

Submerged-Hull Ships Tame the High Seas

With less area for waves to batter, the new submerged-hull ships should be faster, safer, and more comfortable in foul weather.

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National defense and NATO commitments have forced the Navy to look at ship designs that can operate under sea conditions that would keep conventional ships in port. The goal is to reduce ship motions in rough

waters and open seas, such as in the North Atlantic, to levels where the crew can work normally.

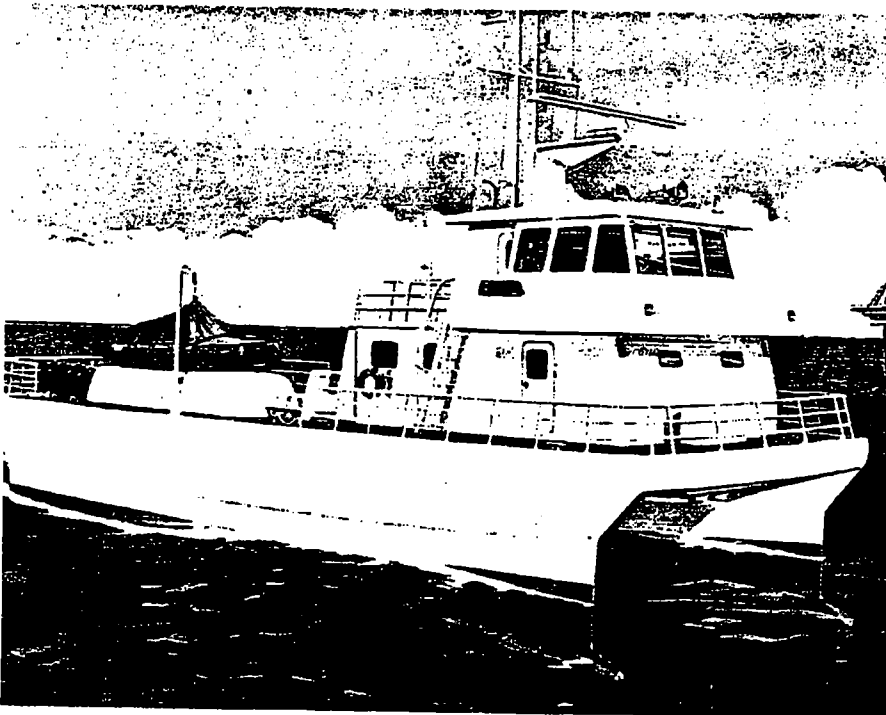
One technology that is generating interest is the SWATH (Small Waterplane Area Twin Hull) ship. Two West Coast companies in particular — RMI Inc. and Lockheed Shipbuilding Co. — are working on SWATH designs that feature a

number of advantages over conventional monohull ship designs. Improvements include better ride quality, improved operation in rough open seas, greater crew efficiency and safety in rough water, the ability to maintain speed in high waves, enhanced low-speed maneuverability, and automatic motion control.

Twin hulls

RMI's first SWATH ship, the Halcyon, is an aluminum structure. However, other materials are being considered, according to Lockheed designers. For instance, composite materials could be combined with metal for the hulls, and fiberglass could be used in the superstructure.

Two submerged cylindrical lower hulls provide most of the buoyancy on SWATH vessels. These parallel hulls carry struts that support two upper hulls and the ship's main platform. Because at cruise speeds the struts provide a smaller waterplane area than a traditional displacement hull, this arrangement of hulls and struts makes the SWATH ship much less susceptible to heavy wave action. The upper cross structure provides a large unobstructed deck area for work crew activity,



RMI's Halcyon SWATH 60 demonstrator, with speeds in excess of 22 knots, features an aluminum side hull assembly (upper right) that has sufficient depth for open sea operation. The ship has exceeded design goals and has shown better-than-expected fuel consumption during endurance trials.

