what your view of the room would be if you saw it with only one eye while looking through a rectangular hole cut in the end of a black box taped to your face.

I can quote numerous instances where ROVs visiting the same spot that had been visited previously (and marked) by submersibles were unable to locate targets because the field of view and the perception of the surroundings are less complete. For example, at the same spot visited with the *Pisces V* submersible a day before, an ROV driver never found the target. A researcher spent a day looking for a given type of small animal with an ROV and never found one, but came back the next day with the *Johnson Sea Link* submersible and immediately found many. I revisited an Ocean Drilling Program drill site target area marked previously using the *Shinkai 6500* submersible and could not recognize my marker though staring directly at it for 5 minutes with a camera mounted on the end of the drill pipe. And when ROV pilots get a chance to dive with *Alvin* to areas where they have worked many times, their customary reaction is surprise. "I never realized it was this rugged down here." "I never imagined the site looked like this."

For biological studies, observation of complex biosystems is far better performed by human observers *in situ*, particularly for perturbation experiments. Something critical may be happening beyond the field of view of ROV cameras that an observer at the site in a sub would catch with peripheral vision. The same is true for some geological applications, the most effective way to perform geological mapping is to have a skilled person *in situ* looking at the structural relationships in 3-D and tracing formation contacts. In some instances shimmering water from gently effusive springs, which is critical for identifying sampling sites, simply can’t be seen with an ROV because of the optical interference from video transmissions (screen flutter).

Sampling is much easier with the parallax vision afforded by the pilot looking out a view port than it is from a flat video monitor in an ROV control room. The rate of sampling is thus faster with a sub. Today’s precision biological sampling requirements demand the visibility afforded from a view port. For many operations, including deploying large and awkward seafloor observatory equipment, the power and lift capabilities of a submersible are critical.

Maneuverability

The chief problem ROV operators have in complex terrain is the difficulty of avoiding fouling the tether. In active hot hydrothermal regions you cannot land on up close to active vents with a tethered vehicle and do detailed work for extended periods. The tether would be in danger of destruction in the hot effluent. In the recent efforts to examine and recover remains from the Ehime Maru the first attempt to observe the ship failed because the tether of the first ROV used was fouled in the ship's rigging. Such problems do not present themselves for untethered occupied submersibles. The Hawaii Undersea Research Laboratory has been operating at Loihi Seamount, the active seafloor volcano south of the Big Island, for years. After the 1996 eruptions at the summit, the topography of the site changed dramatically with new pit craters and collapse features. The *Pisces V* made numerous dives to the new site helping to establish a seafloor observatory at the site and a 3-D map of the complex new terrain. Both JAMSTEC and the Monterey Bay Aquarium Research Institution had considered operations with their ROVs in the new eruption site until they discussed the topography with the *Pisces V* chief pilot. In the end, they both refused to perform lowerings because of potential fouling hazards for their tethers. Thus, whatever new scientific discoveries might have been accomplished there with the ROVs will never be known.

Problems of managing the tether for an ROV become increasingly difficult as current complexity, velocity, and as ocean depth increase. JAMSTEC's *Kaiko* ROV, capable of operating at depths in excess of 10,000 m (the world's deepest-capability ROV) was designed to enable scientific work to be performed at the Challenger Deep the deepest point in the world's deepest trench, the Mariana Trench. On its maiden voyage the ROV was deployed to the Challenger Deep, but was unable to move across the seafloor because of the difficulty in managing its tether. Essentially, it performed no better than the Trieste, which got there first with two observers.

Unobtrusiveness

Fish habitat studies require unobtrusive presence and the capability sometimes to be able to observe from a silent and dark vantage point. The slightest movement of an ROV is translated to its tether and propagated along the tether's length. A submersible can maintain station or be set to move nearly imperceptibly slowly and soundlessly across the seafloor. A submersible can essentially become part of a reef and observations (even hand feeding of fish at bait stations) can take place unobtrusively.

Reliability

Frequent recertifications of occupied vehicles makes them reliable platforms. During his Midway Expedition when it came time to lower the ROV into the water Bob Ballard was heard to comment to the effect that "these things always break down." The ROV he was using did fail at first, though as soon as replacement parts arrived, Bob, as usual, succeeded in his quest and found the USS Yorktown. *Alvin*'s remarkable success record stems from the fact that basically the sub has been in use for many years and the bugs have been worked out. It is an incredibly reliable work-horse, but it could be much more versatile with the improvements envisioned by the NDSF.

Capacity for outreach, education, and recruitment

The best way to communicate the excitement of scientific discovery to the people who ultimately fund our efforts, the pubic, is to get them to see our science through our eyes. If there is a reason for them to want to do so, if our eyes have looked out the view port of a submersible, the task is much easier. Human beings will identify with a person more readily than with a robot, with an astronaut on EVA more readily even than with the popular Mars Rover. Recruiting youngsters to become the scientists of the future is more effective if they know they can share personally in the goal of discovery.

My PhD student, Nathan Becker, who has used two subs and several ROVs, says with regard to this issue, "Perhaps I'm a romantic, but I believe that there's value in sending people into extreme environments for exploration, whether in space or on the sea floor, and I see it as the extension of a long tradition of exploration going back to Lewis & Clark, Captain Cook, or even the early Polynesians searching for new islands. The fact that we are willing to assume such risk in search of discovery shows just how important it is. And I think that when we turn over such experiences to machines we loose something as human beings. The day we stop allowing scientists to visit the sea floor is the day I quit marine science."

The Deep Submergence Science Committee is preparing a position paper on this subject that it will present to the National funding agencies that support the NDSF and to the Ocean Commission.

Thank you.