Lessons Learned
from
Research Vessel Crews, Technicians and Operators
to be used for the
Design and Construction of New Research Vessels

Submit your lesson learned

2009 Feedback:

Contributors:

- Steve Lanoux, U. Texas, 9/21/2009
- Daniel Schwartz, UW, 9/16/2009

SMR Section	Type	Vessel	Lesson Learned	Solution
Design/Process				
Ship control	Past Mistake	R/V *Thompson*	The R/V *Thompson*'s bridge layout was -- and remains -- awful. The layout uses a massive, cast-iron console that runs nearly the beam of the ship and occupies somewhere around 70% of the footprint of the wheelhouse floor. Several of the sections of this console have simply four or five indicator bulbs and a couple of switches, with the remainder of the volume of the console being air. Visibility from the center line steering station is poor. On each bridge wing is another	Start with a clean sheet of paper, incorporating commercial ship design philosophies. My prior command, the R/V Seward Johnson, has a large, airy, open one-room wheelhouse/bridge with 360 degree visibility (and she was commissioned six years prior to AGOR-23.) The Chart table is an island with hooded lighting very convenient to the main conning position. A comfortable conning officer's chair is placed on the centerline facing modern inclined panels with integrated CRT (or, by now, flat-panel LCD, displays) for navigation, radar, AIS, FLIR, etc. (Make sure that these displays are truly dim-able to the extent required for night vision: most COTS flat panel displays are not capable of being sufficiently dimmed.) Visibility ahead and to

			massive steel cabinet for what are supposed to be side conning stations. The latter are totally unusable for that purpose as they are populated with slow, non-intuitive spring loaded Z-Drive controls, placed so far inboard that one cannot simultaneously look out over the side or stern while handling the ship. A total waste of space. The entire layout of the wheelhouse reflects naval ship design from an era when underway manning of such a space would probably have had eight or nine people up there, rather than the two that is typical during transits and operations on a UNOLS ship. The chart room is a dark, windowless, closed cabin aft of the main console, and that effectively blocks any visibility aft from the main conning station. There are no open bridgewings on the *Thompson*, hence there is no place for an out-door gyro repeater/bearing stand for navigation or sun amplitudes (to check compass error), no place for a lookout to go out and listen for fog signals or for a navigator to shoot a sun or star line. When you're on the bridge, you are in a box. This is a study in how NOT to design a ship's bridge!	the sides from this centerline chair was excellent. Two additional chairs are located, one at either side of the wheelhouse, right up against the windows, providing comfortable and secure seating for lookouts while affording them unrestricted views from across the opposite bow to directly ahead to abaft the beam. There are two generous side bridge wings with gyro-bearing repeaters -- where a lookout in fog by sound and sight (as required by the COLREGS) can be stationed. Put the chart table -- with a low hood for the light if necessary -- near the main conning station so that the watch officer can take one or two steps over to look at a paper chart. (Yes, I know ECDIS is here,...and computers never crash either, do they?) Make sure that there are windows all around for 360 degree visibility, including astern. It's important to look astern frequently as a 12 knot R/V is not the fastest ship in the ocean--not to mention periods at zero speed, on station. The bridge can be designed in CAD with a three dimensional virtual simulation so that a number of experienced ships' deck officers can "walk" through the space, checking out sightline angles and traffic patterns, before the first piece of steel is ever cut. This technology has existed for well over a decade and was used for designing the Boeing 777 and other jet airliners, as well as modern cruise ships. Finally, make sure that the "Czar" of making these layout decisions is an experienced research vessel Master, not a bureaucrat following the exact letter of some mil-spec design manual for ships with 250 person crews...which is basically what happened with the *Thompson* back in the late 1980s.
Outfitting				
Rescue Boat	Good Idea		The rescue boat davit, which provides a true underway/rough weather launch and recovery capability is priceless!	Make sure the new ships have something like this system.
Process				
Propulsion	Past	All the Z-	Over the last fifteen years, our	Employ top contract attorneys to write a strong contract for the

