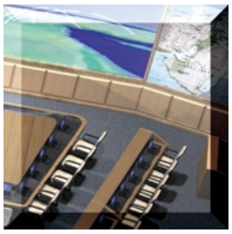

Mine Countermeasures Requirements To Support Future Operational Maneuver

George W. Pollitt

Historically, the Navy's mine countermeasures ships and helicopters were designed for Cold War applications, which emphasized clearance of our own ports and gave amphibious assault low priority. Today's naval mission requires regional contingency operations where friendly forces must be capable of projecting power ashore. For example, the attempted assault of Kuwait during Desert Storm by the U.S. Navy/Marine Corps team demonstrated the difficulty of executing an amphibious assault where the enemy's coast is defended with mines, obstacles, and shore fire. To fight effectively in the littorals, naval forces must develop a capability to insert marines and materiel from sea to shore where the shallow water and beaches are thus defended. This article examines alternatives for conducting future amphibious operations and discusses some of the more promising mine countermeasures techniques. (Keywords: Breaching, Mine countermeasures, Mines, Obstacles, Operational maneuver.)

INTRODUCTION

The Chief of Naval Operations, Expeditionary Warfare Division, tasked APL to analyze mine countermeasures (MCM) requirements for enabling Operational Maneuver from the Sea (OMFTS) using Ship to Objective Maneuver (STOM) tactics when mines and obstacles have been deployed. Researchers at APL took a broad view of assault options that could be developed by 2015. Information generated by this study will allow the Navy to identify the future MCM platforms and systems to conduct amphibious assaults in hostile environments.

This article outlines the process used to determine future MCM requirements and describes the key issues of the mine and obstacle threat, operational concepts, critical sequences in breaching mined beaches, near-term and far-term baseline capabilities, and potential solutions to enable assault without operational pause in hostile and defended environments.

STUDY APPROACH

The following procedures comprised APL's analysis of requirements to overcome a mine and obstacle defense:

1. Characterize the threat.
2. Review operational concepts.
3. Identify required countermeasures functions by depth and land zone.

4. Compile countermeasures capabilities, both current and budgeted.
5. Note deficiencies anticipated for the 2010–2015 time frame.
6. Brainstorm and select future options.
7. Evaluate key options using amphibious time lines.
8. Determine requirements for the far-term baseline.

Researchers conducted a broad search of alternatives to reduce the likelihood of overlooking viable solutions. MCM and breaching functions for both sea and land mines were addressed. Approximately 450 systems and techniques were considered. The countermeasures packages were selected on the basis of their ability to cope with the expected operational environments, thoroughness of clearance and reduction of risk to following forces, rate of clearance applied, and risk to countermeasures forces. Individual systems were selected on the basis of the same criteria plus supportability and programmatic issues such as lift, reliability, operator training requirements, technical maturity, time to develop, and affordability.

THE MINE AND OBSTACLE THREAT

Mine and obstacle threats were reviewed in detail with Army, Navy, and Marine Corps intelligence activities. It was concluded that most countries cannot defend their entire coastlines with mines and obstacles. There are important exceptions, however, including areas of high strategic value. Also, a wide diversity of mine types and technologies continues to be developed.[1] This diversity drives the countermeasures designer to seek solutions that are independent of mine type, such as brute force techniques. However, the diversity is so wide that no single system solution can be identified.

Because mines are small and can be transported without easy detection, intelligence on an adversary's inventory is unlikely to be complete. Incomplete intelligence plus the diversity of possible mine types require friendly forces to acquire a full toolbox of countermeasures capabilities.

At least some mines designed specifically for the energetic surf zone will stay in place without being tied to obstacles or special anchors. Therefore, the absence of obstacles or conspicuous tie-downs does not guarantee the absence of mines in the surf zone. Data on mine movement are sparse, and there is a need to characterize mine movement for both the countermeasures designer and the operational planner.

Minefield configurations were prepared for nominal and high-threat cases. The main difference between the two was the assumption that friendly forces could suppress covering fire in the nominal case, but not in the high-threat case. The study also examined the minimum countermeasures requirements for the case in which beach defenses were incomplete.

