

SVC participants' comments on *Alvin* sphere

Ergonomics

1) Seating configuration

Novice #1: I found the starboard bench very comfortable offering plenty of surfaces to lean against to view out of the view ports. There was plenty of space between the port and starboard benches.

Intermediate #1: The configuration for the 2 observers and pilot worked well. It allowed easy access to the forward portholes and we were able to sit comfortably in the sphere with no issues.

Experienced #1: It is much better than the way in the old, especially for that arrangement on the front.

Intermediate #2: Found multiple ok seating positions: upright to rear facing forward (on descent)- blocks monitor; back between windows- could stretch legs; kneeling to see outside view ports. No one position good for all times with monitors to rear → internal stills of me facing away from view port to frame imaging shots for video.

Experienced #2: The overall ergonomics of the sub are much better. Seating is much improved, and lighting is much improved. I especially enjoyed being able to stand straight up in the sub, behind, the pilot, and observe from that position for a while. I am 6' 2" tall, and this felt really good. There were some ergonomic issues. First, the oxygen bottle valve handles do jut out a bit, and it's easy for a tall person to knock their knees on them. Second, the position of the monitors behind the viewport is problematic, and forces the observer to choose between looking out the viewport and looking at the monitor. Not good. Finally, some attention should be paid to the orientation of the Velcro on the seat cushions; some sections unzip upon sitting on them, and then they end up sticking to one's clothes.

Experienced #3: The new curved, slightly raised benches are much more comfortable and provide opportunities for the observers to change positions without interfering with the pilot. The higher portion in front of the viewport is excellent for leaning when looking out the forward viewport. Best location to sit – between the two viewports allows the observer to look out of either viewport as well as easily check on what video is being recorded by looking at the high monitor on the opposite side of the sub.

Experienced #4: The seating configuration is very good for someone of my size. I had plenty of room to do all operations. In my case I was using two laptop computers so I had to make sure there were no problems with inadvertently touching the mouse or the keyboard.

Intermediate #3: The seating configuration is very comfortable and a significant improvement over the previous sub. The angle near the forward observer porthole is great for leaning against when adjusting video and during ascent/descent. The little ledge beneath the forward observer porthole is great for placing items (e.g., pen, camera) and it is nice that there is little danger of accidentally bumping the pilot's controls near that porthole.

Experienced #5: I found it very uncomfortable to observe through either observer viewport on the port side. The angle of view was not direct for either, so I found myself peering at odd angles to see things. Unfortunately, I cannot think of a way to improve the ergonomics of viewing. The discomfort is no worse than in the old *Alvin*, the comfort no better.

HOWEVER, the bench and shelf arrangement have many benefits. It was very easy to go into "*Jason*" mode to watch the action on video, and very comfortable. I found that with the zoom capability on the camera (which my eyes at least do not have), I could see more than I could through the viewport; I tended to 'ground-truth' the video with glimpses through the viewport. This was a very satisfying approach for me.

Ascent and descent are very comfortable (though a longer leash on the port EBA would be useful) and the sphere is spacious, with room to stand stretch, shift places with others. This to me is an ideal operational mode – ensures the recorded video captures the sampling and view-shed to share with others not on the dive.

I used the small shelf forward to stow eyeglasses, my pen, and the audio recorder. They were not in the way of my looking through the viewport, and I always knew where to find them. While the design of the seating may change, it would be great to retain some sort of shelf or box convenient to the observers for their small kit.

2) Seating materials

Novice #1: The cushions are very comfortable with plenty of padding.

Intermediate #1: The cushions are a vast improvement over the old seats, and were very comfortable and well insulated.

Experienced #1: It is also better than what it was before, not too slippery against the metal floor beneath.

Intermediate #2: Ok, but Velcro straps hard to put in place for “wall” pads (brought out daily for drying). Tendency to slide down wall with heavy observers. Padding could be thicker? In *Shinkai* → like a futon!

Experienced #2: The cushions are comfy, for the most part, but the Velcro strips can jab you in the back. They are not oriented properly.

Experienced #3: Considerably better than the material in the old sub. Padding is good. Coverage of the surfaces of the sphere where the observers sit is very good. Would be good if this coverage extended further back in the sphere to either side of the O₂ rack as anything stored in this area gets soaked from condensation.

Experienced #4: These were very comfortable. I remarked that they were so comfortable that I could easily fall asleep if I were not so busy.

Intermediate #3: I found the seating materials to be one of the key improvements. They were more insulating, a bit firmer, and most importantly, did not slip around at all despite my gyrations in the ball.

Experienced #5: The seating material was comfortable. The easy fix will be to rethink the Velcro viewport protector, which, when not attached, stuck to clothes, blankets, etc.

3) Seating size

Novice #1: I am on the smaller side. I had been concerned that I would be uncomfortable trying to see out of the forward starboard viewport while leaning on the bench, but that wasn't the case. In the mock-up the viewport was too high for me, but this was perfect.

Intermediate #1: I am a short person (5'4") and fit easily on the bench. I was able to sit in multiple positions, including stretching my legs along the bench with my head at either end, sitting cross-legged, or extending my legs into the sphere.

Experienced #1: I am average size person. However, the current design helps me when I use computer. There is more room for me to move around with the notebook on hand and to see through the side window.

Intermediate #2: Large observer, seating size felt fine. Wouldn't want to lose space to make it bigger.

Experienced #2: I am a tall observer, and seating felt much better. The biggest issue is that if you're tall or large or both, then you might find it hard to use the viewport behind you very much. That makes me worry a bit about that viewport getting scratched, etc. if you're not using it and aren't paying attention.

Experienced #3: I'm an Average sized person. Seating size is excellent and allows observers to sit in different positions. I had hoped that more space would be available either side of the O₂ rack so observers could stretch their legs towards the back of the sub rather than across the sub. This space is now occupied by the scrubber canisters.

Experienced #4: As noted above, I am on the smaller side so was quite comfortable.

Intermediate #3: I'm the smaller side, or perhaps the medium side (if that's possible). I found the seating size comfortable, but didn't find it to be significantly larger than the previous configuration. In my opinion, it all comes down to where you put your legs. I tend to sit on my knees facing the portholes, so more legroom didn't really affect me. I found I could stretch out my legs either onto the softlime cans or under the pilots seat. I tend towards leg-stretching passivity, so if someone else dominated the leg space, I was happy to sit cross-legged.

Experienced #5: For a small body size, the seating size was fine.

4) Viewport positions

Novice #1: The visibility from the sub was outstanding. At times during the dive the pilot used the starboard viewport to get a better view of the outside. This wasn't an issue because I still had a great view from the starboard side viewport.

Intermediate #1: The new forward observer viewports are fantastic addition to the sub. It allowed me to see the pilot's view without getting in the way.

Experienced #1: That is great design for providing observer an opportunity to see through the forward window. With the old *Alvin*, we were not being able to see directly what was happening in front of the basket. This is particularly great and helpful for stbd observer. And as we all know it is often that a first time diver or an inexperienced observer will take stbd seat. They are the one actually need more opportunity to see the real world outside of the ball. As to the sideview port, I felt it is not easy for me to use it. It was placed a little too low. I had to bend myself down to see through from it.

Intermediate #2: Very happy with the 3 front viewports → allows scientists to be engaged and also very useful for pilot to share and get multiple perspectives. Used side viewport to find stuff and explore new flow sites.

Experienced #2: Outstanding positioning of the front viewports. WOW. However, the side viewports are not very useful when you have the front viewports to look through. I'm glad they are there, but I think an acrylic disc should be fastened over them to keep them from being damaged, as they are easy to disregard.

Experienced #3: Forward viewports are a huge improvement and transforms the efficiency of use of the sub because of the overlapping fields of view with the pilot. The side viewports are still important, and I used them more than I expected. Positions are good and allow easy use.

Experienced #4: These are excellently positioned, but in one instance the pilot and the two observers were all looking out at their respective front ports, and were bumping into each other. This made for a very funny moment.

Intermediate #3: The viewports aren't going to change, so I don't see a point in ranking them. The addition of a second observer porthole is fantastic. Equally fantastic is the position of the forward observer porthole. It provides a much better view of what the pilot is doing. The addition of a second porthole provides a distinct improvement in the ability of the observer to find sites, markers, target...a common occurrence. I found the position of the aft observer porthole to be a bit low. I tend to sit on my knees, facing the portholes. I had to bend uncomfortably low to really get my eyes in that porthole. I could see raising the bench so that I could lean on it with my elbows to get lower more comfortably.

Experienced #5: The ability to see some of what the pilot sees through the port observer's viewport is very powerful because they improve the dialogue between pilot and scientist, who share a visual perspective. Brilliant improvement. Under certain circumstances the side viewports will also be useful.

5) Viewport size

Novice #1: The viewable area was larger than I imagined it would be.

Intermediate #1: Both forward and side observer viewports are sufficient in size.

Experienced #1: Although we may always ask for a larger one, however, I am satisfied with the current size.

Intermediate #2: Really pleased we got the biggest size possible for forward viewports but pilot does have best view in the house. (the pilot shared nicely.)

Experienced #2: Outstanding, the best I've seen. Their size makes it so that you have a very wide field of view when you're up close. Not quite the same as the old *SeaLinks*, but darn good.

Experienced #3: Bigger is always better, but the larger forward-looking viewports are a big improvement.

Experienced #4: The viewports were easy to look out of. I could see one third of the basket easily looking outside the front starboard port and by tilting towards the right I could see a little bit more of the basket. The starboard port was less easy to look out of but much better than the previous *Alvin*. I enjoyed taking still photographs with the *Alvin* digital camera.

Intermediate #3: I thought the viewport size was great.

Experienced #5: Surprisingly, I did not notice a difference between the large and small viewports. I had expected to be 'wowed' by the new 'picture window' view, but I was not. So while the larger viewports are a quality enhancement and increase the field of view, they did not change the quality of my viewing experience in the submersible compared the old *Alvin*. I imagine that in a side-by-side comparison I might recognize a difference, but I effectively did that with the side and forward viewports; not a great difference to me.

6) Field of view

Novice #1: The field of view was excellent. I have to say that although there was overlap between the viewport fields of view, I also wanted to see everything that the pilot was seeing. I couldn't help but peek over his shoulder occasionally.

Intermediate #1: The viewport size was big enough for me to have a wide field of view. From the right I could see the left third of the *Alvin* basket all the way to the far port side of the *Alvin*.

Experienced #1: As being indicated above, now we could not only have a view to the side, also a view forward. It is revolutionary for observer. It really makes you feel you are there.