	Mistake	Drive equipped AGORs	community's collective experiences in dealing with the manufacturer for parts and service has been nothing short of miserable. From failing to respond to e-mail inquiries, to failing to return phone calls, to astonishingly long lead times for delivery of replacement parts, to outrageous prices for nondescript parts, to the seemingly months-long 'vacation' periods in which no one at the factory is available for consultation,... the list goes on and on. (This is not my personal opinion: anyone connected with the AGOR globals can provide endless 'horror stories.')	new ship's Z-Drives (if that is the propulsion system chosen) that delineates response times for parts and service inquiries with penalties for failure to deliver specified services and parts, in effect for the first ten years after delivery. Make this part of the bid package. If, as one might reasonably expect, the manufacturer adjusts the price upward to include the anticipated costs of these guarantees of responsiveness and service, all the better, because it will show that they take their responsibilities and the penalties seriously. Even with a higher buy-in cost, the downstream and lifetime costs (and the avoidance of downtime at the dock with canceled cruises) will more than pay the difference.
Construction				
Construction	Past Mistake		Check the materials of the fasteners in piping systems. Seawater systems in particular are subject to low-level induction current generated by the flow though the pipes. Dissimilar metals can see accelerated galvanic corrosion.	Use of cadmium-plated fasteners in seawater systems must be rejected with 316 stainless or monel being installed. All piping systems should receive engineering review for use of appropriate fasteners.

Community feedback received from 2004 survey:

SMR Section	Type	Vessel	Lesson Learned	Solution
Construction				
				Engines and machinery can be soft mounted. Decks can be floated where possible. Although I've never seen this on a research ship, the Navy uses a relatively simple bubbling system aboard their surface ships for sound quieting.

Acoustic systems	Good Idea	Ocean Class	In as much as financially possible, ships should be sound quieted. Radiated noise from the engines and machinery can reap havoc on sonars and other acoustic sensors.	Called the "Prairie Masker" system, air is pumped out small orifices in the hull to create a shroud of small bubbles. This acoustically insulates the surrounding water from the radiated noise of the hull, making the ship very quiet. While care would have to be taken to prevent bubbles in front of installed sonars, this might be a good way to reduce the overall noise signature of research ships.
Maintainability	Good Idea	R/V Oceanus	During the construction and assuming it will be steel, take great care to dimetcote both sides of all steel surfaces. This will add somewhat to original costs but will save much more over the lifetime of the vessel. In most cases, the steel on the outside is treated but the inside is given less consideration regarding dimetcoating. Consider that ships typically rust/waste from the inside out and not the other way. Additionally, gaining access to the inside steel surfaces once conctruction is complete is very time consuming and expensive should steel treatment, repair or replaement be needed.	
Maintainability	Past Mistake	R/V Gyre	One of several major problems that have kept us in the poor house. Tank coatings. The tanks on Gyre were not treated correctly during constuction and have cost a fortune in upkeep. A detailed study throughout the industry should be undertaken to determine which coating systems actually work. You cannot believe what the paint sales people will tell you. The coating formulas are changing constantly due to stiffer regulations passed down from EPA. and other organizations. Lips on watertight doors where the the paint is continually worn off from traffic should be stainless steel. We have made this mod in some locations with great success. Sea water piping should be of corrosion resistant material. Some study of the most suitable cost effective available materials would be helpfull. Exposed	

			steel on weather decks should be accessible for proper maintenance. Coamings, bulwarks, tank vents, rails, ladders, all tend to have inaccessible areas causing major corrosion problems.	
Maintainability	Past Mistake	Alpha Helix	Alpha Helix was designed as a biological research vessel and converted to a physical oceanography platform. Changing a vessel's mission without fore thought leads to problems in the future. We have strange runs of piping and wiring because of this. Some are difficult to reach for repairs or cross over electronic equipment tht suffers from a leak. Due to its age, wire ways for electrical and data runs are full.	
Navigation	Good Idea	Ocean Class Research	I am continuously amazed at how frequently one is unable to find permenant placards or other markings identifying the ship's center of gravity, center of buoyancy, for-aft centerline and athwardship's centerline or reference line, and at least one distance from the keel making. These reference marks are key to the installation of precise navigation equipment common to the research fleet.	The reference lines described above should be professionally surveyed and marked with conspicious metal placards that are unlikely to be painted or hidden by equipment. Moreover, each line and it's reference data should be well defined in the documentation.
Operability	Good Idea	M/V Otter / Explosives	While underway, steering hydualic rams burst seals and jammed hard port rudder. No easy means to bring the rudders to midships.	Include in construction phase anchor point in which to rig up come-alongs or chain falls to use in order to move rudders in case of a mass failure.
Over the side handling	Good Idea	Research Vessel	I would recommend any new vessel hydrobooms and/or A-frames or J-frames to have attachment points for more than one type/size of block, so that changing from a ctd wire to a 1/4 hydro wire, to a trawl wire could be done at sea, quickly and safely.	Ensure the wire trains from the various winches can be fair leaded without having to remove one wire for another.
Over the side handling	Good Idea		Developments in Deployment and recovery systems in over the side ops such as CTDs, ROVs, towed acoustics platforms, towed undulating platforms, workboats and skiffs have made near hands free deployments/recoveries possible. Implementation of such handling systems aboard UNOLS vessels is in order. Handling systems should be explored early on in	Examples of handling systems (Weibe's Biomaper . Dynacon systems aboard the R/V Shoyou Maru, R/V Shunyo-Maru, R/V Mirai)