OPERATIONAL CONCEPTS

The objectives of OMFTS include the following: focus on the operational objective; treat the sea as maneuver space; create overwhelming tempo and momentum; apply friendly strength against enemy weakness; emphasize intelligence, deception, and flexibility; and integrate organic, joint, and combined assets.[2]

The STOM is the agreed upon tactical application of OMFTS objectives.[3] It attempts to control the tempo and overwhelm the enemy, maneuver combined arms from over the horizon, dilute enemy strength by enlarging the battlespace, control the vital area by fighting outside it, and maneuver to cause an exploitable reaction.

The debate on breaching of the very shallow water, surf zone, and beach minefields centered on whether forces applying STOM tactics would always be able to bypass defended beaches. For a variety of operational reasons, it was concluded that "in-stride" breaching is a continuing requirement and that breaching in some cases facilitates STOM-type operations. The availability of an in-stride breaching capability to friendly forces will provide the tactical planner with viable assault options that compel defenders to disperse their forces.

NEAR-TERM BASELINE SYSTEMS

The APL study defined the baseline case for the near term (from the present to 2004) as the package of current and budgeted systems with the earliest capability to penetrate from deep water through the beach fields in a nominal mine and obstacle environment (assuming shore fire can be suppressed) without expecting significant casualties or operational pause. All budgeted components of the near-term baseline should be acquired by about 2004. Key developmental components of the near-term baseline include the following:

- CH-60 variant helicopters deploying an Airborne Laser Mine Detection System—a gated laser search system; an Airborne Mine Neutralization System—a mini-torpedo device; and a Rapid Airborne Mine Clearance System (RAMICS) (Fig. 1)—supercavitating projectiles fired at moored mines
- The Very Shallow Water MCM Detachment, which is currently experimental, fully outfitted to use marine mammals, divers, and low observable craft (Fig. 2)
- Landing Craft, Air Cushion (LCAC) deploying the Shallow Water Assault Breaching System (SABRE)—line charge devices; and Distributed Explosive Technology (DET)—explosive net devices to neutralize mines in the surf zone

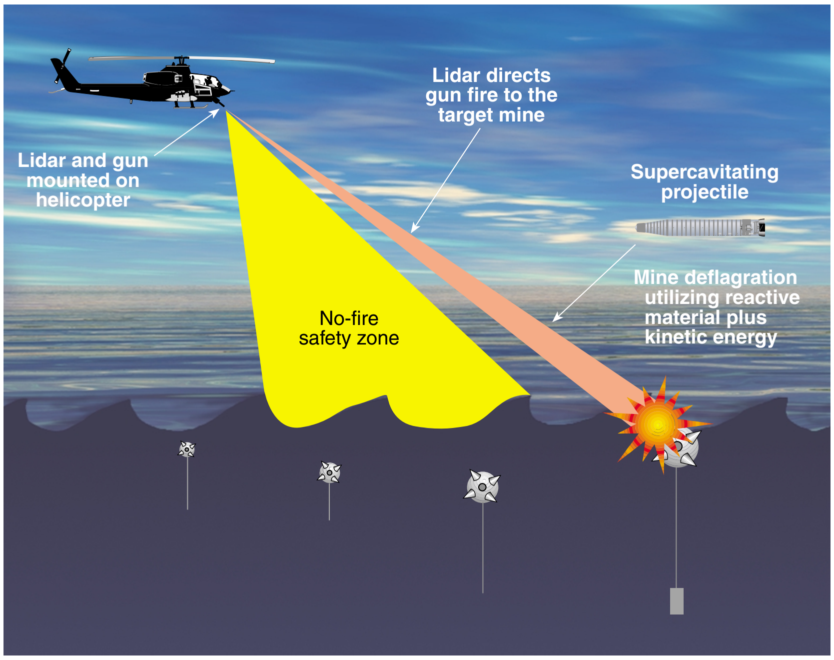

Figure 1. A CH-60 helicopter equipped with the Rapid Airborne Mine Clearance System (RAMICS) will reacquire moored and floating mines and target them using a lidar. RAMICS will fire supercavitating projectiles to neutralize the mines.

- Combat breacher vehicles, such as the Assault Breaching Vechicle (ABV)
- Organic MCM systems that would include the Remote Mine-Hunting System (RMS)—remotely controlled, air-breathing, semisubmersible vehicle-towing mine-hunting sensors; and the Near-Term Mine Reconnaissance System—a submarine-launched Unmanned Underwater Vehicle (UUV)

CRITICAL SEQUENCES IN BREACHING MINED BEACHES

STOM-type assaults can be performed in the near term only when certain favorable conditions exist. Because of the difficulty in effecting the breach, the beach and surf zone breaching process is sometimes referred to as the Surf Zone/Beach Dilemma.