Intermediate #2: Viewport views very good and cameras can still allow you to see even more (as with old *Alvin*).

Experienced #2: Outstanding!

Experienced #3: See comments above.

Experienced #4: the only thing that hampered view for my dive was the amount of surface sediment that was disturbed and which was pushed into the water column.

Intermediate #3: The field of view, when taking into account both portholes, is much improved. From the forward porthole, I was able to easily see the port manipulator doing work. The aft porthole had a good view and with enough illumination that I found myself taking quality stills out that port when the pilots were busy working.

Experienced #5: The added field of view is valuable, but offset by the discomfort with which one views.

7) Layout of video displays

Novice #1: I think that we all agree that that video displays should be relocated. In my opinion if the displays could be located more forward in the sphere it would allow you to look out the viewport and also easily see the video display.

Intermediate #1: It would be beneficial to have the video display (viewer) just above the front observer porthole so that the observer can easily confirm that the video being captured is what is being viewed outside the sub. Currently, it is necessary to move the head back and forth between the video screen and the porthole. Having the video recording screen across from the observer seat facilitates confirmation that the video is being recorded. However, there was no time code, so while the REC was lit on the screen, apparently much of the video was not recorded for this dive from the port side PATZ cam.

Experienced #1: I felt a little uncomfortable for viewing the video display. I need to spin my head back and forth from the front view port and the display. I would rather have it set in an old way, same direction with the front operation.

Intermediate #2: Port observer → can see nav. display (to share with pilot and discuss targets, etc., during dive) and main pilot eng. display. Easy to see recording deck display too, including red “bars” across screen to confirm recording. Would love to find location to front of sphere for observers video display → looking to rear = not ideal.

Experienced #2: I did not like these. The monitor that you use to see all the channels is located behind you, and thus you have to choose between that or the viewport. Also, the confidence monitor for the digital recording decks is small and located across from you. Some thought should be given as to how to do this better.

Experienced #3: The small video displays mounted up high on either side are very useful and easily visible as a means to track what is being recorded. The mounts for each observer are not optimal (and are temporary according to the Expedition Leader) – some sort of folding, swinging arm that allows the observer to move them at will would be preferable.

Experienced #4: The video display

Intermediate #3: I'm reviewing the video displays assuming that all future video kinks are worked out (in terms of recording all video, fixing overlays, etc). The observer video display is in a great spot. I considered the potential of moving that display forward, to allow easier viewing of the display and viewing out the portholes at the same time, but I don't think that would be helpful. My opinion is that video collection should have your full attention when you are doing it and facing it opposite the direction of the portholes helps in that regard. The position and naming

convention of the recording decks is a bit confusing. Having the port-controlled cameras recording on the starboard deck is odd. Having those video files labeled as stbd is misleading. I like having a monitor up on the deck to make sure the correct feed is recording, but ideally, I would like to have two monitors on each deck so I can see what the stbd and port decks are recording. Basically I want to make sure the other observer or PIT is recording what I think they should (i.e., that we aren't recording the same thing, or one is getting a wide shot and one a close-up). If both monitors were in place, you could have the port deck recording the port feed and stbd deck recording the stbd feed, reducing later confusion....or is all of what I just wrote confusing?

Experienced #5: Given that I was disinclined to crane my neck to peer out of the viewports at odd angles, the location of the video display was absolutely ideal for me. I sat facing aft to manage the video and zoom and turned occasionally to look out the viewport.

8) Video controls; e.g. are the pan/tilt, iris and brightness and zoom controls appropriately responsive?

Novice #1: I have no previous experience with video camera controls and it probably shows. It sure would be nice if there were a video simulator of some sort on board the ship where potential divers could practice before diving. It wouldn't have to be sophisticated just something to give you a little more familiarity with the controls. Maybe on deeper dives there is sufficient time to get familiar with the controls. More labels on the controls and video displays would be helpful. I didn't experience the control sensitivity issues that others mentioned. However it would be nice to have a convenient holster for the control. I sat on the controls resulting in cameras and zoom changes.

Intermediate #1: The video controls need a little fine-tuning. The pan/tilt is too sensitive and it is not possible to slowly pan in either direction, which is not ideal. Zoom controls were easy to manipulate. However, focus far/near was difficult to manage with the button set up. There are still some lighting issues, so I'm sure that the focusing will be improved with better lighting, but having the focus and zoom on a dial instead of buttons also allows for smoother fine tuning, ultra fine focus for imaging, and transitioning from far to near.

Experienced #1: They are fine and easy to use. The only problem I felt is that the stick for the pan/tilt is very easy to be hit unintentionally to cause the move. I also felt the control for the pan/tilt is a little too sensitive. Sometimes it is difficult to have a fine adjustment for the view.

Intermediate #2: Pan is a little jittery and too fast. Fixed location video works well but a sweeping shot across a scene → tricky. Iris, focus, and zoom all ok. (Impaired on my dive by lighting.)

Experienced #2: The controller is OK for now, but should be changed. Pan is a little touchy. The controller is on a long leash and is easy to sit on, and thus change the channel you're recording etc.

Experienced #3: Pant/tilt – this is excellent on the PATZ cams; the sponson cameras are slower and also a little jerky. They also tend to shake at the end of a pan. Good range of motion, particularly on the PATZ cams. Iris – fine. Brightness – controlled only by iris and can be in auto mode. Zoom – fine. Video changing (Video Up and Down) – very confusing. No indication of which camera is being observed – needs to pop up on overlay or be clear from the controls. Particularly confusing because each observer can view all cameras, but only controls those cameras on his/her side of the sub. This needs more work and is important for the upcoming cruises.

Experienced #4: I was only able to record the starboard pan and tilt camera. However, the video control box is a problem because it is too easy to touch a control and inadvertently switch between screens on the monitor or record the wrong camera. The joystick for the pan and tilt camera works well as did the focus and zoom controls. I did not see much of an effect using the iris.

Intermediate #3: PATZ pan and tilt are too slow. It's good to limit speed to get nice, smoothly panned video, but you are going to miss capturing moving critters if it is too slow. Thankfully, that is easily remedied as the pilot sped up the pan/tilt by modifying settings in the ball. Not sure that all the pilots would be able to do that though. There is a bug in the panning/tilting of the PATZ that cause them to run off in one direction to full-stop. You can curtail that by panning or tilting the other way, but often times you can't catch it. The company is apparently aware of the issue. It would also be nice to have a way to control speed of zoom so you don't have to jerk in and out and can do it more smoothly. Otherwise, controls are good. I would also like to see a dedicated hook for the controls so it is less likely to sit on it or set something on it and change video.

Experienced #5: The pan, tilt, and zoom are too responsive – impossible to use them without jerky motion – videography with these controls is at most basic. Would be good to have a 'safe' space to park the control box.

9) Video overlays; e.g. are they easily turned on and off? Are they useful information?

Novice #1: The overlays could easily be toggled on and off, but there were some problems with the overlays during the dive behaving randomly. The time-stamp randomly disappeared, but would often reappear when switching cameras.

Intermediate #1: Overlays were easy to turn off and on. All the information was present except altitude read 0 the entire dive. I noticed that when toggling among the different cameras, there was a delay with the overlay such that it added confusion regarding which camera was being viewed at any given time. This may be something that just takes getting used to.

Experienced #1: Yes, it is easy and straightforward for being turned on and off. If the altitude could also be shown there, it will help the observer to make spatial verification during transit and searching for the target or the marker.

Intermediate #2: Very happy: x, y depth, HDG, channel viewed, and "rec." If flicking channels, latency means it can take some seconds for overlay to catch up. (4) Because time "froze" once on my dive → caught within 2 min, pilot rebooted.

Experienced #2: Quite good and easy to read.

Experienced #3: Easily turned on and off. Not much information at present: time, depth, heading, x-y.

Experienced #4: The video overlays had very useful information, but the altitude only gave a value of zero so this needs to be corrected. It was much too easy to touch the video controller and turn off the overlays inadvertently. We should have a rocker switch that turns the controls for the monitor, recorders and overlays on and off.

Intermediate #3: Overlays are easy to turn on and off, but need to be populated with information like depth, altitude, x and y. I typically get that info from the overlay for note taking and it is difficult to find on the pilot's displays. I much prefer, however, that it is not burned into the video.

Experienced #5: Useful information and very easy to toggle. But what about having access to this info on the post-dive video? This is important.

Nomenclature of the video cameras and recorders: Calling the port observer's recorder on the starboard side of the sphere the 'port recorder' is confusing in conversation. Indeed, I am pretty sure as port observer, I was recording onto the deck on the stbd side of the sub, but the video file was in a folder labeled stbd (not port as I expected. Come up with a better naming scheme. For example: The alpha

deck records the port observer's video, beta deck records the stbd observer's video, then label the video folders port-alpha, stbd-beta. And put those labels on the decks themselves.

I understand there is tremendous flexibility in labeling on the pilot's monitors (they are just text lines); as the shakedown continues, I am confident the label logic will settle into something universally useful.

10) Navigation software: How easy is it for the observer or pilot to drop targets, adjust underlays (i.e., switch b/w multiple underlays), collect screen grabs?

Novice #1: No comment

Intermediate #1: The software seemed easy enough for zooming in and out of the nav screen. We did not attempt much in terms of switching between underlays, dropping targets, and such. The underlay was too bright, so it was difficult to see the targets. It seemed to be challenging to measure the distance between points, because selecting different menu options did not respond immediately to the touch. The touch screen sensitivity may need to be addressed.

Experienced #1: By seeing the pilot doing this, I think it is convenient.

Intermediate #2: Looked very familiar from *Sentry* and *Jason* (also NDSF). Underlay and prior targets worked very well together with nav. fixes. Touch screen gooey in ball = not very pilot friendly. Targets dropped by pilot in ball got erased at dive end. Targets in Top Lab = safer option.

Experienced #2: I think the pilots need more training time with the software. I assume they'll get that on later expeditions, but I was surprised at how little chance they had to familiarize themselves with the software. For the most part, it worked fine though.

Experienced #3: Able to drop targets and collect screen grabs quite easily. Underlays did not work.

Experienced #4: I did not drop any targets for this dive, but it seems relatively easy to do in the touch screens. I noticed that the pilot would touch the computer screens and on a few occasions nothing would happen. There is a keyboard to enter information and the USB wireless device was left off the bottom. We had to find it by contacting top lab.

Intermediate #3: I love the new nav display. As the pilots get more familiar with the software they will have much better control on changing colors of the targets, tracks, vehicles, etc. I did play with that in the ball and it works great. It is also easy for the port observer to reach up and get a screen grab of the nav display, which is a big improvement. The only improvements I can recommend are to get the same nav software running in top lab and get the pilots more experience fiddling with display changes.