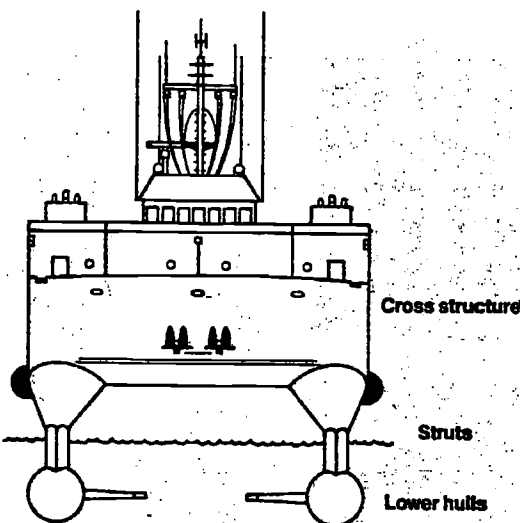
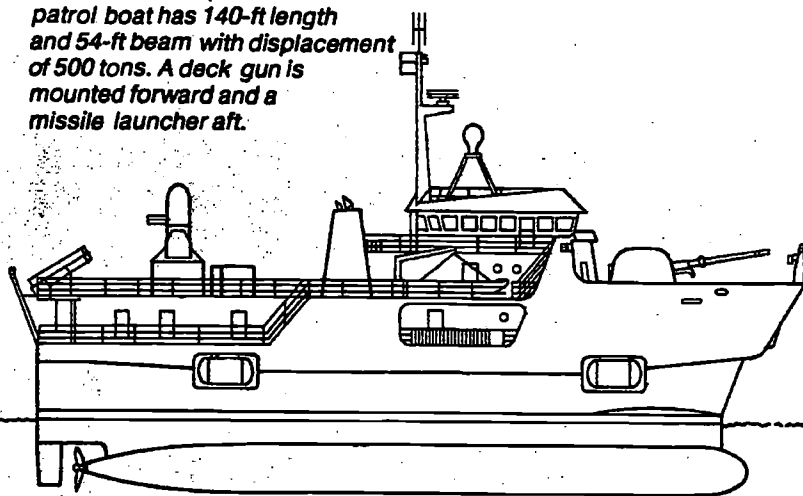
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MACHINE DESIGN/MAY 8, 1986

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Lockheed concept of SWATH patrol boat has 140-ft length and 54-ft beam with displacement of 500 tons. A deck gun is mounted forward and a missile launcher aft.



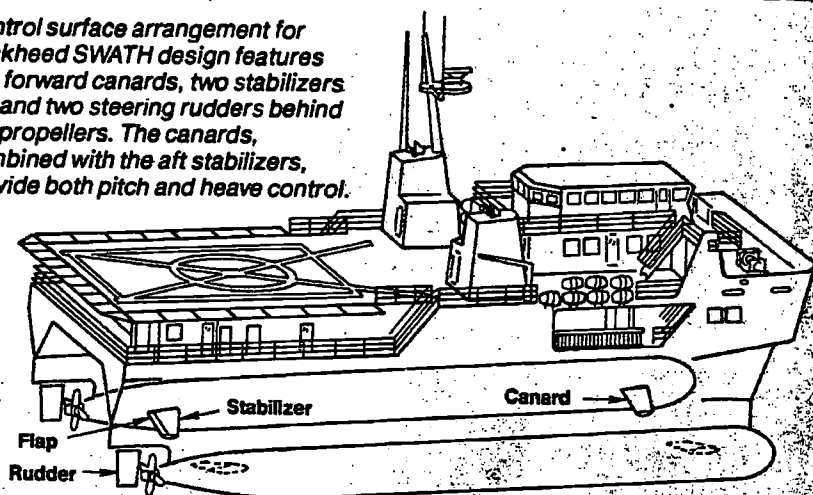
cargo handling, and machinery space.

Due to their larger wetted surface, SWATH ships cannot claim any speed advantage over monohull ships in calm water. On the other hand, SWATH ships, unlike monohull vessels, do not need to slow down in rough water to ease crew comfort or avoid slam damage. SWATH vessels also excel at low-speed maneuverability, thanks to the wide separation of their lower twin hulls. And the twin-hulled ships can easily turn in place at zero speed.