In the near term, SABRE and DET would be used to breach the surf zone, but this breaching would require LCACs, which are unarmored, to approach a hostile beach before armored combat craft arrive (Fig. 3). The second step, following breach of the surf zone, would be for a Landing Craft, Utility (LCU), which is a slow displacement craft, to deliver a mechanical breacher like the ABV to the beach. If the LCUs were used, it would be very difficult to generate the tempo needed for STOM-type tactics.

The speedy, but unarmored, LCACs cannot deliver mechanical devices initially because they cannot off-load in the surf zone and the beach is presumed mined. (Line charge alone is not particularly effective for clearing an initial craft landing site at the water's edge, nor is a fuel–air explosive.) Thus, assuming the Very Shallow Water MCM Detachment has already cleared the very shallow zone and Navy MCM have cleared the shallow water approaches, the order in which craft would approach the beach in the near term would be (1) LCAC employing SABRE and DET, (2) LCU delivering a mechanical breacher, and (3) assault amphibian vehicles (AAVs) negotiating the beach lane breached by the mechanical breacher.

There are other difficulties with the near-term approach. Neither the Very Shallow Water MCM Detachment nor SABRE and DET explosive devices are capable of reducing obstacles in the active surf under

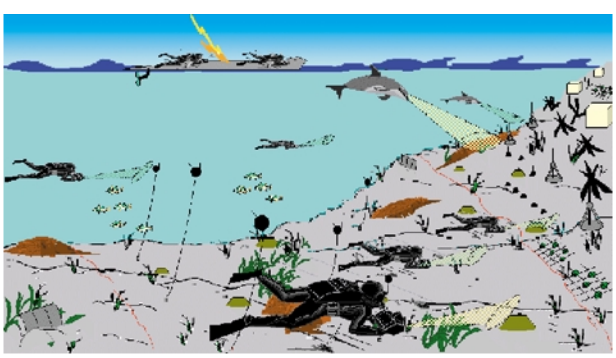

Figure 2. In the near term, the Very Shallow Water MCM Detachment will search for and neutralize mines using divers and marine mammals.

Figure 3. LCAC firing a SABRE line charge into the surf zone. A special autopilot has been designed to facilitate this capability. One LCAC can carry a combination of SABRE and DET systems.

most conditions. Also, unless the LCU can find a gap between the obstacles, it cannot get close enough to the beach to off-load the mechanical breacher. If it can off-load, the depth of the obstacles in the surf zone may be too great for the mechanical device to clear them. If the initial mechanical device is an ABV, its mission would be to clear a path for the AAVs and to motor march with them in accordance with STOM tactics. In this case, the landing site would still require clearing. Unless another LCU delivered a second mechanical device to clear a site, the LCACs would be unable to deliver materiel to the beach. Accordingly, a separate mechanical clearing step would be needed to open the beach for LCAC operations and the Assault Follow-on Echelon.

As noted, it is difficult to generate the tempo needed for STOM-type assaults when slow-displacement LCUs are used. Assuming near-term baseline capabilities, STOM tactics may be used without LCUs, but only when three favorable conditions exist: (1) the Very Shallow Water MCM Detachment is able to clear lanes in the very shallow water region clandestinely, (2) either no obstacles have been laid in the surf zone or there are gaps between the obstacles that LCACs can penetrate, and (3) there is a known unmined beach area large enough for LCACs to set down, off-load, and turn around. Still, unarmored LCACs would precede armored craft to the beach.

FAR-TERM BASELINE SYSTEMS

The far-term baseline is defined as the earliest package of systems that can effectively support a STOM assault to penetrate from deep water through the beach fields in a high-threat mine and obstacle environment. Covering fire is not assumed to be suppressed. If a package of systems is funded as required, the far-term capability is envisioned to become available about 2015. The baseline would consist of near-term capabilities plus the following, which are listed in their approximate order of application:

- Littoral remote sensing and other intelligence, surveillance, and reconnaissance capabilities
- Long-term mine reconnaissance systems—submarine-launched UUVs
- Platform-independent UUVs
- Stealthy Small Water-plane Area Twin Hull (SWATH) vessels
- Remotely controlled influence sweeps
- A mother ship to tend UUVs, RMSs, remotely controlled influence sweeps, SWATH vehicles, and CH-60 helicopters
- Explosive excavation
- Overhead battle damage assessment to inform assaulting craft of conditions after application of explosive countermeasures
- Near–real-time common tactical picture shared by all members of the assault

POTENTIAL SOLUTIONS

Examples of interesting and potentially effective options for dealing with the mine and obstacle problem on a defended shore are discussed in the following sections. These solutions vary in technological risk from the explosive excavation approach, which is in the conceptual stage and therefore high risk to mine-hunting UUVs, which exist today. All provide significant assault-enabling capability that is not currently operational.

