DISCUSSION OF RESULTS

A. User and Operator Surveys

1. Summary of Deep Submergence Community Questionnaire on Improved Submersible Capabilities - 1999

Introduction and Background

The purpose for conducting this science user survey was to help identify the requirements and specifications, from a science perspective, for a new or improved submersible by identifying and evaluating the current submersible deficiencies. As a result, the survey was designed to provide an opportunity for negative inputs but many positive comments were obtained in the context of items/features which are highly valued and should not be changed. These positive comments will be presented prior to the specifics of the survey. It should also be noted that this survey did not address the issue of the requirement for a submersible capable of operating to 6000 meters as that has already been addressed by a DeSSC survey.

Summary of Positive Comments

Many positive comments were received concerning the Alvin Operations Group support and performance, specifically the excellent pilot skill and experience, generally rated as the best in the deep submersible operations field. The cooperation between the Alvin Group and equipment developers was also mentioned as a positive attribute. The superior manipulative capabilities of Alvin, its large sample storage capacity, and the success with the Inductive Coupled Link (ICL's) were mentioned positively. It was also noted that although improvement remain, large strides have been made in the video system in recent years.

Summary of Survey Specifics

Number of participants: 48

Fields of Expertise:

Benthic Biology	8	(17 %)
Vent Biology	15	(31 %)
Deep Sea Sediments	7	(15 %)
Sediment Processes	7	(15 %)
Physical Processes	2	(4 %)
Ocean Chemistry	6	(13 %)
Vent Chemistry	14	(29 %)
Marine Geology	21	(44 %)
Petrology/Rock	6	(13 %)
Marine Geophysics	13	(27 %)
Ocean Engineering	1	(2 %)

Dives in ALVIN

1 to 10	25 (52 %)
11 to 30	14 (29 %)
>30	8 (17 %)

Dives in other subs

Together, 35 of the participants made a total of **over 345** dives in other submersibles. These included the MIRs, Nautile, Cyana, Shinkai 6500 and 2000, Pisces, JSL, Turtle, and Sea Cliff.

Last used ALVIN

1999	45 %
1998	23 %
1997	13 %
Prior to 1997	17 %

PI or Chief Scientist on ALVIN Cruise

54 %

KEY SCIENCE RELATED IMPROVEMENTS FOR SUBMERSIBLE

SYSTEMS UPGRADE

Most Critical Areas for Improvement

Increase available power	16 (33%)
Increase bottom time	15 (32%)
Improve video imaging	13 (27%)
Improve external payload	13 (27%)
Improve manipulator performance	8 (17%)
Improve/expand sampling devices	7 (15%)
Improve accuracy and reliability of navigation	5 (10%)
Improve viewport locations	5 (10%)
Maintain/improve crew support/pilot experience	3 (6%)
Fix internal camera - strobe sync problem	2 (4%)
Devise observer equipment simulator	2 (4%)
Improve Nav displays in the sphere	2 (4%)
Improve exterior lighting	2 (4%)
Improve/replace sonar system	2 (4%)
Increase depth capability	2 (4%)
Improve video controls	1 (2%)
Improve external 35 mm camera system	1 (2%)
Increase hydraulic power	1 (2%)
Improve manipulator work area	1 (2%)
Improve electrical/electronic interface	1 (2%)

Improve data logging/recovery system	2 (4%)
Develop fiber optic penetrator	1 (2%)
Provide Homer Probe system	1 (2%)
Provide better swimmer training	1 (2%)

The following is a collection of participant comment summaries drafted by the NDSF at WHOI. They have been written as objectively as possible but the reader is encouraged to review the actual survey results found in the appendices of this report. No attempt has been made to evaluate the validity of the comments or the practicality of the recommended changes.