Experienced #5: No experience with dropping targets or adjusting underlays. I could not see the underlay (wrong angle – too high - for observer viewing). Did not try to collect screen grabs, but I have seen some in the archives and welcome this feature.

11) Doppler Velocity Logger (DVL). Is it constantly getting bottom lock on both hard and soft substrate?

Novice #1: No comment

Intermediate #1: Although we didn't test this explicitly, there did not seem to be an issue with obtaining bottom lock either on hard or soft substrate.

Experienced #1: I felt it is fine, although I did not pay much attention to it.

Intermediate #2: Seemed ok through most of dive but Top Lab did have to "restart nav" once, mid-dive. Dive was mostly on soft sediment; nav. very good functionality all-dive.

Experienced #2: It's all good.

Experienced #3: It works.

Experienced #4: This seemed to work well and there's perhaps some need to work on it to make it perfect.

Intermediate #3: I have never tested the DVL on *Alvin* before, but this subs DVL performs very well. The dead-reckoning point-to-point navigation is similar to the past in that there is drift, but that is inherent with the system. My tests show that the DVL performs well up to and above 85 m altitude, which is more than sufficient to conduct surveying with *Alvin*.

Experienced #5: Not tested.

12) Layout of scientist controls

Novice #1: No comment

Intermediate #1: The flexible hand held video controller on a coiled line was easy to use.

Experienced #1: We need a fixed pocket for placing the video controller and pen or a small flashlight, even for that small recorder. It is not a big effort but helps.

Intermediate #2: Video controller very accessible but adding “pockets” or “pouches” on sub walls would be good for stowing joy-stick controller, also audio rec., pens, notebooks, glasses.

Experienced #2: Again, the video controller is problematic. Too easy to change settings unintentionally, or to kick and break, etc.

Experienced #3: The only controls the scientists have are for the video systems. These are on a panel that is on flexible coiled lines so easily moved as the scientist moves. Much better than fixed position controls.

Experienced #4: The lighting controls were easy to use, but the gooseneck light was difficult to turn exactly where I wanted it.

Intermediate #3: All I can say in this regard is that I have much better access to the nav screen and can assist the pilot in dropping targets, etc.

Experienced #5: Video box: this is great – easy to read, easy to get used to what is where. Observer reading lights – great! Would be good to have some control over lights for side viewports and possibly even some for illuminating video forward.

13) Interior lighting

Novice #1: Interior lighting was good, allowing good exterior viewing and yet plenty of light for note-taking and reading. For those of us with older eyes it is important to remember your “readers.” The dim light would have made it otherwise difficult for me to see. I think because of my size, I didn’t find the gooseneck light very useful. It seemed to be too high and I couldn’t get it to stay in a position that would allow me to see reading material better.

Intermediate #1: The various lighting options were useful for different purposes. There were times when we needed more light for viewing our notes and taking pictures inside the sub, so the overhead lighting and individual lights helped. The red light option was used for part of the dive and this helped us see outside better while still enabling us to view our notes.

Experienced #1: I am very happy with the changes comparing to the old way. We get more light if needed, and also easy for us to do the adjustment.

Intermediate #2: Cool and sexy, no more work needed. Easy to see to read, write notes, read controllers.

Experienced #2: Pretty good, although I thought the physical placement of the light was a bit weird. Also, I wouldn’t mind a bit more light. The red light, though, is a nice touch.

Experienced #3: Excellent, and adjustable. Many options including white and red light – major improvement over *Alvin*.

Experienced #4: The lighting was great and I liked the idea that I could change the color when necessary to make it easier to use computers or write in a book.

Intermediate #3: The interior lighting is certainly more flexible than in the previous sub. The ambient lights from above are more than sufficient to note-take and do various other tasks. I had limited use for the port observer light...I turned it on only once. I would say those could be removed, but I’m sure that there are situations where they would be very useful even if I didn’t experience them on my dive.

Experienced #5: Terrific. Very useful – sufficient light on the emergency ascent was a plus.

14) Availability of contextual information (time, pressure, etc.)

Novice #1: I found this information was available whenever I looked for it.

Intermediate #1: The environmental information was easy to find, either from the pilots GUI, nav screen, video overlay, or other displays. The heading on pilot's GUI display would disappear intermittently.

Experienced #1: Yes, they do, except altitude number.

Intermediate #2: Everything I wanted was on overlay except altitude read-out not working on my dive → stayed at "0" all dive, even in 4 m off surveys.

Experienced #2: We need altitude on the overlay. Otherwise, it's fine.

Experienced #3: Large monitors for the navigation, pilot's GUI, and the forward-looking sonar/Imagenex good as I found myself looking at them frequently, particularly the nav and the GUI.

Experienced #4: Items on the overlay were easy to read.

Intermediate #3: There are so many readouts on the three pilot displays that it can be difficult to parse it all for the information you want. Typically, I will use the overlay to get basic information (e.g., time, depth, xy, heading, alt). Other information that I can use (e.g., SOG, vert. velocity) are difficult to find. Once you are clued in to the location, however, it is much simpler. I could envision a customizable overlay that adds additional info or replaces info if the user wants it.

Experienced #5: On the video display, very easy. Of course, this requires video to be running. When it is not, not so easy. I did find depth on the pilot's monitor.

15) Ease of reading of contextual information

Novice #1: Although the display font was small, it was surprisingly easy to read.

Intermediate #1: The displays were of sufficient font size to ensure easy of viewing.

Experienced #1: It is easy and clear.

Intermediate #2: Fine.

Experienced #2: Fine.

Experienced #3: Large monitors in the forward part of the sub good.

Experienced #4: But it was less easy to read other monitors that the pilot was using. It may get easier with familiarity of the inside of the *Alvin*.

Intermediate #3: No comment.

Experienced #5: When on display. I needed more time to assess.

16) Ease of accessing existing accessories (e.g. cameras, pens)

Novice #1: It was easy to access the accessories and the pilot was helpful in showing us where everything was stowed. The only reason I gave this a 4 is because there is room for minor tweaks. Because most objects in the sub are black, I had a knack for losing things. Nothing major, just pens and the small black neoprene covers for the recorders. If these were neon colored, they might be less likely to get lost (note – I found everything that I lost before the end of the dive).

Intermediate #1: Cameras, voice recorders were easily accessible, but storage of cameras and keyboards seemed to be an issue and not particularly secure. I would suggest adding a drawer or two, or pockets on the wall for additional storage, if possible.

Experienced #1: As mentioned above, it will be convenient if there is a fixed pocket for small items like pen and handheld recorder.

Intermediate #2: Could do with storage pockets (see 12 above). Otherwise, end up using shelf under viewport.

Experienced #2: Was not happy with the lack of storage. Also, some storage seemed odd. For example, the storage right under the viewports should not be first aid; that can go elsewhere. Make that cubby for audio recorders, etc.

Experienced #3: Storage of loose gear in the sub needs work. When we spent some time at the surface, a lot of gear fell off the shelves on to the floor. Cameras, keyboards, etc. not well stored. Easily accessible but needs better storage.

Experienced #4: accessing accessories was fairly easy. I use the *Alvin* inside still camera often to take pictures out of the viewports.

Intermediate #3: No complaints at all. It's not a 5 because it wasn't bad in the old *Alvin*.

Experienced #5: Seems fine; could be better with an organizer and clear invitation to scientists that cameras and pens etc. are available to use.

17) Ease of taking notes, both written and audio

Novice #1: Note taking seemed straightforward. The combination of written notes and audio did the job. On our dive it wasn't essential, but on other dives an event logger of some sort with pre-programmed choices could be helpful.

Intermediate #1: With sufficient lighting, it was easy to take notes with both the audio recorder and hand written notes. However, it would be nice to have access to a tablet computer with event logging capabilities to see how easy it is to log the dive digitally.

Experienced #1: I took notes with both audio recorder and clipboard, and sometime along with operating the computer. They are all convenient and easy. With an enlarged room, these activities are much easy.

Intermediate #2: I used both half-page size notebook with holder for maps, etc. (loose pages) and sub's audio recorder (first user, so didn't trust 100%) → both fine.

Experienced #2: Pretty good. No good place to rest the clipboard except near the front viewports, which is a very, very bad idea because they could scratch the acrylic.

Experienced #3: Did not test the audio recorders. I had a clipboard and very easy to take notes as more personal room in the sphere.

Experienced #4: It was much easier to take notes both written and audio in the new *Alvin* because of the additional space.

Intermediate #3: Same as above. It is neither better nor worse than previous sub. I should note that I'm more of a note writer than audio person, so I didn't use the recorder. They do look nicer and easier to use than the old audiotape versions, but I think the digital audio devices have been in play for a while.

Experienced #5: Would be great to have audio recorders accessible beside the observers rather than stowed; depends on need and use of course.

18) General layout and “atmosphere”

Novice #1: The atmosphere was delightful. Granted, I am a small person (under 5-feet), but the sub was very comfortable. I could position myself to peer through the viewports from various positions on the bench. The ability to be able to stretch and move around will be greatly appreciated by future users on longer dives.

Intermediate #1: As the dive progressed, I grew accustomed to the different tools/gear available for the dive. The shelf below the viewport was useful for storing important items like the voice recorder, sheet with waypoints, and notes. Some additional storage for cameras (internal handheld) would be good.

Experienced #1: It is well designed. I can see a lot details being addressed carefully. For instance, the CO₂/O₂ indication and video recording are placed in the opposite side from the observer. The only concern I have is that the condensation drops now are coming directly from the top falling on to the spot, the middle back, where I tend to lay my leg and feet.

Intermediate #2: Overall, very good – no immediate suggestions for improvement.

Experienced #2: Really great overall. The pilots need to pay attention to storage and organization. Also, they can add more Velcro without adding glue by using Velcro “loops” around the speedrail stuff, and using those loops to stick gear to.

Experienced #3: Significant improvement over previous *Alvin* – “atmosphere” extremely good with more space and improved internal lighting. General layout good – note comments on scrubber can positions and loose gear above.

Experienced #4: It seemed that once we started using more and more items in the *Alvin*, more clutter and encroachment on the space occurred. For example, the oxygen mask on the starboard side fell into my rear space and onto my science pillowcase containing other gear.

Intermediate #3: I think the general layout is improved over the previous sub. Besides the obvious improvements (e.g. more portholes), what immediately came to mind are the additional places to stash gear whether it is notebooks, laptops, cameras, etc.