Explosive Excavation

The single most significant concept in enabling STOM-type assaults is the explosive excavation technique. The objective of explosive excavation is to blow a channel through the surf zone and beach minefields. Experiments have demonstrated that a series of explosive charges placed in a straight line and detonated simultaneously form a line charge analog,[4] i.e., the detonation makes a single, coherent trench instead of a series of individual craters. Explosive excavation differs from carpet bombing and other explosive techniques because it does not attempt to neutralize mines and obstacles; it merely throws them out of an excavated channel by detonating beneath them. The feasibility of placing the charges precisely in a line (preferably by air) and detonating them simultaneously has not been demonstrated.

Advantages

If explosive excavation is found feasible, it offers overwhelming advantages. It is faster to use than other breaching techniques and can be applied without prior preparation to the surf zone and beach area, thereby making it easier to catch the enemy off guard with no time to muster reinforcements. Explosive excavation breaches obstacles as well as mines. In-water obstacles are perhaps the toughest of all the beach denial threats to counter.

The concept can also be applied by air, leaving the amphibious assets intact, i.e., Amphibious Task Force lift is not sacrificed. As was the case in Desert Storm (with the “daisy cutter” bombs), the enemy would be stunned and confused following such a large explosion, even if its vital equipment survived intact. The period of confusion could be exploited by immediate assault.

Another advantage is that explosive excavation can breach both surf zone and beach. Other approaches require multiple systems to be applied in virtually every case. The presence of a channel cut through the surf zone and beach mitigates the effects of breaking surf for assaulting vehicles and simplifies their tracking. The ejecta form berms along the sides of the channel, helping to protect vehicles transiting the channel from direct fire. Berms are not formed at the ends of the channel.

Disadvantages

Explosive excavation has its disadvantages. Using air delivery would deprive other missions of needed air support. If Air Force delivery is used, it would deny the Navy/Marine Corps direct control over the bombing and channeling operation, and close coordination would be required. The end of the channel might be too steep for amphibious craft to climb, or the sides may otherwise be impassable. The gradient and other characteristics of the resulting crater are heavily dependent on soil type. However, there are potential solutions to the gradient problem. A water cannon might be used to cut through the slope, and the use of smaller bombs at the end of the pattern might reduce the resulting gradient. Also, bomb spacing and bomb burial depths might be varied at the end to achieve the same aim.

There are technical challenges involving precision emplacement, both horizontal and vertical, and simultaneous detonation. A special piece of ordnance may be required to position the charge at the proper depth beneath the bottom. Another potential problem is that if one bomb predetonates on impact, it may scatter the other bombs and disrupt the pattern around it.

Unmanned Underwater Vehicles

Platform-independent UUVs (Fig. 4) can contribute significantly to the clandestine phase of an amphibious operation. They show potential for providing significant search in deep and shallow water and even into the very shallow water zone. Search and marking operations can be conducted before the assault commits overtly to the intended littoral penetration points. The search potential is increased if the UUVs are platform independent because a variety of methods could be used to launch and recover the vehicles. Launch and recovery options include submarines, surface ships, boats that operate routinely in the area of interest, and aircraft, both fixed and rotary wing.

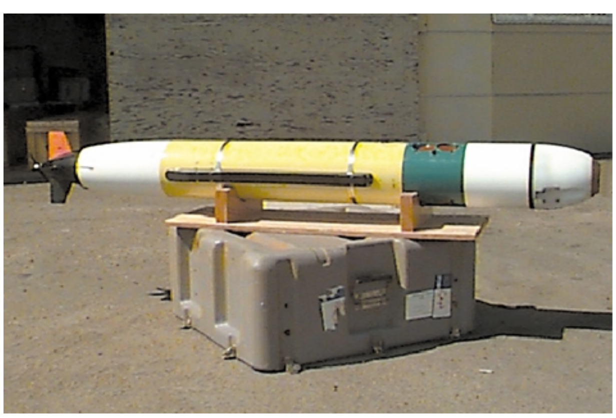

Figure 4. Small mine-searching UUVs, such as those being developed under the Semi-Autonomous Hydrographic and Reconnaissance Vehicle Project, can detect, classify, localize, and potentially identify mines clandestinely. Their platform independence and ease of handling provide tactical flexibility.