Primary Science-Related Attributes

Basic Configuration

1. Vehicle size, maneuverability and speed	Adequate	41 of	48 (85%)
2. Avail. power (capacity) for mission accomplishment	Adequate	27 of	48 (56%)
3. Dive duration	Adequate	30 of	48 (63%)

The survey indicates the basic vehicle configuration is fine however the available power needs to be increased so that it is not the normal limiting factor for dive duration. Time on the bottom needs to be extended and not limited by the current 8 AM to 5 PM guideline, but rather by another more inflexible limit such as daylight or battery recharge/maintenance time.

Sampling Capability

1. Manipulation (dexterity, area of access, lift capacity, etc.)	Adequate	32 of	48 (67%)
2. Science basket (weight, size, volume, and position)	Adequate	25 of	48 (52%)

There was significant interest in improving the science sampling basket. Top among the concerns was size and weight limitations. Other areas of concern were strength, blocking manipulator access to sampling areas, flexibility in compartmentalization, and electrical connections. There were suggestions to make elevators more of a standardized piece of available equipment.

Several comments expressed the need to increase the functionality of the manipulators for current and future work. Areas of concern included dexterity, force feedback, area of access, and the learning curve associated with effective utilization.

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Science Documentation

1. Imaging and image recording (film and video, interior and exterior cameras, location and field of view, lighting)	Adequate	24 of	48 (50%)
2. Data logging (selection of sources, flexibility)	Adequate	29 of	48 (60%)
3. Post dive data availability, format/medium	Adequate	27 of	48 (56%)

There were many recommendations to convert to digital video recording but with the stipulation that the recording systems be chosen so that they are affordable for the scientists (mini DV suggested).

There were several suggestions concerning the 3-chip camera including moving it off the manipulator and providing its own pan and tilt. It was also suggested that the RGB output from the 3-chip camera be utilized to maximize its performance. An aft looking camera and a camera mounted underneath the pilot's viewport were suggested. It was recommended that the observer monitors be changed to color LCD flat screens and that the ease of use of the camera controls be improved. The ability to record sonar imagery was requested. The 35 mm external cameras and strobes were cited as in need of improvement and the reliability of the strobes and synchronization system for the internal 35 mm cameras was mentioned as being deficient.

The data logging system was recommended for improvement with increased flexibility, ease of input, and event recording. It was desired to have in-sphere navigation be graphically displayed perhaps in conjunction with information from a GIS data base.

Post dive data handling needs improvement in streamlining availability, copying, and post processing of navigation data. It was recommended that data be provided in either tab or comma delimited files. It was also recommended that rapid VHS duping equipment be provided so that all scientists can leave the cruise with a VHS tape.

Science Instruments/Tools

1. Standard science instruments normally carried — Adequate 37 of 48 (77%)
2. Available science instruments — Adequate 32 of 48 (67%)
3. Payload avail. for science instruments (interior and exterior) — Adequate 29 of 48 (60%)
4. Interface ease for user supplied science instruments (interior and exterior) — Adequate 28 of 48 (58%)
5. Available electric power sources (voltages) for science equipment — Adequate 35 of 48 (73%)
6. Available hydraulic power for science tools — Adequate 33 of 48 (69%)

The submersible needs a better collection of well designed and maintained hand tools. In addition it needs longer push cores and push cores that allow easy sample extraction on deck. A simultaneous Hi and Lo Temp probe that can be used without connecting wires was requested along with an improvement in the robustness of the ICL design. The navigation system needs improvement including the addition of a Homer Probe capability.

The need to standardize and document the user electrical interface (including RS-232 for external instruments) to make it closer to a "plug and play" system was mentioned as well as the provision of standard "J" boxes for general science use.

The hydraulic system needs increased pressure for drilling systems and valve manifolds that provide better circuit isolation. Drilling capabilities should become standard. The multi-chamber hydraulic slurp system requires an overhaul and a volumetric monitoring system.

Comfort, Controls and Display

1. Observer position and comfort — Adequate 19 of 48 (40%)
2. Control accessibility and operability for observer operated

equipment?	Adequate 21 of 48 (44%)
3. Video and data display visibility and functionality for observers	Adequate 24 of 48 (50%)

ALVIN is uncomfortable compared to all other submersibles, and changing viewport locations could improve that situation.