Experienced #5: Terrific- it will evolve as use grows and as specific needs identified and resolved.

19) Ease of accessing and using emergency safety gear?

Novice #1: The EBA was very accessible. Training on use of the EBA was extremely helpful. The pilot was very patient and thorough during the training session. We learned that because of my small face, I would likely require help from the pilot to properly seal the mask to my face. It was useful to know this in advance of the dive.

Intermediate #1: We did not have to use any safety gear, but all of it was readily accessible. The CO2 canister on the port side was loose at the beginning of the dive, so we tightened it up.

Experienced #1: Yes, it is easy.

Intermediate #2: Happily, not tested, but seemed very straightforward → no concerns.

Experienced #2: GREAT, though I think a laminated quick response card with easy instructions would be a grand idea.

Experienced #3: My EBA was directly accessible on the shelf above the scrubber can. Other emergency gear was readily accessible.

Experienced #4: Fortunately we did not have to use safety gear, but it appeared to be easy to access. We did tighten up on the calcium hydroxide canister, which ensured that the carbon dioxide levels were maintained at a very low level, less than 0.4%. For this dive, both the carbon dioxide and oxygen levels were maintained easily.

Intermediate #3: Thankfully I don't have any experience using any of the emergency or safety gear! I think the EBAs are about as easily accessible as in the past and those are the main item I look for when I get in the sub.

Experienced #5: EBAs: easy access. Important to color code and label all O2 valves so that, under emergency conditions, an observer can work these safely. EBA valves are not visible or well labeled.

****Are there any other features or accessories you would like to see included in the *Alvin*?**

Novice #1: It would also be nice to have more storage pockets or shelves in the sub.

Intermediate #1: It would be nice to either have a shelf or hook for observers to stash our gear rather than having it on the bench. It seems like there is some room by the port side scrubber. The sphere became a little cluttered with various gear as the dive progressed, so easy access to storage would be helpful. A drop down shelf for a laptop would be useful, one that can be stowed or lowered down as needed. As mentioned in #15, a tablet with event logging capabilities, synced to the sub's computers, with time/depth/date at least. Similar to the frame grabber or *Jason's* virtual van, having an interface that allows continuous event logging so we don't have to rely completely on hand written notes is needed for ease of database management post dive. The data are then readily accessible and allow for ease of sample handling after the dive. The event logger would have the capacity to be modified given the dive objectives, whether geared towards photomosaicing (recording start/end lines, altitude, etc.), sample collection, observations, etc.

Experienced #1: The only suggestion I can make is about the in-sphere notebook for the observer. This time I used a notebook from the *Alvin* group. It is fine. However, it will be much better if we could have a tablet.

Intermediate #2: Tablet (e.g., iPad mini) for note-taking electronically.

Experienced #2: Tablets for note taking. Waterproof booties to cover your socks (the condensation in the sub is more noticeable, and your socks get wet...not a big deal at all, but slightly annoying)

Experienced #3: no comment

Experienced #4: no comment

Intermediate #3: I would like to see an improvement in the video controls, preferably a way to hook the controls up and out of the way. Other suggested improvements are addressed in the above responses.

Experienced #5: Perhaps a removable shelf to hang on the aft rack to stow laptops in use – thinking of Kang's ghostbuster tablet that was down amongst our feet – seems like there would be room to put it up out of the way but still accessible.

****Do you have any other general comments about the in sphere attributes of the Alvin?**

Novice #1: no comment

Intermediate #1: It seems like the pilot's seat may get very uncomfortable after long periods of sitting. I think that this should be modified to avoid generating grumpy pilots.

Experienced #1: They are well designed and set. I hardly find an alternative way to make it better. However, I still think, the pilot seat may not be a best design.

Intermediate #2: no comment

Experienced #2: no comment

Experienced #3: Significant improvement over the previous sphere. The pilot seat needs rethinking. Seems unstable and uncomfortable. Manipulator controls beneath the control panel seem tight with limited movement.

Experienced #4: no comment

Intermediate #3: no comment

Experienced #5: no comment

SVC participants' comments on *Alvin* vehicle attributes (out of sphere)

1) Maneuvering to and around target

Novice #1: The vehicle seemed to respond well to maneuvering commands and the Pilot was skilled at piloting the vehicle.

Intermediate #1: The pilot was able to maneuver seamlessly in this low current area.

Experienced #1: I felt it was now easier and gentle going around, especially with lateral thruster.

Intermediate #2: Pilot reported *Alvin* to be a little floaty and light. This was probably a good thing for the start of the dive working around delicate corals: better to float gently overhead than be grinding around at the seabed. The pilot's immediate take, mid-dive was that *Alvin* probably wasn't as nimble as old *Alvin* but that mostly it was more a matter of getting the feel for the new sub.

Experienced #2: Pilot said the vehicle took a while to trim out, but I think they're just getting used to it again. I think the sub was a shade less nimble, but given its size I was really impressed.

Experienced #3: Excellent maneuverability – comparable to previous *Alvin*. Enhanced by addition of lateral thruster – allows vehicle to crab sideways. Also new command and control system allows auto x,y, auto heading, auto altitude – station keeping simpler and excellent. Allows pilot to be more engaged in science and dive objectives.

Experienced #4: Maneuvering was very easy compared to the previous *Alvin*, and the lateral forward thruster allowed us to do more things with less power use.

Intermediate #3: As far as I can tell, maneuverability was improved. I think that it is due in large part to simplified trimming and ballasting procedures. In addition, the improved thrusters really help. As a PIT was driving for much of my dive, I don't think I got the full experience of maneuverability.

Experienced #5: Very maneuverable.

2) Maintaining neutral buoyancy

Novice #1: No comment

Intermediate #1: There were no issues with maintaining neutral buoyancy.

Experienced #1: Now it is much easier and efficient to operate the VB. There are selections for fixed amount to be pumped in and out. I don't think it had this before. I had relatively heavy equipment to unload on the seafloor. It was easy for pilot to make changes accordingly to maintain the neutral buoyancy after the deployment.

Intermediate #2: We seemed to have no trouble getting neutral at the start of the dive and the pilot waxed lyrical about how easy the new pilot GUI was to allow him to trim buoyancy, using the variable ballast system to tweak weight up and down to get light and get heavy for survey vs. sampling operations.

Experienced #2: No problems at all. Sub trims out well. There is a slight bias towards the basket, but I think they can fix that with some foam swapping etc.

Experienced #3: No problems.

Experienced #4: It seemed that maintaining neutral buoyancy was not a significant problem, but we did stir up much sediment. Picture view that much to the soft nature of the top sediments.

Intermediate #3: Again, the PIT was learning about maintaining neutral buoyancy, but I thought it was much more straightforward and efficient to adjust buoyancy. One thing to note is that the software controlled VB had a limit on how heavy you could make the sub and there were instances where the pilot wanted to get heavier than that (e.g., push cores). The group should look at modifying the software to ensure you can go as heavy/light as you want, especially in situations where you are diving shallow and deep.

Experienced #5: Variable ballast controls very effective. Trimming to and maintaining neutral was systematic, straightforward.

3) Battery power consumption roughly compared to old *ALVIN*

Novice #1: No comment

Intermediate #1: Our dive lasted over 6 hours bottom time at 1095 m (max depth). After accomplishing a number of different objectives, including sampling, gear collection, manipulating sensors, and conducting rough mosaics, there was still some battery power left at the end of the dive.

Experienced #1: We had a normal dive with instrument deployment and operation. The power was not the problem, although the port arm was not used much.

Intermediate #2: This seemed fine and better than we might have feared. We had a shallow dive to 1000m but then worked the vehicle busily all day for 6.5h and still had gas in the tank at end of the working day when it was time to come up. The pilot estimated that we probably couldn't have stayed working a full extra hour but 30 minutes more would easily have been doable = 7h of working bottom time.

Experienced #2: Our dive was looong, despite lots of flying and manipulating. Easily comparable to the old *Alvin*, and likely somewhat better.

Experienced #3: Not sure how any scientist can answer this. After a 5.5-hour dive to 350 m, we still had at least another 1 hour of battery power. Seems similar.

Experienced #4: I was very pleased with the battery power consumption in this dive. We did not do as much manipulating with the port manipulator so I would reserve judgment until I saw the vehicle work under the conditions that we use it at hydrothermal vents.

Intermediate #3: Without a doubt power consumption is reduced in this vehicle. This is evidenced by the fact that we haven't had a single dive end due to batteries. I would say that my dive pushed the limits a little bit as there was some heavy manipulator use – an inadvertent manip hydraulic system left online, and some good-sized transits at higher than normal speed (0.4 kt) for testing mapping capabilities. From a mapping perspective, significant thruster use during mapping transects has the potential to shorten mapping dives. Part of this issue could be resolved by adjustments to the auto-xy system. At the ends of track lines and during speed changes, the thrusters were working hard to get the sub to do exactly what we asked it to do (e.g., stop on a dime). It may be better to lessen the reliance on auto-xy in these situations and use only auto-heading and auto-alt. Then the pilot can drive the line and control speed in a more logical manner. The current *Alvin Reson* is a bit of a power hog, which will exacerbate high power consumption on mapping dives. The newer *Reson* model is much more power efficient.

Experienced #5: This is not based on personal experience but what others have conveyed about how load light the submersible is due to design elements, including LED lighting, lateral thrusters, etc.

4) Speed during transit

Novice #1: We seemed to transit with ease and at a good speed.

Intermediate #1: We didn't try to go max speed, usually 0.5 kt between major targets, with no major issues.

Experienced #1: Although we did not run at a full speed during our transit, the capability is satisfactory if needed

Intermediate #2: We already knew that *Alvin* could do 1kt if required. We never attempted that because we wanted to make useful observations as we progressed (we were very much in exploration mode looking for seep sites all through the day whenever we were not parked and sampling/imaging). The vehicle managed to proceed nicely at a good height off-bottom so that we could keep the seafloor in sight at all times and make observations that led, in turn, to discovery 😊.

Experienced #2: Ran at full speed and hit about 1 knot. Nice. NOTE: the sub's speed while lateralizing, however, is pokey.

Experienced #3: Vehicle specification was that it should be able to transit at 1 knot or more. Test carried out to determine speed vs. battery consumption demonstrates it can reach speeds of 1 knot or more, although it consumes more power (see Table).

| Speed (m/s) | Speed (knots) | Power usage both batteries (amps) |
|-------------|---------------|-----------------------------------|
| 0.2 | 0.4 | 20 |
| 0.35 | 0.7 | 20 |
| 0.43 | 0.84 | 30 |
| 0.49 | 0.95 | 35 |
| 0.55 | 1.07 | 40 |

Experienced #4: Speed was not an issue on this dive. We seemed to get between locations fairly easily, but did not have to transit far to get to many of our targets. Top speed was 0.5 knots, and the transit was done at 0.25 knots.

