SECTION 10
Douglas Wolff
Monohull Design and Construction

Monohulls as research vessels have represented the stock-in-trade from the fifteenth century European voyages of exploration until the late twentieth century. Even now, the monohull concept has significant advantages over other hullforms in many applications. Although the SWATH, catamaran, and other "modern" hull forms are increasingly common, the versatility and economy of the monohull design ensure that it will continue to play a major role in the fleet of small research vessels.

Significant advantages of the monohull as compared to SWATH and multihull designs include:

- Low acquisition cost
- Efficient use of enclosed volume
- Propulsion system flexibility
- Excellent maneuverability
- Low relative maintenance

Acquisition Costs

Addition of a new vessel to the fleet requires a careful analysis to determine if the market will support the capital and operating costs. Without delving into the "demand side" issues, it is clear that a lower capital investment will enable the operator to be more price competitive in a slow (buyer's) market, and to recoup the investment faster in an active (seller's) market. Monohulls offer lower cost per unit volume than other hull configurations. This is due to the relationship between hull surface area and volume. This ratio is minimized in the case of a monohull, thereby reducing the quantity of materials and the amount of labor required to assemble the hull. In addition, machinery costs are increased in the case of a multihull due to the redundancy required for multiple propulsion and ballast systems, and are difficulty involved in machinery installation in cramped spaces.

Hull Volume Utilization

Because the enclosed volume is in a single hull, the monohull offers excellent flexibility in layout of machinery and accommodations spaces located below deck. For example, the machinery space can be located aft to reduce shafting length, or forward to permit accommodations or laboratories amidships where the ride is more comfortable. If a cargo hold is required, a monohull has maximum usable volume for an amidships or aft hold.

Propulsion Flexibility

With regard to propulsion machinery, the monohull allows the choice of either single or twin propulsors. Each option has advantages: a single propulsor occupies less space and will be lighter and less expensive; twin propulsors provide better maneuverability as well as take-home power in the event of a propulsor failure. Only the monohull design allows for the advantages a single propulsor offers.

Dynamic Positioning

Dynamic positioning (DP) has become commonplace in monohull will typically be fitted with forward and aft jet thrusters for 360^o directional control. A twin propulsor vessel may be able to dispense with the aft thruster, working the two propulsors against each other as required to obtain the required thrust in conjunction with the forward thrusters. In either case, DP control is available to suit the mission requirements.

Maneuverability, Access and Maintenance

The relatively narrow beam and large waterplane area of the monohull vessel also offer advantages. Many areas served by small research vessels have limited port and repair facilities; the narrow beam allows access into smaller marinas, marine railways and dry-docks that may be accessible to multihulls vessels. Maintenance is reduced due to reduces wetted surface areas and fewer sea chests installed in a monohull.

Large waterplane area can be advantageous in that the vessel draft will be less affected by weight growth than will the draft of a vessel with less waterplane area; i.e. a monohull will be less weight sensitive than a multihull of comparable length.

Having discussed the advantages of the monohull design, it is now appropriate to touch on the disadvantages, which are:

- Seakeeping
- Deck area
- Perception

Seakeeping

The relatively large waterplane area, an advantage when considering weight growth, is a negative factor when considering the issue of seakeeping. Greatly simplified, we can generalize that a vessel will react to the dynamic input of swells and waves proportional to the waterplane area - increased area will result in increased ship motions. Methods for reducing motion are well established and include both active and passive systems. Active systems include fin stabilizers and rudder control, both of which are controlled by sensors measuring and responding to vessel motions. These active systems are very effective when the vessel is operating at speed, but the effectiveness is greatly reduced as vessel speeds are reduced. The complexity and cost of active roll reduction systems have generally precluded their use in small research vessels.

Passive roll reduction systems include bilge keels, a deep centerline keel, a centerboard or daggerboard, flopper-stoppers and anti-roll tank. Bilge keels (also called rolling chocks) are widely used because of their simplicity, low cost and effectiveness at all vessels speeds. Properly designed bilge keels create minimal drag and increase roll period while reducing roll amplitude; poorly designed bilge keels can reduce vessel speed while providing little reduction in roll amplitude. At the cost of reduced effectiveness, bilge keels can be made discontinuous in way of over-the-side launching operations to minimize the risk of fouling.

A deep centerline keel is very inexpensive, but is somewhat less effective in than bilge keels and increases in draft, a problem for shallow water operations. Course keeping is enhanced while maneuverability is reduced; increased resistance to transverse forces by wind and waves may enhance dynamic positioning.

Centerboards and daggerboards offer great flexibility and effectiveness in roll reduction and draft control. They also provide an excellent location for transducers well below boundary layer flow. The major disadvantages of high cost and impact on interior arrangements make these systems generally unacceptable on smaller vessels.

Flopper-stoppers are common on small fishing vessels and are very effective for roll reduction at minimal cost. Their use on research vessels is usually impractical due to the requirement for over-the-side booms, entailing a complicated mast and rigging arrangement, along with the increased potential for fouling scientific equipment on the in-the-water units.

Anti-roll tanks are probably the most effective method for passive roll reduction, but the expense, weight, and space requirements prohibit their use on small vessels.

Deck Area

Working deck area and laboratory space are the premier commodities on any research vessel. For equal length vessels, multihulls have a clear advantage, often up to 30%, in working deck area and lab space.

Perception

Despite their numerous advantages, monohulls suffer from the perseption that multihulls represent the state-of-the-art and are therefore inherently safer, more comfortable, faster or just plain better. Perceptions, true or not, play an important role in completely marketing a vessel; monohull operators must work harder to convince the market of the advantages of their vessel for the proposed operations.

Conclusions

There is no optimum hull form for small research vessels. Viewed as a platform for conducting research, the hull will be subject to numerous compromises affecting cost, range, seakeeping, payload, complement, maneuverability, data collection and analysis, capability, even esthetics. It is incumbent upon the vessel design and selection committee to become educated in these areas so that rational decisions can be made, resulting in the acquisition of a vessel best suited for the intended operations budget.