The New Approach to Mine Warfare

By Norman Polmar

With the advent of reliable unmanned systems, the U.S. Navy’s approach to mine countermeasures (MCM) is evolving from surface ships, helicopters, and explosive-ordnance disposal (EOD) teams—the “MCM Triad”—directly hunting and sweeping mines, to unmanned systems conducting the most hazardous phases of these operations. The reasons for this shift in MCM include (1) the proliferation of sea mines, (2) the increased sophistication of mines, and (3) the reduction of U.S. MCM forces.

The U.S. Navy’s mine-hunting and -sweeping capabilities still exist, primarily with the SQO-32 variable-depth sonar and SLQ-48 mine-neutralization system (MNS), the latter a tethered vehicle carried by the 11 surviving Avenger-class ships, the countermeasure systems towed by the increasingly obsolescent MH-53E Sea Dragon helicopters, and with EOD teams. The MH-53E helicopters and Avenger MCMs are being retired in the near future with their nominal replacement being the littoral combat ship (LCS) and the MH-60S Seahawk helicopter. In the meantime, the Navy has increased the number of EOD platoons focused on mine countermeasures from 12 to 18.

Originally, all LCS hulls—with 52 planned—were to be able to “swap” MCM, surface warfare, and antisubmarine warfare mission modules, with up to 24 MCM modules to be procured. The early 2015 decision to build or convert at least 20 LCS hulls to a “frigate” configuration, which could not accommodate MCM systems, reduces the potential MCM capabilities and capacities significantly.

Further, several planned MCM systems have been canceled, such as the LCS/MCM airborne- and surface-influence sweep system. This major MCM component was axed because the twin-engine MH-60S helicopter would be unable to tow the system after an engine failure—a safety risk too great for the aircraft and crew. The AQS-20 sonar has also been canceled for the airborne system associated with the MH-60S for the same reason. Several other MCM systems also have been canceled or delayed, bringing into question the “robustness” of the LCS/MCM concept.

The large, three-engine MH-53E helicopter can operate the current and planned MCM systems, but these aircraft are approaching retirement by 2025—if they last that long. In recent months some 70 percent of the Navy and Marine Corps MH/CH-53E fleet has been grounded because of wiring and fuel-line malfunctions that have resulted in mishaps, injuries, and casualties.

Thus, increasingly, the Navy’s approach to MCM is to remotely map out minefields for follow-on neutralization or avoidance. More Mark 18 REMUS—originally remote-environment measuring units—are being employed to locate mines and to carry out other underwater missions.

The advantages of the Mark 18 system compared to more conventional mine-location methods include: (1) flexibility of vehicle configuration, (2) flexibility of launch platform, (3) relatively low unit cost and manpower requirements, and (4) the clandestine nature of REMUS operations, denying an enemy indication of Navy areas of interest.1

The family of Mark 18 vehicles consists of torpedo-shaped devices fitted with global positioning systems (GPS), inertial and baseline navigation devices, communications, and open-architecture payload space for dual-frequency and synthetic aperture side-scanning sonar, forward-looking sonar, electro-optical sensors, and future sensors.

At this time two basic Mark 18 configurations are being used by the Navy, with their length varying with the payload:

<table>
<thead>
<tr>
<th>REMUS</th>
<th>Mod 1</th>
<th>Mod 2</th>
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</thead>
<tbody>
<tr>
<td>Diameter</td>
<td>8 inches</td>
<td>12.75 inches</td>
</tr>
<tr>
<td>Weight</td>
<td>80 pounds</td>
<td>800 pounds</td>
</tr>
<tr>
<td>Depth</td>
<td>330 feet</td>
<td>660 feet</td>
</tr>
<tr>
<td>Endurance</td>
<td>6–8 hours</td>
<td>20–24 hours</td>
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More capable mods are under development. (The Hydroid firm that produces REMUS also has a REMUS 6000 vehicle that can dive to 20,000 feet.)

The launch-platform flexibility has been demonstrated with Mark 18 vehicles having been launched and supported from SSN/SSGN submarines fitted with the dry deck shelter (DDS), various surface ships, and the Navy’s ubiquitous 36-foot rigid-hull inflatable boats (RHIBs).

Further, the firm CTC Technologies, working with Hydroid, has developed an aerial launch capability from the MH-60S Seahawk that requires no modification to the Mark 18 and an easily mounted and released attachment for the helicopter. The Mark 18 is lowered to the water while the helicopter is in a hover mode. Upon reaching the water, the vehicle is automatically released and begins its programmed mission. At this time the air-deployed vehicle would be recovered by a RHIB or surface ship. Under development are the means for a helicopter to rendezvous with the Mark 18 at a predetermined location and recover the vehicle.