Intermediate #3: Transit speeds near bottom were not markedly different than I remember in the old sub. I think the new sub is capable of higher speeds (especially off-bottom), which may come in very handy for mapping purposes. The ideal survey speed for the Reson is near 1 kt...this depends, of course, on the hydrodynamics of the vehicle and how stable it is at those speeds. I was not inclined to test those speeds during my dive because a) I had a number of other tasks and didn't want to use up all the power and b) it would be difficult to evaluate the vehicle stability without looking at bathymetric sonar data collected at the same time.

Experienced #5: We maintained a steady and comfortable-for-viewing and video-recording transit speed and a useful altitude throughout an ~400-m transit.

5) General purpose lighting

Novice #1: Lighting of the surrounding areas was good.

Intermediate #1: It was difficult to see out ahead when transiting and, while we didn't stay close to the bottom (~ 4m), it seemed like we should have been able to see more in front if the lighting had been available to do so.

Experienced #1: The lighting for transit and basket are all fine.

Intermediate #2: While you can always ask for more light, I didn't feel compromised in terms of being able to see out of the sphere all day, with one exception. At some point I was transiting across the seafloor looking out the port side window and asked if I could get more light to try and see farther. The extra light the pilot turned on was high (above viewport?) and lit up near-field suspended matter = made it harder to see farther, close to ground so I asked him to turn that light back off: maybe additional light low down would be better? Or maybe it would make no difference at all: would be good to look at *Alvin* on deck, in the dark, to see what lights shine where.

Experienced #2: The lighting for general purposes was OK up close to the sub, but seemed dimmer than *Jason*, for example, out farther.

Experienced #3: The only general-purpose light I am aware of is the basket light, which was fine.

Experienced #4: On the transit, video lights were turned off, and the general-purpose lights gave enough light for basket checks.

Intermediate #3: I found the general-purpose lighting to be equal to the previous sub. The fact that it is done with LEDs at a significant power savings makes it a net positive. Comparatively, I think HMI lights are capable of putting out more light (and importantly, concentrating light output at specific locations on the vehicle), but it is not necessary for routine operations and observations from the portholes.

Experienced #5: Great – seems to be improving daily from conversations at science meetings. I miss the ability to turn on and off lights to enhance viewing – this seems especially important should a scientist wish to look out to the side.

6) Lighting for imaging and video

Novice #1: The lighting seemed good. The SVC was useful in adjusting the lighting to optimize video performance.

Intermediate #1: The lighting was better than for dive 4680, but there needs to be additional lighting to allow for fine focus while on full zoom. There were objects that weren't too far from the sub's front basket (<1m) yet at full zoom, the lighting was insufficient to allow for fine focusing on animals, methane ice worms for example, and the video quality was very pixilated.

Experienced #1: It is still necessary to make changes and adjust or even add more to make the camera run well with its zooming power.

Intermediate #2: Over the course of my dive, I found myself struggling to get good images from the HD video cameras. I typically had the Iris wide open and still could not get enough light on a subject to focus sharply when zoomed in. With 20:20 hindsight, I should have made more effort to coordinate with co-observer to use additional lighting on any given subject rather than try and do everything with single operator's controls.

Experienced #2: This was a bit shabby when we first started our operations, but got better with time. This too will take some time. It would be nice to have some lights on the manip for spotlights.

Experienced #3: I am not a good judge of imagery, but the lighting for the PATZ cams seemed good. For the sponson cams, the images seems a little less well lit and may require additional lighting (although given they are imaging over a longer forward distance, this may not improve). Lighting for the down-looking camera seemed good.

Experienced #4: A couple of the outside lights were repositioned for this dive and partially corrected the problems noted on previous dives. Additional lights were added for dive 5 so should be more helpful.

Intermediate #3: On my dive, there was a light on the stbd manip. This light was absolutely critical for shooting good video. The best video was shot where that light was pointed. It allowed me to iris down, get better focus, and produce more interesting/pleasing imagery (because of the directional lighting). Because we were deploying a chemical sensor with the stbd manip, it was convenient to have that light trained on a particular area for a long period of time. Where the stbd arm was not pointed, the video was not as good. It wasn't bad, but more light is better. It is clear that video lighting and general-purpose lighting are two different beasts. The best video lighting is concentrated and moveable to the area where imagery is being collected. For still photography, I found the ambient light much better than the

previous sub. I was able to take useful, quality still photos out of the portholes, which wasn't possible in the past. Admittedly, the cameras are probably better low-light performers as well. I did not pay a great deal of attention to the lighting for the down-looking camera.

Experienced #5: Improving daily, I understand. We were able to run through some lighting options for video and had some clear choices for combinations of lights. On reviewing video post-dive, white balance is an issue. My 'best' video was blue.

7) Still frame camera performance

Novice #1: No comment

Intermediate #1: While the still camera performed according to the pre-dive settings, we were unable to access the camera's settings to allow any manual changes, including adjusting the aperture, shutter speed, etc. After pressing "menu" in the camera software option on the PC, no menu options appeared on the still cam's video display. Regarding the camera's images, the lighting is better than for dive AD 4680, but it is still unevenly lit. The starboard side is overexposed while the port side half of the images are less well lit. The lighting for the camera needs to be mounted on each side of the camera. I believe that currently both lights are mounted on only one side. If the menu options were available, then the aperture can be adjusted to avoid overexposure.

Experienced #1: As indicated above. Although I could not be sure how to make improvement, I do think, it needs more testing. With more attention, the frame quality will be improved.

Intermediate #2: The lighting on my dive was inadequate (I predict) to get the best from the Science Camera. When we turned on the down-looking light, we found that it was on the same circuit as the basket camera, which then shed weird shadows all across the seafloor ruining the images. By turning those off and using the Port & Stbd Obs #1 lights we were able to generate reasonable low but even light levels across the SciCam field of view which was great for observation purposes but, back on deck, the images downloaded the next day were rather dark and not crisply focused (we did not learn how to access more sophisticated controls for the camera on this dive but nor was there much point, given the lighting handicap). The best images obtained are fine for operational purposes – understanding the setting of a scientific feature, placed equipment – but nowhere close to publication quality. Given the effort that went to selecting and acquiring such a high end deep-submergence camera, this DEFINITELY merits attention as a priority to get up and running and working well for Science users ASAP.

Experienced #2: Pic quality seems like it WILL be fine once we get the bugs ironed out. Given how important this is to the program, it needs attention. That means A) the mounting and usage needs to be improved, B) the lighting needs to be improved, and C) the pilots need to get used to the software to be able to change it quickly, or they need to write macros as shortcuts, or someone needs to build a new GUI.

Experienced #3: The still frame camera was only in video mode on this dive. However, the down-looking imagery appeared excellent and very high resolution. Only issue was at full Zoom Out, the edge of the basket appeared in the image.

Experienced #4: I have not seen photos yet.

Intermediate #3: Let me clarify my low score here. First, I did not spend much time dealing with the down-looking camera. Second, the previous sub had the potential to be configured for downlooking photography by adding strobes, which is a huge benefit for downlooking photography. Without a doubt the current downlooking camera is an improvement over the previous sit-cam. It is also an improvement over previous add-on downlooking cameras in that its operation can be controlled from within the ball. Another key improvement for downlooking photography is the auto-xy, -head, -alt. Most of these improvements are not yet operational (in the sense that the *Alvin* team needs some experience with them) and some attention needs to be paid on how to use all of them in concert. All of this is in the context of the fact that downlooking photomosaicing is really a phase II improvement, and I don't expect it to be as good as its going to get at this point. So...don't take the low score here as an indictment of the subs capabilities.

Experienced #5: Underused on my dive; not set up for proper use I presume. Images were out of focus. I understand this camera is intended for use on the manip; it will be important to have a science-user interface accessible so port and stbd scientists can control the camera settings.

8) Video camera performance

Novice #1: Video quality was good, but there were recording issues that the WHOI engineers worked hard to evaluate and correct during the cruise.

Intermediate #1: While the camera seemed to work fine, we had issues with lighting that hampered the quality of the dive video. In addition, while the Port side PATZ camera appeared to be recording (REC was on display), the video was only recorded for the first 2 hours of the dive.

Experienced #1: They are very good, especially the PATZ and downlooking cameras. Adequate lighting will make them better.

Intermediate #2: The PATZ cameras worked really well (new to me) so I am hopeful that improved lighting all across the front of the sub will help make them even better for close-in zoomed work as well as general observations. The main limitation to any one PATZ (like the viewport) is when parked at the seafloor = very limited field of view for far side of basket: but that is why we have the observers' monitor that also allows us to see what the other observer is viewing. I am more familiar with the InSite Mini-Zeus cameras that are also on the brow and on the pilot & science pan & tilts on *Jason*. Because of the increased height of *Alvin* (and maybe also need for more light) the ability to zoom in and focus on delicate features on the *Alvin* MZs seems less good (from memory) than the equivalent on *Jason* (brow-cam feed). That may not be accurate. On *Jason*, only one watch leader controls how all cameras and lighting get used to optimize cinematography = will require different collaborative culture in *Alvin*, between observers, to get the same top-level results?

Experienced #2: The PATZ cameras were awesome! The downlooking cameras were great, really great in fact, but I'm not sure how useful they'll be for high quality imaging given how far they are from the subject. For contextual info and seeing all around, however, they are amazing.

Experienced #3: The PATZ cameras are excellent, and a great addition – highly versatile, high-resolution images, good range of pan and tilt. Sponson cameras are good but may need some lighting additions. Slow in pan and tilt and tend to shake at end of movement. Some reflections on one side of image at Full Zoom Out. Downlooking camera resolution appears excellent.

Experienced #4: Because we did an experiment with the video recorders, I only experimented with the pan & tilt in the starboard transom.

Intermediate #3: With the right lighting and attention to detail both the MiniZeus and PATZ cameras perform excellently.

Experienced #5: Good – PATZ are great. White balance – neither camera was balanced properly.

9) Ease of interacting with still and/or video camera(s)

Novice #1: No comment

Intermediate #1: Some of the comments are stated above in the “inside” assessment, but basically, the pan and tilt stick on the video controls is too sensitive. It is not possible to slowly pan from side to side. Additionally, the fine focus buttons would be easier to use if there was a dial. The interaction with the still camera needs improvement. See #7 above.