Advantages

Unmanned, untethered, autonomous, or preprogrammed underwater vehicles (torpedo shaped) have many operational advantages for mine search. There is, of course, reduced risk to personnel, and because UUVs are platform independent, they do not require dedicated MCM or support vessels. They can provide organic MCM capability to Fleet units and can be deployed from ships taken up from trade or even fishing boats, as available.

Another advantage is that multiple UUVs can operate from a single support vessel. When searching, these vehicles perform essentially the same function as a fully manned MCM vessel, i.e., they each operate a single mine-hunting sensor package. However, unlike manned craft, they do not have to slow down for safety reasons while searching.

The deployability of UUVs is a major advantage. They can be designed as flyaway packages or can be added to prepositioned materiel storage. For port break-in operations and choke point clearance that facilitate amphibious assaults, these vehicles can be deployed from a pier in the absence of a ship. They could be delivered to the search area and recovered by MV-22s or submarines, providing a long standoff capability.

The stability of the UUV platform is conducive to good detection capability. Because motion compensation is less of an issue for these vehicles than for towed sensor bodies, they should be excellent platforms for buried mine detection sensors. They can also operate in bad weather (except for the recovery phase), at night, clandestinely, in very shallow water, in hostile environments, and under ice. They are politically quiet, when necessary. (By contrast, the use of surface MCM vessels and airborne MCM are conspicuous and attract press coverage.) They can survey routes without giving away route positions. Lastly, torpedo-shaped UUVs are less likely to become fouled by floating debris or underwater obstructions than tethered craft or RMS configurations.

Disadvantages

Despite the many favorable aspects of UUV use in MCM missions, there are a few disadvantages. Current technology limits them to shorter ranges than is desirable for preassault reconnaissance. Other related technologies are also immature, such as underwater navigation, guidance, and control; computer-aided detection and classification; mass storage devices; and microminiaturization. Another drawback is that autonomous or preprogrammed UUVs do not provide commanders with continuous and instantaneous command of the vehicles. For first-generation systems, operators will not have the same confidence in UUV operations that they have in manned operations. Also, communications with underway vehicles, long standoff ranges, and employment of UUVs from specialized platforms such as submarines can be costly. Finally, because they use advanced technology, their maintenance may require greater skill levels than other countermeasures approaches.

The Mother Ship Concept and Small Craft Use

Because dedicated MCM platforms are expensive, vulnerable to diverse threats, and slow to arrive in theater, it is prudent to consider smaller, unmanned, or lightly manned vehicles that can perform similar functions. The Navy is investing in small systems that can operate from forward-deployed combat ships and submarines to ensure that there will always be an MCM capability where our combatants operate. These so-called organic systems can perform to a limited extent in hostile environments, such as the shallow part of an amphibious objective area, but conflicting operational requirements of the host platform interfere with their use as amphibious mine clearance systems. For example, the host platform will have requirements to clear deep water first in order to protect the battle force of which it is a member, and must conduct non-MCM missions during amphibious assault operations. Accordingly, if the organic MCM systems are to provide maximum utility for amphibious clearance, other hosting options are needed.

A single mother ship could tend many small vehicles that are remotely controlled, autonomous, or manned by small crews. This concept was used in the 1960s when former minelayers, USS *Catskill* and USS *Ozark,* were converted to MCM command and support ships, MCSs 1 and 2, respectively.[4] The concept was abandoned because the small minesweeping launches they employed were open-deck and limited to Sea State 2 and because the command and support ship design was top-heavy. Both shortcomings can be easily remedied today.

An MCM 1 Class vessel has a crew of 83 officers and men; yet at any given time, only a small fraction of the crew is engaged in operating the sonar and mine neutralization vehicle, which comprise the main battery of the platform. However, large MCM vessels provide some advantages over smaller platforms such as endurance, stability, drawbar pull, and the lift required for heavy, deep-ocean systems.