The Office of Naval Research began the REMUS program with the Woods Hole Oceanographic Institution in 1991 with at-sea tests of the REMUS 100/Mark 18 testbed being carried out two years later. Hydroid was founded in 2001 and began developing and producing REMUS AUVs. Kongsberg acquired Hydroid in 2008, with the Norwegian firm also having initiated an underwater vehicle program in 1991, and a few years later its unmanned vehicles were being used in offshore gas and oil operations. Their joint efforts have produced several hundred REMUS-type vehicles, leveraging the research-and-development investments made by both the U.S. Navy and Norwegian Defense Research Establishment, renowned for its work supporting NATO with innovative technologies for undersea dominance of the North Sea and Arctic Ocean.

The Mark 18 Mod 1 had its combat debut with the U.S. Navy in the Persian Gulf in 2003, being employed to identify bottom objects and help the Navy clear the ports of Umm Qasr and Az Zubayr in Iraq.2 This was the
world’s first unmanned underwater vehicle to be used in a combat environment. Subsequently, the more-capable Mod 2 entered service with the Navy in the Middle East in 2011. Navy EOD units have operated these vehicles in several other areas.

At press time, the Navy had carried out more than 600 missions with the Mod 2 vehicle with an operational availability in excess of 98 percent. Another example of the basic vehicle’s efficacy was the search for the wreckage of Air France Flight 447 that had crashed in the mid-Atlantic in 2009. Three REMUS 6000 vehicles were operated simultaneously from a search ship, locating the remains of the Airbus A330 in 2011 at a depth of 13,000 feet. (Other unmanned vehicles then were able to recover the aircraft’s black boxes.).

Most recently, REMUS vehicles working with divers from Navy Mobile Diving and Salvage Unit 1 operated from the USS Fort Worth (LCS-3) and successfully located and helped to salvage the wreckage of Air Asia Flight 8501, which crashed into the Java Sea in December 2014.

Within the U.S. Navy a variety of ships have deployed REMUS vehicles, among them the joint high-speed vessel. At this time the platform of choice is the RHIB, which is employed by EOD teams for bottom surveys to identify mines and other seafloor objects. A RHIB fully fueled, fitted with the REMUS launch-and-recovery system, and carrying two Mark 18 Mod 2 vehicles weighs 18,000 pounds. This RHIB-based system can easily be handled on board ship and by shore facilities.

The SeaFox mine-neutralization system operates with Avenger MCMs and EOD teams to kill mines that REMUS locates; these “neutralizers” go in the same boat with the REMUS. Other underwater vehicles are in use that promise MCM capabilities, specifically the General Dynamics Blue Fin and Knifefish. However, the track record of the REMUS/Mark 18 and its mission and platform flexibilities make it a leading candidate for future MCM systems, especially for the LCS/MCM mission module, which has suffered delays and technical/operational problems.

The U.S. Navy will not procure new MCM ships in the immediate future, and the truncated LCS MCM program will not provide sufficient capabilities for the Navy’s worldwide, littoral-regional MCM missions. These vehicles will enhance the effectiveness of both the surviving Avenger-class ships and the LCS/MCM platforms. A new approach to mine detection must be undertaken, and unmanned, autonomous, multipurpose, multi-platform vehicles are the obvious solution to this important requirement.

Today more than 300 REMUS/Mark 18–type vehicles are in service with 17 navies, plus a large number with civilian operators. More advanced variants of the REMUS are under development for the current seafloor-survey, MCM, and related roles, with possible “picket sensors” and antisubmarine missions in the offing. The vehicle’s characteristics point toward major advances in several areas of naval warfare.

Also, the Navy’s Director of Undersea Warfare, Rear Admiral Joseph Tofalo, in April announced that REMUS 600 underwater drones will be deployed from Virginia-class attack submarines fitted with a dry deck shelter (DDS). Earlier REMUS vehicles had operated from the submarine Florida (SSGN-728) fitted with a DDS.

“Now you are talking about a submarine CO who can essentially be in two places at the same time—with a UUV out deployed which can do dull, dirty, and dangerous type missions. This allows the submarine to be doing something else at the same time,” Tofalo said. “UUVs can help us better meet our combatant-command demand signal. Right now, we only meet about two-thirds of our combatant commanders’ demand signals, and having unmanned systems is a huge force multiplier.”

Hydroid’s REMUS 600 is a 500-pound, 10 2/3-foot vehicle, with dual-frequency side-scanning sonars, synthetic aperture sonar, acoustic imaging, video cameras, and GPS devices. It is also fitted with the most certified Li battery system in any UUV.

“We’re using commercial off-the-shelf technologies to do real-world missions for the combatant commander,” Tofalo said. “The oil and gas industry uses these things for all kinds of functions. The submarine force will be adapting this. The sensors are similar to the sensors that the oil and gas industry might use. They might be surveying where their oil pipes are, whereas we might want to be looking for a minefield.”

Mr. Polmar, a columnist for Proceedings and Naval History, has gone to sea in forward-deployed mine-sweepers and gone into Libya with an EOD team. He has consulted for the Hydroid company.