Experienced #1: Sometimes, the channels will be switched without my control, and the pan will be moved and turned without my knowledge. I am not sure if I did anything wrong. Otherwise, they are easy to use.

Intermediate #2: Science camera manual is a BOOK = nobody yet seems familiar enough with this camera to come up with a short-cuts cheat-sheet or know quite how to get the best from it (camera was new for this cruise, no camera aficionados have yet dived).

PATZ & Mini-Zeus cameras much easier to interact with and get decent results. Key problem is with pan & tilt controller. Sometimes the pan would just take off, unsolicited, to full limit of travel if you did something not quite right (but I never found out quite what it was I did to upset it so it kept recurring). I did also once try a gentle pan across a pretty panorama and it was pretty horrible – could not select a slow pan rate and what I got was also quite juddery.

Experienced #2: This was not so good. The WHOI-made controllers are still a bit wonky. The GUI for the downlooking still cam/videocam is terrible. This needs WORK. The pilots need to do some work in this regard (or shoreside support).

Experienced #3: See comments in in-hull section.

Experienced #4: More work is needed to get the type of resolution required for the still cameras. Thus this aspect is not easy and I rated at three. Video cameras seemed easy to interact with.

Intermediate #3: I assume this refers to the video controls. The obvious issue with the controller is the ease by which the observer can switch channels without trying. Some sort of cover or a place to hang the controller would be great. The other thing that would be useful would be to have buttons for coarse focus and fine focus. At high-zoom it is hard to get the best focus so moving in smaller quanta of focus might be helpful. The same may apply for panning and tilting. The proper p/t speed at high zoom is not the same as at wide angle, so a toggle between rapid and slow would probably be beneficial. As for the still camera, as has been duly noted, the menu on the pilot's computer leaves a lot to be desired.

Experienced #5: Can science interact with the science camera? I know we could toggle and record it, but what can a scientist control?

10) Efficacy of photomosaicing seafloor

Novice #1: No comment

Intermediate #1: We attempted a few activities to help refamiliarize the pilot with the different settings needed for setting up *Alvin* to perform photomosaics. Auto xy and altitude worked fine. We set the step at 0.5, and our height above bottom was ~ 2m, and ran a 5m line. With the proportional gain set at 1000, we did not make way on a straight course very smoothly. We adjusted the proportional gain by doubling from 1000 to finally 8000 and found that helped smooth out the line. Initially, *Alvin* would be slow to start, then try to catch up to the target end point, but that yielded uneven photographic coverage of the seafloor. Adjusting the differential gain seemed to have no effect on *Alvin's* ability to smoothly move in a straight line at a slow speed. Speed was adjusted from 0.2 m/s to 0.05 m/s and proportional gain set at 8000, and that yielded a great deal of image overlap. We then tried a 10m line going forward then lateral to port 10m on auto controls and *Alvin* followed the lines without issue. The speed probably could have been increased, or the still interval increased to adjust, but some fine-tuning is still needed to facilitate photomosaicing. Pilot was very knowledgeable about how to adjust the controls. Generating a photomosaic cheat sheet for all controls would be a valuable time saver, but more time on the seafloor adjusting controls is needed.

Experienced #1: We did not perform the task and get the results to be checked. However, as we know that with those excellent auto-piloting capabilities (altitude, heading and x-y) it should be done nicely. The experience from pilot may also play the weight.

Intermediate #2: Not yet able to be tested. Some things are a definite 4 – we were able to use auto-altitude, auto x-y (with lateral thruster) and autoheading to hover in a single spot. The pilot was not familiar with how to use the additional *Jason*-like software to set up a square wave raster for mosaicing but we discussed that post-dive and the next pilot WILL know how to do that (4682). Thus, all the maneuverability required for the process now exists for the first time. But that should be tempered with a 2 at the time of dive 4680 because we could not get the camera into its sweet spot. By driving manually while in auto-altitude and auto-heading I believe that we did collect overlapping images in a way that could be mosaiced. But because speed was not controlled (pilot driving manually for speed) then the regularity of spacing etc. that closed-loop control can offer was not fully implemented.

Experienced #2: No comment

Experienced #3: Did not conduct photomosaicing on this cruise.

Experienced #4: Although I did not interact when photomosaicing was done, more work is needed to get this aspect more efficient. I watched as the others experimented with the controls, and it is obvious that everyone will need to get some training on these controls before they enter *Alvin*. Otherwise good photomosaicing will not be easily accomplished.

Intermediate #3: I'm very optimistic about the improved ability to photomosaic given the new c+c. I think my opinion on how auto-xy should be used differs from some of the *Alvin* group. My feeling is that you dial in a substantial position move (e.g., 50 m) and let the sub head that way, whereas I have been hearing reports of small position moves (e.g., 1 m). I think there should be some more clarity on best practices with auto-xy.

Experienced #5: No comment

11) Efficacy of framing and photographing a particular target

Novice #1: The cameras seemed to respond well to the controls, even for a novice.

Intermediate #1: It is very feasible to frame and photograph targets, but the image quality is reduced because the lighting needs to be adjusted.

Experienced #1: With easy maneuvering and good VB operation, the sub is very easy on this task.

Intermediate #2: Seemed fine in all regards. A particular joy was being able to get a little light with the VB then skooch sideways with the lateral thruster at the hydrate mound to line ourselves up rather than lift all the way off bottom, back up and then drive forward again on a slightly different trajectory.

Experienced #2: The cameras and the lighting and the sub all have the potential to yield amazing video and still frames. The challenge now is to get those optimized for easy use by scientists.

Experienced #3: PATZ cam controls of movement are very sensitive and sometimes difficult to center a target in the frame. Downlooking camera was fixed so n/a.

Experienced #4: This is obviously much better than the previous *Alvin* because the observers can look outside the viewports in addition to looking at the monitors.

Intermediate #3: Again, auto-alt or auto-depth seems to be a big improvement on getting *Alvin* positioned for imaging a target that would have traditionally been more difficult (e.g., on a wall, from a specific alt, etc.).

Experienced #5: Video framing was easy, but zoom, pan, tilt too fast for good videography.

12) Quality of video imagery

Novice #1: I didn't see the imagery from my dive, but the previous dives were high quality.

Intermediate #1: The quality of the video is limited by the lighting available.

Experienced #1: Need improvement. The quality may be limited by inadequate lighting. Increased lighting will make it better with the zooming power the camera currently has.

Intermediate #2: I thought I was going to get better imagery than I did from this dive. With 20:20 hindsight, not paying more attention to choreography of lighting from across the sub may have compromised what I could have achieved.

Experienced #2: The quality of the video is GREAT when the lighting is great. The problem is that the sub was rigged with a good number of lights but the positions were chosen arbitrarily. The *Alvin* ops group knew they needed optimizing but we ran out of time. Moreover, I worry they will not have too much time on the early upcoming cruises. Nevertheless, the potential for spectacular images is there, they just need to configure it so that happens.

Experienced #3: Appeared in the sphere as passable for the sponson cameras, very good for PATZ cams, and exceptionally good for downlooking cam. Have not seen the recorded product.

Experienced #4: The quality of the original video imagery looks very good to excellent, but we have to make sure that we don't lose any of the data during the recording.

Intermediate #3: Seriously improved. See dive 4683 video.

Experienced #5: Mixed – white balance needed.

13) Quality of photomosaic

Novice #1: No comment

Intermediate #1: Because we didn't complete a photomosaic per se, but ran a couple lines, I can say that there was sufficient image overlap. However, due to our inability to manually control the still camera and adjust the aperture, it was not possible to obtain the optimal light for the downlooking images. This is resolvable.

Experienced #1: The task was not fully conducted for verification.

Intermediate #2: No comment

Experienced #2: No comment

Experienced #3: Did not conduct on this dive.

Experienced #4: We viewed the photomosaics on the pilot cam to see if there was good overlap between frames. I need to see the resulting photographs to better comment on this aspect.

Intermediate #3: No comment

Experienced #5: No comment

14) Quality of macro stillframes

Novice #1: No comment

Intermediate #1: Lighting is a big issue for the still camera as of now. In addition, the images are being recorded as jpegs and the compression appears too severe. The images are very pixilated when zoomed.

Experienced #1: A bit too dim, as mentioned above, with improved and adjusted lightings, it will be better.

Intermediate #2: Science camera shows lots of potential but lighting seems to be hindering the best possible imaging: again, impressions in the ball were not as good as what was achieved in cold light of the following day.

Experienced #2: These were OK. The problem again is light and auto gain. The camera defaults to auto gain, meaning it changes its virtual "ISO" to compensate for lower light. Thus it looks fine on the screen but the images are kind of crappy. We turned this off and upped the exposure time and things got better fast!

Experienced #3: Did not conduct on this dive.

Experienced #4: I have not seen photos yet.

Intermediate #3: I have not paid attention to the macro still frames.

Experienced #5: No publishable images collected on my dive from the science camera, but we spent no time with any adjusting, if such a thing is possible. Out of focus.

15) Efficacy of manipulators for sampling geology: e.g. is the new configuration well suited for sampling sediments and rocks?

Novice #1: No comment

Intermediate #1: We mostly used the port side manip for sampling and it worked fine for rocks.

Experienced #1: During my dive, it was a full use of stbd manipulator for equipment deployment and sensor measurement. The push core samples and rock sample were also collected. Although we did not get enough chance to use the port manipulator much due to ground, the limited operation also makes me believe it will be very powerful if being fully used. I am very happy with the performance overall.

Intermediate #2: We had a ground fault on the port manipulator so did not use that much. Even so, the pilot (on his first science dive since 2010) was able to take 3 push cores, take a carbonate rock sample (friable rock). He was also able to swing manipulators back out of the way of cameras and view-ports.

Experienced #2: The manips work better then ever, and sampling pushcores etc. was greatly enhanced by the longer reach.

Experienced #3: Completed 6 push cores in about 15 minutes so seems good. Did not try to pick up rocks. Easily picked up weights out of basket suggesting manipulation is good. Problem with port arm gripper that did not close completely after sticking open.

Experienced #4: The new placement of the manipulators did not appear to impede any type of geologic sampling.

Intermediate #3: The manipulator efficacy is largely a function of pilot skill. In that sense, the manips are awesome. That said, the new configuration is very helpful. It is common to set the sub down and look for a sample within reach. Now that the reach is extended by the swing arm, there is greater reach. It's really that simple.

Experienced #5: But seems like there will be no impediments.

16) Efficacy of manipulators for sampling biology: e.g. is the new configuration well suited for sampling fragile organisms?