			the design of new ships, as the structural concept of the vessel may need to be molded to accommodate such systems	
Design				
Electrical	Good Idea		Enclosures under Mast (primarily instrumentation mast) to house network, AD converters, Serial net devices,,,,,) Would make integrating fixed and visiting instrumentation easier. New vessels designs should incorporate such enclosures.	
Habitability	Good Idea	R/V Oceanus	Habitability: I absolutely believe that all crew berthing should be designed for single rooms with shared heads and showers. It's time we caught up with the modern world.We have the ability to incorporate this into the design without taking up additional space.Crew members spend months aboard on a continual basis.Privacy goes a very long way to attracting and retaining top talent which is in very short supply.The ability to have your own space allows for good rest without others comming and going as well as to be able to work on a computer and conduct other tasks without disturbing others is of paramount importance.	Consult with other operations and recent designs, especially in the european sector to see how they have provided for their crew. Two single rooms need not take up more space than one room for two if designed creatively.This also solves gender issues for crew accomodations which is of great importance for staffing considerations
Habitability	Good Idea	Large/Medium	Regarding ship silencing, the "Prairie" system pumps air through a pipe in the center of the propeller shaft and out through small holes on the leading edge of the propeller blades. It is designed to eliminate a submarines ability to determine a ship's speed by "blade count". It is expensive, difficult to maintain, and weakens the edge of the propeller- It is not recommended for research ships. The "Masker" system pumps air through belts around the belly of the ship to create a sound-deadening layer of small bubbles over the hull. Sea suctions need to be extended out from the hull to avoid air binding pumps and engine cooling systems, adding to the expense of construction and increasing drag on the hull. It cannot be used at low speeds because even extended sea suctions will draw in the air unless it has laminar	Once the mission for a research ship is determined, the naval architects should be asked to consider a Masker type of system for silencing. However, soft mounting engines, use of diesel-electric propulsion, and sound deadening designs will be far less expensive and much simpler to maintain.

			flow. This may mean it is not useable just when the sonars need it the most.	
Habitability	Good Idea	Any R/V	With the amount of time spent on these vessels personel should have there own rooms, for privacy sake.	There is a way to give everyone there own room with a minimun amount of space used. Imagine a set of bunk beds in different rooms. The bottom rack could be open to one room and the top rack could be set into an ajoining room. This will give everyone privacy and still saves room on board for scientific work areas.
Over the side handling	Past Mistake	Atlantis	The starboard hydroboom was set forward of the two winches wich held the wire for different operations. This design allowed for unfavorable angles on the wire to the end of the boom.	The hydroboom should be placed in between the two winches it will decrease the angles to the end of the boom and allow for easier rigging. Also there is a need for a booth that is in a spot that makes it easy to see the deck and over the side, with windows that allow the operator to see the wire on the winches.
Ship control	Good Idea	R/V Oceanus	GOOD IDEA TO REPEAT: During Oceanus mid life refit, a new ships bridge was built. Myself,along with two other ships officers as well as others participated in the design.The concept was to construct a bridge for a one or two person operation.The crew who actually operate the vessel should have major input on design and equipment location.	Design for maximum visibility for reduced manning.Arrange the majority of equipment and instrumentation to be centered around the primary steering station so that the watch officer has maximum availibility of what is needed all in one location and forward looking. That is, all pertinent instrumentation can be viewed as one looks forward.The communication center and chart room should be separated from the bridge (same level) yet close enough for easy access. This minimizes distraction on the bridge. Too often the bridge design is tasked to the naval architects who present their idea of what should be. This is especially true with vessels built under naval