Video controls need to be fixed in place as they are currently difficult to find and break occasionally while on their tether. The video camera Pan and Tilt should be more reliable. The data systems keyboard and monitor are positioned poorly making it difficult to access.

Current observer monitors are inadequate with hard to read/interpret data displays. These need to be replaced with an increased number of flat screen color monitors.

Observation

Generally 38 of 48 (79 %) of participants indicated that the present ALVIN (and SEA CLIFF as they are the same) observer viewport configuration could use some improvement. Of these, a majority thought that overlapping views with the pilot would help to integrate their efforts as it seems to on other submersibles. Five of 48 (10 %) thought that the present viewport configuration was adequate. It was noted that pilots sometimes have difficulty seeing over large equipment in the basket using their viewport. Lighting in the area of the side viewports could be improved.

The most important criteria for determining optimum viewport arrangement was judged to be pilot ease of use and safety. The second consideration seemed to be increased overlap between at least one observer and the pilot while maintaining a total horizontal field of view as large as possible. Providing the proper scale and direction of view for the scientist was important and different for the various participants but the majority favored a higher and more forward view with maximum overlap with the pilot. Other lesser important placement criteria were comfort, and cost.

Manned Submersible Attributes Considered Important for Deep Submergence Research Activities

- physical presence allowing a wider field of view, a 3-D view, a better perspective of relationships within a site, a sense of scale for the environment, and ability to conduct sensitive fine scale manipulation
- manipulative capability due to mass/stability
- large payload
- maneuverability and ability to rapidly traverse due to absence of tether
- flexibility with multiple tool capability
- large area of view allowing for quicker observations and a greater opportunity to see something unexpected and act on it
- physical presence provides a sense of adventure

The following tabulates the response to the question " If our efforts were to be concentrated in one general area, which should it be?".

Note: several respondents included more than one area.

11 of 48 (23 %)	Rearrange viewports
9 of 48 (19 %)	Imaging
6 of 48 (13 %)	Increase power capacity
6 of 48 (13 %)	Increase bottom time
5 of 48 (10 %)	Improve manipulative capabilities
3 of 48 (6 %)	Electrical interfaces for instrumentation
3 of 48 (6 %)	Navigation
3 of 48 (6 %)	People
2 of 48 (4 %)	Data logging
2 of 48 (4 %)	External load capacity
1 of 48 (2 %)	Increase depth capability
1 of 48 (2 %)	GIS data base
1 of 48 (2 %)	Homer probes
1 of 48 (2 %)	Infrastructure support
1 of 48 (2 %)	Sonar
1 of 48 (2 %)	Reliability
1 of 48 (2 %)	Mechanical interface
1 of 48 (2 %)	Fiber optic penetrator
1 of 48 (2 %)	Internal load(weight/size) capacity
1 of 48 (2 %)	Routine sensors
1 of 48 (2 %)	Observer simulator

2. Operator Suggestions

These suggestions regarding a new vehicle design were obtained from various ALVIN operators and members of the engineering staff at W.H.O.I.

A. Operational
- improve manipulator maintainability and provide force feedback
- improve viewport arrangement
- provide true lateral motion with dynamic position control
- provide a more efficient stern propeller
- improve the interior layout
- provide a moveable basket for more flexibility in sampling
- provide a safety view aft
- optimize displays/controls
- improve design for single pilot workload

B. Electrical
- modify battery tank arrangement for improved maintainability
- reduce size of electronics
- seal internal electronic panels to reduce grounds and improve maintainability
- improve electrical interface to basket
- reduce wiring complexity

C. Mechanical
- improve accessibility of O2 bottles and ease of recharging
- reduce weight of fairings

D. General
- eliminate loose camera controllers
- improve documentation
- convert from film cameras to video/digital
- maximize commercial off the shelf equipment where possible