Novice #1: No comment

Intermediate #1: The manipulators crushed at least 1 live clam, so it would be helpful if the sensitivity of the jaws could be increased. Otherwise, several live clams were successfully collected with the jaws because the scoop remained topside.

Experienced #1: We did not do a lot of biology sampling. However, the pilot did a good job with the manipulator to collect clams and push core samples. The new setup is well suited for this task.

Intermediate #2: I think this sub is going to work well for Biology. At his first attempt, and with a compromised manipulator, the pilot was able to pick up 2 clams (one unbroken) and place them in the basket. I anticipate use of scoops, slurp sampler, etc. will be very easy because of both the manipulators' configuration and the pilot's improved ability to see out front using all three available forward-looking viewports.

Experienced #2: We did not collect any bio samples, but I have no doubt they would work well as they always have.

Experienced #3: Not conducted on this dive.

Experienced #4: The manipulators sampled biological organisms well. We forgot to bring a scoop to collect clams; therefore, the port manipulator was used to pick up a few clams. In one instance a live clam was squished. It would be ideal to have a pressure compensation system for the port manipulator on sampling fragile organisms.

Intermediate #3: From what I've seen, the manipulators are not any better at sampling fragile organisms. Not sure if there is a learning curve on the new manipulator that will ultimately make it better.

Experienced #5: Not sure – we did not spend a lot of time trying to pick up delicate animals. Some mussels were crushed, but if collecting all mussels whole had been a priority, I think the pilot would have been more deliberate. There is nothing inherent in the manipulators to preclude sampling fragile biology that I observed.

17) Efficacy of manipulators during instrument operations including sampling, deployment, recovery and other operational tasks?

Novice #1: I had never experienced the sampling capabilities of the sub first hand before this dive. Pilot made it look easy. When taking the push cores with *Alvin's* manipulator arm, he was able to remove the core from the basket and insert it into the specified sampling location all within one minute (I timed the operations). The combination of human observation, manipulator arm maneuverability, and pilot experience allowed the sampling operations to be successfully and efficiently carried out.

Intermediate #1: It seemed like it was difficult to collect and recover push cores with the cores on the forward port side of the basket. We used the port manip and it was challenging to recover and replace them in their respective quivers. I'm not sure if this was due to placement of the cores on the basket with respect to the port side manip (maybe too close?) but maybe time will tell. The instrument recovery, major/gas tight sampling went well with no major issues. At times, because the pan/tilt on the port PATZ cam was hard to smoothly control, it is difficult to adjust camera views for the pilot to assist with sampling.

Experienced #1: As being indicated before, the manipulators were operated with an excellent performance to take a major pair sample, deploy a timed gas-tight sampler (6-shooter), handling the need for ghostbuster chemical sensor. From these tasks, it is easy to exam the viability and effectiveness of new setup for the arms. I am very satisfied for that.

Intermediate #2: Another winner. the pilot was able to use the starboard manipulator to handle Kang's gear, and even pass science equipment from one manipulator to the other. Not bad after 3 years' inactivity.

Experienced #2: Outstanding.

Experienced #3: Not adequately tested, but lifted three individual weights out of basket at beginning of dive, and then picked one up and returned it to the basket.

Experienced #4: The port manipulator was almost exclusively used during our dive so I cannot really comment on the starboard manipulator and its possible performance.

Intermediate #3: Again, no better/worse than previous manip operations.

Experienced #5: Push cores were deployed and 1 was recovered effectively.

18) Efficacy of additional degrees of freedom on the manipulators?

Novice #1: The manipulator was able to reach most of the desired sampling areas.

Intermediate #1: I probably should have asked for clarification on this question. The manipulators are appropriately placed so that they can be moved out of the image for good video. There seemed to be some issue with getting used to the internal controls and resulting external action of the manip, but I think this may just take getting used to, as the pilot is very experienced and well-acquainted with the manip controls. It was hard to tell if placement of the push cores limited the full functionality of the manip as it appeared that it was easy to get the manipulator jammed into a position that didn't allow full range of motion. In other words, it was easy to pin the port manip into a bind that didn't allow smooth collections.

Experienced #1: With the swing arms installed on the both side, the manipulators can now be operated more towards to side, which will also put the use of side lighting and windows. These features have certainly extended sub's functional ability on the seafloor.

Intermediate #2: I didn't really see this tested on my dive so impossible to comment.

Experienced #2: The "shoulders" are a wonderful addition to the sub! They really improve the sampling capabilities of the vehicle.

Experienced #3: Not sure we adequately assessed this to give it a mark. Manipulators can be moved out of the field of view of the viewport, and out of the field of view of the cameras.

Experienced #4: I am not sure I know what this question is getting at. The positioning of the manipulators can be done easily so all can see through the view ports easily.

Intermediate #3: See previous comment.

Experienced #5: Not observed.

19) Efficacy of onboard sensors

Novice #1: No comment

Intermediate #1: Because of the ICL ground, there was no functioning external temperature probe on the dive. O2 and CO2 sensors performed appropriately.

Experienced #1: If this means for T-probe, then it is fine with readings. However, it was not being picked out for measuring temperature due to ground problem with port arm. I think, it should not be the problem if being used.

Intermediate #2: Because of the manip problem, we had the T-probe in the basket but could not pick it up to test with it around clam sites or hydrate orifice. But it did register a different and plausible (4-5°C) value in the basket at the seafloor vs. 15°C or more on the way back to the ship.

Experienced #2: They all worked as planned. There were intermittent issues with the ICL.

Experienced #3: Operated the Imagenex and the forward-looking sonar, and both seemed to be working fine.

Experienced #4: The sensors for oxygen and carbon dioxide work effectively. There were no *Alvin* sensors used during this time. There were no sensors including temperature as the ICL had a ground.

Intermediate #3: The only onboard sensor I made much use of was the downlooking Imagenex scanning sonar. It worked okay...it was misaligned, so the seafloor always appeared to be steeply sloped. This is a quick fix, but won't be necessary once the RESON is installed. It does highlight the importance of aligning the RESON during installation.

Experienced #5: The science-provided Ghostbuster interface was flawless – my impression is that labels of switches are cryptic to the pilots; with experience this will improve, but having logical labels would be useful.

20) Efficacy of onboard samplers

Novice #1: No comment

Intermediate #1: The pushcores and major sampler worked fine with no issue.

Experienced #1: Push core samplers are good. Major pair samplers (not only this dive) were ?? although worked fine. More check with ICI may still needed.

Intermediate #2: Push-cores good, clam fell out of basket, rock didn't.

Experienced #2: Good as always. Fired Niskin bottles, major samplers, used pushcores.

Experienced #3: Closed 5 Niskin bottles successfully. Slightly awkward positioning of the bottles in the sample basket.

Experienced #4: In this dive, push cores and a double major were used to collect samples from the *Alvin* group samplers. These worked well.

Intermediate #3: no comment

Experienced #5: no comment

21) Efficacy of GROUND detection and management with user-supplied instruments

Novice #1: Grounds were detected throughout the cruise program.

Intermediate #1: It appeared that ground detection and any issues with comms from the sub to user-supplied sensors were sufficient for resolving issues quickly.

Intermediate #2: Before this dive and after the previous one (Dive 4679) the ground problem was experienced on deck with RS 232/ICL line 1 and 2 (port side science). It was fully tested fine before the previous dive (Dive 4679). After its being resolved, the line communications went well during the dive. During the dive, we did experience the ground complications sustained with port manipulator and briefly early with 120-battery power. They were detected and isolated successfully. In my view, what is more critical by design and construction is not that the ground occurred, but if it could be detected and isolated effectively during dive. Therefore I would still rate this high.

Experienced #1: Kang's instrument was troubleshot using GROUND detection on the night before dive. Whole team worked heroically until 11pm to fix it. No problems with Kang's gear at the seafloor = success!

Experienced #2: This seems much improved, although we had a high number of grounding issues, including serial comms dropouts that may have to do with poor shielding, etc. This needs some attention.

Experienced #3: Hard ground immediately identified on entering water in an ISE instrument in basket. No other grounds detected during dive.

Experienced #4: The ground detection is similar to the previous *Alvin*.

Intermediate #3: The ground detection and particularly management system seems to be much improved. The fact that no dive was cut short because of grounds despite multiple instruments being put on the sub for the first time in several years was really astounding.

Experienced #5: no comment

22) Payload capacity

Novice #1: No comment

Intermediate #1: We were on the light side so additional *Alvin* weights were added to the basket, however, the basket was fairly packed with gear. So, while additional gear could probably be accommodated weight wise, space would not allow any more to be added. The placement of the J-boxes near the aft end of the basket seems to impede the possible addition of gear.

Experienced #1: The sub now has much more payload than before. During this dive I took this advantage to carry relatively heavy equipment (~80 lbs) to the bottom for deployment. It went well. With this load, we were still able to bring other tools and equipments such as major pair, gas-tight, sensor system, and sampling box.

Intermediate #2: Not really tested but entirely adequate for what we needed.

Experienced #2: Looks promising!

Experienced #3: Did not test the payload capacity on this dive.

Experienced #4: Because extra weights are added to the basket, payload capacity was not at optimum load.

Intermediate #3: I didn't have the opportunity to push the payload capacity.

Experienced #5: no comment

23) Ease of preparing and dismantling the *Alvin* basket

Novice #1: No comment

Intermediate #1: The layout and access to gear both before, during, and after the dive seemed ok. Removal and replacement of push cores was a breeze.

Experienced #1: Although effort will always be necessary on dealing with this, I don't see any complication or abnormal difficulty with it. From my experience with installing the sensor system on the basket, I also feel it is easy to work with.

Intermediate #2: Seemed fine.

Experienced #2: Better than before in some ways, but position of the J boxes is awkward. They could? / should be oriented with the bladder facing up, then a second tier of green grate should live over them to fasten science gear.

Experienced #3: This was the first dive of the series so there were a number of changes to the basket configuration. The basket is slightly larger so there is more capacity. Once more experience is gained with this basket, this should improve.

Experienced #4: The pilot did the layout of the basket and we added our gear to it. We would have preferred our holster and wand to be up front but heavier items were placed there for obvious reasons.

Intermediate #3: More basket space is better than before, but the increase in space is minimal. I have not seen any marked improvement in the ease of basket changes.

Experienced #5: Seems like there is no difference from the old *Alvin* and still an issue when science wants a basket change out and *Alvin* crew has already put in long hours.

24) Ease of interfacing user-supplied equipment with *Alvin*

Intermediate #1: Despite extensive deck testing and confirmation that the instrument gear worked on the dry side, while on the dive, there were issues with the AIS instrument that were resolved. See Luther's dive log for more details.