				contracts where the thinking is that there will be several watch standers and the equipment is scattered all over the bridge. The console pannels where the equipment is to be installed should be removable with cutouts for the original installation. This way as future equiment is added or changed out with different "footprints" a new removable pannel can be made fairly inexpensively to replace the old one. This allows for upgrading without compromising the console.
Ship control	Good Idea	R/V Gyre	We have found some limitations which could be alleviated by the addition of stern controls. These should have a clear view of the back deck operations, they would be a big improvement to the safety of deployments and retrievals over the stern. Most of the work boats built by industry these days have this feature.	
Storage	Good Idea	R/V Atlantis	The laboratory layout of Atlantis was very well thought out. Having most labs on one level gives very easy access to the labs for science to load and unload. This reduces set up time and packing time. The forward science hold also is in a good location and allows for using a crane to load bulky equipment into the vessel. The ease of moving equipment from the hold to the labs is very good. Pallet jacks can move equipment easily.	The central hall that runs up the centerline from the Alvin hanger to the science hold should be widened a little to allow a pallet jack with full pallet to be run along the whole hallway. If a door could have been incorporated into the aft end of the hallway then pallet loads could be brought directly from the aft deck to the science hold instead of having to drag pallets through the main lab. This would give you two means of loading bulky equipment into the science hold and would decrease loading time.
Storage	Good Idea		Hazardous material lockers for bulk storage and for working quantities along with spill response stations should be incorporated into basic design plans of new vessels.	
			Winches and other equipment on exposed weather decks are a high maintenance item. Excessive noise	

Winches	Good Idea		from winches can sometimes be a problem for operators and people working on deck. Winches should as quiet as possible, and mounted in a protected area where possible. Where the winches are not in plain view of the operator, a good clear resolution monitor should be installed Winch operators must be able to see the working deck, and all the personnel involved in the deployment, and also have a clear view of packages being deployed.	
Working deck area	Good Idea	Alpha Helix	Helix was designed as a biological research vessel and converted to physical oceanography duty. Interior design is excellent for its size. Labs are roomy and interior is spacious for its size. However, deck space is undersized for oceanography work particularly for coring and moorings	Lesson is a ship cannot serve two masters. While we have adapted to the shortage of deck space it is a shortcoming that can never be corrected without expensive and extensive designs. Remember when designing a ship its mission or requirements probably will change over the years so insure space exists to accomodate it.
Outfitting				
Communications - internal	Good Idea	Healy	The USCGC Healy's pager system is quite nice for getting ahold of people in an inobtrusive way. It would be a nice addition to any ship's telecom suite.	
Cranes	Good Idea	R/V Gyre	Having had both knuckle boom cranes and straight boom cranes, we have found the knuckle boom far superior for use at sea. One drawback is they tend to have less capacity than the straight boom variety.	
Data network and onboard computing	Good Idea		Modulated Cable TV systems porting Camera and Data acquisition displays should be incorporated in new vessel instrumentation package	
			Because of advances in processing capabilities, data storage and transfer, future sonar systems are likely to have to ability to optionally store full time series data	By Teleco-grade computer lab, I mean the following: 1) A large capapble CLEAN power supply. 2) A central industrial dedicated UPS for power outages.