Lockheed designers point out that initial SWATH designs had to compromise performance, particularly maneuverability, because the hulls had to accommodate the vertical rudders. Newer designs will have a maneuvering system that does not compromise hull and strut design and yet produces a turning moment that is even larger than those produced by conventional SWATH ships.

Maximum speed range for current SWATH designs is 25 to 28 knots, say Lockheed officials. However, they believe that with better understanding of resistance characteristics and more propulsion arrangement experience, SWATH speeds could increase to 40 knots. Lockheed has been studying designs for two vessels: one of 25 knots and 510-ton displacement and the other of 20 knots and 502-ton displacement. Both will be able

Control surface arrangement for Lockheed SWATH design features two forward canards, two stabilizers aft, and two steering rudders behind the propellers. The canards, combined with the aft stabilizers, provide both pitch and heave control.



to carry helicopters. RMI's 60-ft Halcyon demonstrator SWATH ship, launched in March 1985, has a maximum speed of 20 knots and a cruising speed of 18 knots.

Riding the waves

Six control surfaces provide directional and motion control for a SWATH ship. These include two forward canards, two stabilizer fins aft, and two steering rudders behind the propellers. The canards work with the aft stabilizers to control pitch and heave in rough water, especially as speed increases.

The control system for the Lockheed-designed canards and stabilizers provides normal underway trim for pitch and roll, maintains pitch stability at high speeds, and reduces pitch and roll motion in a seaway. A computer determines the proper combination of deflections from commands received

from either the ship pilot panel or the vertical gyro and altimeter. The computer sends signals to the hydraulic servocontrol unit, actuating the servovalves to position the fins. The control system also automatically responds to the sea and loading conditions, thus minimizing the ship's motion at sea.

RMI's Halcyon uses four computer-controlled, hydraulically operated control surfaces, two forward and two aft in the inner faces of its submerged hulls. The pilot house features state-of-the-art marine electronics, with digital microprocessors standard equipment for ship control as well as navigation and communications.

Power for SWATH ships is normally transmitted from the upper hull by direct mechanical drive or electrically to the two propellers, one on each of the lower hulls. In the case of RMI's Halcyon, power is

supplied by twin Caterpillar 3408 TA marine diesels, each driving the vessel's controllable and reversible-pitch propellers.

Although the power requirements to reach a certain design speed should decrease as the length of the lower hulls is increased, this may not be practical. Lockheed designers point out that SWATH ships have lower hulls that are within the envelope of the upper hull length. This trend will probably continue, they say, because increasing the lower hull length beyond the upper structure's envelope increases the chances of collision damage to the lower hulls.

Highly adaptable

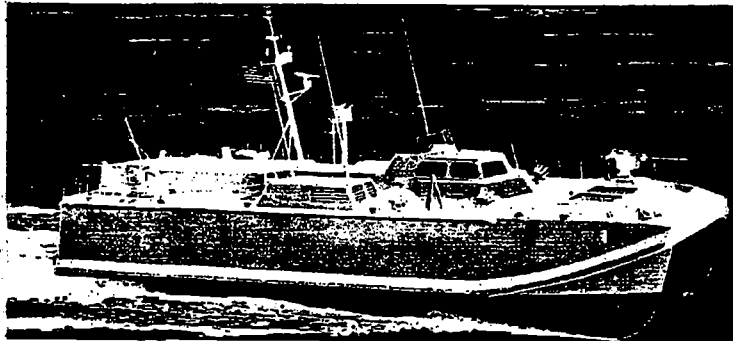
SWATH ship configurations can be tailored to meet specific missions and sea conditions, say Lockheed designers, making it extremely attractive for a variety of military applications. The Naval Studies Board recently recommended that a SWATH ship be used for carrying and launching subsonic V/STOL aircraft for missile targeting and surveillance. The SWATH vessel's