Experienced #1: For this dive, I paid attention to this matter with an effort for interfacing the sub with my sensor system. I used two RS232/ICL lines for the data logging and process control. During the dive, no problem occurred for taking the data and sending the commands. All my need was fulfilled. This new sub now has two interface junction boxes/panels on the basket. It also makes the connection easy. However, during this dive, we were not able to obtain the powerful inside of the sphere. Generally speaking, I believe that the sub is now constructed better and easier for user provided instrument. The further verifications on Ethernet and optical communications are still necessary.

Intermediate #2: But I am happy to defer to Kang to disagree for this dive.

Experienced #2: For the first run, it wasn't bad. I do hope they come up with a more effective J box configuration to facilitate ease of use.

Experienced #3: I was not part of interfacing the ISE instrument to the *Alvin*.

Experienced #4: There were problems interfacing the AIS ISEA serial system. The present *Alvin* does not work exactly as the *Jason* nor as the previous *Alvin*. Although all worked on the deck and in dry mode for our first system, it developed a hardware ground when deployed on the *Alvin* on dive one. This was partly corrected by adding a RS - 232 optical isolator to our system; this has not been needed since our dives in 2000.

Intermediate #3: = I'm not the best person to answer this, but I think the addition of Ethernet is likely to be a big improvement for interfacing user-supplied equipment. I would advocate for a 'best-practices' document on instrument design with significant attention paid to through the ball comms.

Experienced #5: No comment

25) Efficacy of *Alvin* navigation

Novice #1: Throughout our dive there seemed to be issues identifying targets with the sonar. Even after the plaque was deployed, *Alvin's* sonar did not find it. I'm curious if this has been corrected. Ease at identifying targets would make dive operations more efficient.

Intermediate #1: Some details with regards to the appropriate process to disseminate the targets/waypoints for the dive need to be ironed out. There were some inconsistencies between actual planned dive targets and those entered into the top lab nav and *Alvin* nav. Establishing a protocol that is clear from the beginning, or rather, reinforcing established protocol would probably extinguish these issues. We did not try to enter targets on the fly while diving, so I can't comment on how efficient that process is.

Experienced #1: It worked well. We were able find our way around for getting to our targets.

Intermediate #2: Navigation worked well in the ball and seemed both robust and familiar (undistinguishable from proven *Jason* & *Sentry* systems). GUI was tricky for pilot to interact with and when we DID drop a target on the sub-based system it got wiped after the dive ended before the information was captured. By contrast, information obtained by calling to top-lab and asking them to drop a target was preserved.

Experienced #2: Great. Very similar to *Jason*. GUI was a bit confusing for pilots, since they hadn't spent a lot of time with it.

Experienced #3: Navigation worked throughout the dive.

Experienced #4: The auto x,y seemed to work well so that is a good addition to the system. Reading x,y and heading from the pilot computers was not easy. It seems that the navigation system will lower battery power consumption; thus, we may get similar bottom times as before. The first 4 dives seem to give great hope for this.

Intermediate #3: The mechanics of *Alvin* navigation have not changed (USBL + DVL). Both systems perform as expected. There is a new nav interface in the sub. The interface components (e.g., reset sub position to USBL fix, drop a target, etc.) are functionally the same., but it is opaque as to whether the nuts and bolts of that system are improved over DVLNav. The big area for improvement is in how navigation data is delivered to the user. With a little knowledge, any user can grab the USBL navigation and get an accurate overview of the subs position in time, but quality navigation can only be obtained by combining the USBL and DVL data streams. My opinion is that that is a data product that should be provided by the user (although I am aware of the personnel difficulties associated with that). If

providing that data is not possible, a detailed explanation of how it is done and a set of Matlab scripts should be provided.

Experienced #5: We got to our sample sites directly. Seemed effective.

26) Reproducibility of *Alvin* navigation

Novice #1: Throughout our dive there seemed to be issues identifying targets with the sonar. Even after a marker was deployed, *Alvin's* sonar did not find it. I'm curious if this has been corrected. Ease at identifying targets would make dive operations more efficient.

Intermediate #1: Previous targets were re-occupied without a problem, including targets established on previous cruises as well as those created during the SVC cruise.

Experienced #1: I think this question could be related to the previous one. Although we did not try to find any previously marked position to test reproducibility on the navigation, from our experiences for searching known targets from the maps and other sources, I do believe *Alvin* navigation will allow necessary reproducibility.

Intermediate #2: Not sure what was meant by this question vs. (27) below. 48h post-dive I have not found an easily accessed time, Lat, Long file that would allow me to plot my dive track.

Experienced #2: Tracks were solid and repeatable. However, the sonar did not see very obvious targets. I suspect the sonar head was facing 90° to the starboard, and I suspect this has been remedied by now.

Experienced #3: No need on this dive to reproduce *Alvin* navigation.

Experienced #4: We did reoccupy sites and it was easy to find them.

Intermediate #3: Again, I think the inherent limitations in navigation reproducibility are due to positional inaccuracy in USBL and DVL drift.

Experienced #5: no comment

27) Accessibility and ease of use of *Alvin* data streams

Novice #1: No comment

Intermediate #1: Post dive, most if not all data streams appeared to be available with little to no delay.

Experienced #1: It can be done reasonably well.

Intermediate #2: Mostly good. I have chosen to investigate what it takes to copy across an entire dive's video in high-res via klutzy USB 2.0 = 10h for 1TB. A data point useful to discourage others with! The raging debate about proxies mean that I had to wait 36h to get access to such files for my dive – haven't evaluated those yet. 12h post-dive there was no knowledge of where the still images for the Science Camera would end up but they showed up in *Data_On_Alvin* by mid-morning. Suspect this was teething issue. All other data showed up promptly.

Experienced #2: Post dive, getting access to the data is varied. Sometimes it goes quickly and other times it seemed slow. All and all, once we settle on a good proxy and pipeline, this should be better. NOTE the RAW.mov files, which are of highest quality, take a loooong time to download over USB.

Experienced #3: Only data streams I accessed were those displayed on the nav, pilot's GUI and Imagenex/sonar monitors in the sub, and those were accessible.

Experienced #4: This is again more related to the video for me.

Intermediate #3: At present, *ALVIN* data streams are made available, but there is no explanation of what those data streams are (this is an easy fix). My poking around revealed the *Alvin* depth data and I was able to easily ingest that data into any number of software programs. A description of what the various parsed data files are recording is needed ASAP. Without that, it is impossible to say whether the data streams are adequate.

Experienced #5: Routine delivery of an excel file with time/lat/lon/depth/hdg/alt would be great.

28) Accessibility / ease of use of *Alvin* data storage hardware

Novice #1: No comment

Intermediate #1: Most of the data were available within a few hours post dive, which is fantastic. There are issues with video data storage and data loss that are still being resolved, so while the video was accessible several hours after the dive, it was incomplete.

Experienced #1: It looks like if the user is with Mac system, it is just fine. However, it may not be easy for PC user. They need to prepare a Mac ready hard driver for making the copy.

Intermediate #2: Access to high-functioning iMacs for video and to ship servers all seems good.

Experienced #2: Access to desktops computers for shipboard editing, compression etc. is great.

Experienced #3: Have not tried at access data storage hardware.

Experienced #4: There are problems with serial timeouts on user-operated gear. The video data storage is a problem that is recognized and solutions will hopefully be found soon.

Intermediate #3: no comment

Experienced #5: Able to download files easily on the ship.

29) Potential ease of *Alvin* framegrabber system

Novice #1: No comment

Intermediate #1: While this was not a feature for this cruise, I see this as a necessary re-addition to each dive to assist with data management, collections, and observations. If additional comments are needed on a prototype or efficiency of existing system, I can give my opinion.

Experienced #1: It's not available now. But, I think, it should and can be done if being emphasized.

Intermediate #2: Doesn't yet exist, but not as high priority as Science Camera.

Experienced #2: No comment

Experienced #3: No framegrabber system available – cannot judge potential ease. But one is needed, particularly to enable access to video for cruise planning for the next day, given the data pipeline and archiving of video will take many hours.

Experienced #4: No comment

Intermediate #3: The earlier framegrabber (you know, the one that existed) was much more useful than the one that doesn't exist.

Experienced #5: Not operational.

****Are there any other features or accessories you would like to see included in the *Alvin* to improve sampling and data collection capabilities ?**

Novice #1: No comment

Intermediate #1: As noted above, an eventlogger program with time, date, lat/long, depth, heading streams would be very helpful. Plus, additional shortcut tabs for logging different events, whether geological or biological observations, sampling events, other notable issues (e.g., navigation problems), etc. would be of tremendous value.

Experienced #1: As I mentioned above, more attention may be needed for getting optical communication line available for the user, and also to have the clean power available for observer with the need of running user computer inside of the sphere.

Intermediate #2: no comment

Experienced #2: no comment

Experienced #3: no comment

Experienced #4: No comment

Intermediate #3: I would like to see the RESON Multibeam system installed on *Alvin*. In order to collect good Multibeam data, the group should consider also installing a sound velocity profiler and a timing switch. The sound velocity profiler corrects for sound speed in real time. Reson makes a unit that can pipe data directly into the sonar computer and correct data in real (or near real) time. The timing switch has been developed by the *Sentry* group and is used by the *Jason* group and ensures that the Doppler and Multibeam sonar don't step on each other because they use a similar frequency. Having both of these items would make the resulting data both easier to process and much higher quality.

Experienced #5: I remain concerned about slurp sampling – would be good to test this, and I am concerned about the condition of bio samplers. Refurbishment and reinvestment in good bio sampling gear is timely. It is not good to have a spanking new and very capable submersible that can collect a tubeworm but can't keep water in the box. This was not an issue on my dive, but I understood from the pilot that if I wanted to collect biology in May, I would need to bring bioboxes; sounded like I would not be guaranteed good sampling kit.

****Do you have any other general comments about the out of sphere attributes of the *Alvin*?**

Novice #1: No comment

Intermediate #1: For the most part, everything functioned outside the sphere as expected. It was possible to collect samples and sensor data. We didn't have any major issues with the manipulator (port side was used fairly exclusively). However, lighting is suboptimal for fine focus zoom on different objects and for surveying what is ahead while in transit. I understand that the latter is a function of altitude as well, but when the *Alvin* was close to the bottom, it was still difficult to scan the field of view ahead of the sub.

Experienced #1: No comment

Intermediate #2: No comment

Experienced #2: No comment

Experienced #3: No comment

Experienced #4: No comment

Intermediate #3: No comment

Experienced #5: No comment