Data network and onboard computing	Good Idea	Ocean Class Research	rather than small sub-bottom profiles or bottom detects. Some back-of-the-envelop calculations show data rates from a multibeam sonar could be as high as a three Terabytes a day! Moreover, no advances in data systems in the pipeline for any kind of sensor are likely to include a REDUCTION in data colletion levels. For these reasons, research ships should be outfitted with a Telco Grade computer lab.	3) Plenty of 19" rack storage space 4) A climate controlled space with a raised subfloor for bottom to top rack ventilation 5) A halon fire system 6) A wireless infrastructure both internal and external to ths ship 7) Overhead, easily accessible wire runs 8) Core systems (routers/servers) should be NEBS level III complient (teleco standard specifying things like shock and humidity hardened) 9) Adequate wall space for several large-format displays for integrated, real time nav, sensor status, sensor data display.
Data network and onboard computing	Good Idea		In the past Data was collected to be processed at home. Today processing aboard ship is the norm. Implementation of on board database should be explored. Some vessels are supporting limited processing of data. Making such products available via HTML front end appears to be a good solution.	
Data network and onboard computing	Good Idea		Technical support for ships should be increased. IT support aboard vessels is a position in itself.	
Electrical	Good Idea	Knorr/Oceanus	As a necomer to WHOI, I have seen countless landbase styled UPS's need to be replaced at a frequency of most times once a year. Even when they are working, due to the nature of the ship's power fluctuations in magnitude and frequency, these supplies become "used" after a short lifespan. I have found that a new design that has been proven to work is also a "back to the basics" design. We are using 908D Gell Cells, a GMDSS stle battery charger 40 Amp continuous, 60 Amp peak), and a combination of both the 24 VDC source and 24 VDC to 120 VAC (pure sine-wave type) 1KW inverters. As the ship's electronics needs and computers neccessitate the	I can supply both schematics or sources for purchasing these supplies at the lowest possible market values. If anyone needs more help or information, please feel free to contact me at the above E-mail or phone number. Mike Gagne/WHOI

			need for a constant, reliable source, this method has proven it's existance. And by using redundancy with the batterioes and inverters, a backup situation is always at hand. We even have the gyrocompasses connected to this source, and this alone, has proven to be a better method for power sourcing.	
Laboratories	Past Mistake		Ultra pure water systems fed by RO have proven problematic. Again this should be considered in the planning stage of new vessels	
Maintainability	Past Mistake	R/V Gyre	Due to the lowest bidder aspect of most projects the original equipment can come from any place on the globe. This may not be a problem in the early life of a ship, but when you start needing spare parts or a service technician it becomes tremendously expensive, quite often involving long lead times. Shipping costs, rates of exchange, import duties, agent fees, all run up the final operating budget of a vessel when maintaining foreign equipment.	Solution, Buy domestic if possible.
Operability	Good Idea	M/V Sea Lion / Passenger ship	SSG dropped off line while at anchor. We were not able to restart either generators. The ship was equipped with an emergency generator, but not 3 phase. This prevented us from recovering the anchor which was 208v Single phase. Bad weather came up which forced us to leave the anchorage. We ended up slipping the ground tackel for a loss.	When planning ship's power systems, include an emergency generator that is capable of operating key equipment on board.
Ship control	Good Idea	R/V Oceanus	Good idea: Wire and install CCTV cameras which are "pan - tilt - zoom. A determination can be made for optimum coverage.The main control pannel should be placed on the bridge so that the watch officer can monitor deck operations. The benefits are many in addition to monitoring operations for safety, the system should include a C.D. so that situations and operations can be recorded. This will provide for security as well as providing science with a tool with which they can record their work on deck. It would provide a record of what was done for review later.Another huge benefit	As above

			would be to provide students and others a learning tool. People ashore could view the disc in order to learn techniques and procedures for future cruises well in advance of actually going on a cruise.Other benefits could include monitoring of unmanned spaces such as winch rooms where machinery is is in operation.	
Process				
Habitability	Past Mistake		HVAC - get good acoustical advice/review of entire system at outset - as part of design, not subsequent remedial work.	LOTS of rework of various noisy HVAC components on AGORs. Due primarily, I think, to initial treatment of HVAC as a mechanical design issue (duct runs, fans etc.) without comparable effort to engineer the acoustical aspects of the full system. To achieve anything like the desired noise levels in various spaces requires a really good acoustical consultant - perhaps independent - as a primary driver of the whole design, someone with acoustic results (not ease of ductwork fabrication) as primary motive. Air-cooled generators contribute massively to HVAC demand, hence noise; a basic point. Realistic estimates of heat loads in science spaces - esp. labs - are needed. These are less well-determined in design cookbooks than loads for engine rooms, galleys, etc. In some cases gross overestimates of loads have driven HVAC designs, with unfortunate results. Grossly wrong estimates, + or -, should be avoided. Data/experience needed.
				Structure the contract to allow late