SMALL WARSHIP TO BATTLE THE WAVES

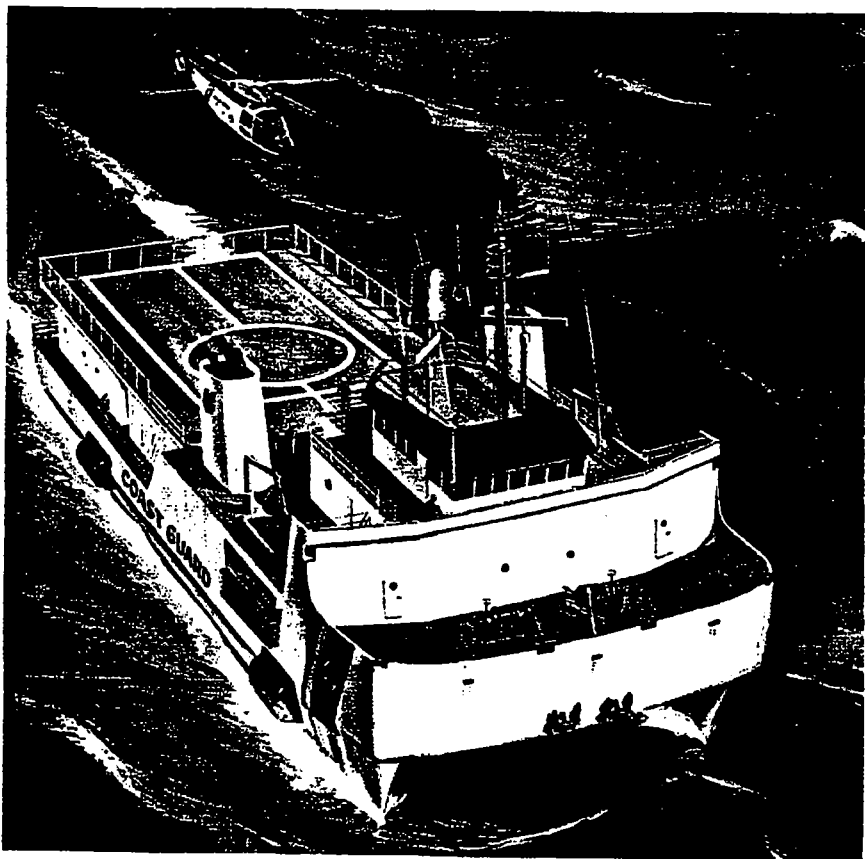
Along with SWATH ships, the Navy has plans for using smaller-size Surface Effect Ships (SES) for high-speed operation in rough water. The Sea Viking, the Navy's Special Warfare Craft, Medium (SWCM), is an 80-ft, 120-ton high-speed, lightweight patrol craft that will operate with task forces and Rapid Deployment Forces.

Designed to fit the well deck of an amphibious transport ship, the craft is powered by two Detroit Diesel Allison 16V-149 TIB engines. Power is transmitted to two fixed-pitch propellers for propulsion and six fans which supply air to the air cushion and bow and stern seals. Speed is in excess of 35 knots.

The Sea Viking is currently under construction at RMI and scheduled for delivery this spring. A follow-on contract for 18 boats is planned.



The lightweight, high-speed Sea Viking is scheduled to be delivered by RMI to the Navy this spring. The ship's welded marine grade aluminum alloy hull features stability characteristics that enable the craft to survive accidental or battle damage.



SWATH ships such as Lockheed's concept of a Coast Guard cutter combine excellent seakeeping qualities and large deck area that is well-suited for helicopter and V/STOL operations in rough waters.

good seakeeping characteristics and its stable platform in moderate and high seas for air operations were credited for the decision.

Other potential applications include use as a patrol boat and a mine hunter. Lockheed designers point out that with the ship's minimum roll and pitch, mine hunting sonar echo returns would be more coherent than in a monohull vessel. The ship's large deck area also allows for the installation of a center well for submersibles or small assault craft.

The Coast Guard is also a potential user of SWATH ships, especially as a cutter and a buoy tender. Additional applications include search and rescue, law enforcement, and protection of the marine environment.

There are also an abundance of possible nonmilitary applications for SWATH ships. These include ferry transportation, hydrographic or seismic surveying, firefighting on offshore oil drilling platforms, offshore crew/supply operations, diving support, and commercial and sports fishing. ■