Life cycle costs	Good Idea		To avoid - too-early "locking in" of some equipment and features, thereby losing the chance to obtain latest and best, except via (expensive) change orders.	selections of items that logically warrant this approach. Example - early selections/decisions are needed for hull form, major subdivisions, main machinery, etc. But use later selections for things like particular science computers, some smaller/more stand-alone instruments, etc. where deferring the selection does not impact design and arrangements significantly.
Life cycle costs	Past Mistake		Lack of standards made development of ARRV design difficult and costly. This was true in determining science outfit, labs, van requirements, cranes, etc.	I think the standard SMRs are a step in the right decision. However, I also think it would be more beneicial to first describe the missions, data collection functions and science suite a class of vessels is expected to perform and then design around that. When we developed SMRs through scientific input and meetings, we were asked to perform and provide everything (i.e. long cores, moon pools, etc) Investigating the possiblity of doing so became expensive. At some point, we need to say no this class vessel does not do that mission. Maybe some demands or missions should only be done by one or two vessels or under contract if they are very unique. The same applies to the number of vans a vessel caries, the weight its cranes, winches, frames can lift or support, type of electirical power, what science equipment it carries and supports, maximum number of scientist it carries, de-ionization method and capacity for water to support science. Computerized data capture, data management and

				navigational systems plus their display and analysis capabilities available to science parties should also be standard. We should strive for as many standards as possible fleet-wide but also with the realization that a large ship is more capable than a small one.
Maintainability	Past Mistake		Give due weight to investment in first-class, rugged, maintainable systems at the outset (design/construction), to avoid recurrent repair emergencies and costs during operations. Cost of operations over the ship life is several times the construction cost. Breakdowns create havoc in science plans as well as in repair budgets. Existing comment on this site re dimetcote as a worthy front-end investment is one example. CuNi seawater piping is another. Propulsion system design and machinery selection to be as "bulletproof" as possible is another.	Listen to experienced masters and engineers about what does and does not run trouble-free at sea. Listen to them on matters of arrangements/accesses such that maintenance can actually be done. Careful, conservative design homework by naval arch./marine engineer on repair/reliability of major systems before selection.
Maintainability	Past Mistake		Shipyard slovenliness re care and handling of received equipment and materials inbound for the ship. Electronics gear left in the weather, or installed on ship but then left unprotected (subject to dings) and/or in ambient air for weeks or months as one example. Storage of hydraulic piping outdoors/in the weeds prior to fabrication/installation as another. Many pieces of gear and material require careful protection and perhaps climate control from the moment they enter the yard until the ship is up and running with air conditioning on. Shipyards tend not to be careful in this regard.	Structure contract with significant penalties for shipyard mishandling or poor care of equipment/materials destined for ship; handling and storage protocols dependent on the items involved.
Operability	Good Idea	various	During design phase, construct full-scale mock ups of bridge, labs, typical stateroom. Use plywood or other light, inexpensive materials.	
				Another comment on the site says it well. Do this design paying careful attention to those with the experience. Clustering/arrangement of instruments to facilitate work on a bridge with few

Ship control	Past Mistake		Bridge design/layout/sight lines - a matter for experienced masters/mates	people is important; this is not a Navy bridge. Provision for ease of future change/upgrade is important. Visibility and lines of visual/verbal communication to working decks are paramount. Large rework of Revelle bridge was made necessary by giving short shrift to views of experts during original design.
Storage	Past Mistake	JOIDES Resolution	Loading and unloading method was time consuming due to having to drop supplies down into the vessel. The mission was to supply all science supplies and equipment for the science party. So a lot of equipment and supplies are loaded. Having to crane large amounts of supplies down to the lower levels of the ship took more time than it should of if a better loading design could have been developed.	By removing or reduing the amount of crane time required to load equipment could have solved a lot of the time issues. This would have reduced the amount of time the vessel spent in port and increased the days for transit and scientific exploration .

Contributors:

Val Schmidt, LDEO/Columbia
Lawrence Bearse, Woods Hole Oceanographic Inst.
Desmond Rolf, Texas A&M University
Tom Smith, UAF
Ron Short, MLML
Jon Alberts, Woods Hole Oceanographic Institution
Steven Hartz, University of Alaska
John Dyke, Woods Hole Oceanographic Institution
Robert Knox, SIO/UCSD
Jeff Callahan, URI-GSO
Steve Lanoux, Univ. of Texas
James McGill, WHOI
Mike Gagne, WHOI

Updated: September 21, 2009