Advantages

Except for the lift of deep-ocean systems, small vehicles tended by a mother ship can provide capabilities similar to those of large MCM vessels. The endurance of small vehicles should be adequate if they are staged from and refurbished by a mother ship as needed. UUVs can operate in high sea states without special adaptations. The 24-ton small SWATH craft (Fig. 5) has demonstrated sea-keeping stability through Sea State 3. It transits at 18 kt and tows small bodies as slowly as 1.5 kt with good steerage. With its draft of only 4.5 ft, it has demonstrated searching in water as shallow as 10 ft.

The Landing Ship Dock (LSD) 41 Class is estimated to be capable of carrying 10 small SWATH hunter/neutralizers and 10 fully hangared CH-60 helicopters. RMS vehicles or remotely controlled influence sweep systems could also be carried as the mission requires. Thus, for shallow-water clearance operations that do not require strong towing capabilities, the force multiplication provided by many small vehicles is clear. Other benefits include the small vessels' lower observability (especially if the SWATH is designed for stealth) and shallower draft. Small stealthy craft could also be used to tend divers, navigation buoys, and the highly effective marine mammal system in addition to their use by the Very Shallow Water MCM Detachment. The SWATH vessel uses a crew of 5 (minimum of 3), compared to the MCM 1 Class complement of 83. Therefore, the use of SWATH and other small vehicles from a mother ship reduces the number of people who must enter the minefields.

Figure 5. The 41-ft SWATH vessel currently operated by Explosive Ordnance Disposal Mobile Unit 7 provides a stable platform through Sea State 3 for searching and prosecuting mines. This one is sized to fit inside a C-5A aircraft.

The mother ship can accompany the Fleet. It can stand back from shore defenses while its small vehicles sweep and hunt in dangerous areas. A single casualty would not be catastrophic to the MCM operation. As a standard Navy hull, the mother ship does not suffer from the materiel problems associated with low magnetic MCM hulls. It can mix and match vehicles carried aboard to fit the mission. It also can support other missions (e.g., anti-submarine warfare) by swapping out vehicles.

Disadvantages

The mother ship concept has inherent weaknesses, however. Implementation requires a large platform, such as an LSD. However, it is not envisioned that specific platforms would be dedicated to the mother ship mission. Ideally, any large vessel with proper handling and command, control, communications, computers, and intelligence (C^4I) capability could support the mission. Small vehicles tended by a mother ship could not handle deep-water hunting as well as the MCM 1 or MHC 51 Classes, nor could they provide high current influence sweeping that the MCM 1 Class or MH-53Es provide. The concept would not provide heavy mechanical sweeping. However, small, remotely controlled craft have demonstrated an ability to tow light mechanical gear. The moored mines that are susceptible to mechanical sweeping are also susceptible to mine hunting, which the mother ship concept can provide efficiently.

CONCLUSIONS

APL's broad study of the options for dealing with mines and obstacles in future amphibious assaults of defended beaches concluded that no single system can solve the problem. Approaches that were found to offer the best potential benefits are listed below:

- Explosive excavation techniques
- Platform-independent UUVs
- An operational, fully outfitted, Very Shallow Water MCM Detachment
- The ABV and other mechanical beach breachers, such as power blade
- Stealthy SWATH vessels to operate in shallow and very shallow depth zones
- Remotely controlled or preprogrammed influence sweeping
- Implementation of the mother ship concept to accompany the Amphibious Task Force and to support multiple, small, low-observable systems
- Airborne optical search followed by rapid prosecution of mine-like contacts
- Enhanced intelligence, surveillance, and reconnaissance combined with a real-time situational awareness shared by all members of the assault force
- SABRE and DET explosive neutralization systems and reliable lane marking

From an operational viewpoint, two concepts stand out as enablers of STOM-type assaults: the explosive excavation technique and platform-independent UUVs. Clearly, the feasibility of explosive excavation must be demonstrated, but the technologies required—precision emplacement and simultaneous detonation—might be achieved by the year 2015. The advantages of mine-hunting UUVs have been known for many years, and as long as expensive requirements are not mandated, platform-independent UUVs should be affordable if possible.

STOM assault in a mine and obstacle environment is a critical issue for the Navy and Marine Corps. The study concluded that a STOM-type assault conducted in a mine and obstacle environment would be extremely difficult using current MCM assets. It could be conducted more easily in the near term (by approximately 2004), but only under favorable circumstances. A STOM-type assault can be conducted in the far term (by approximately 2015), even in a high-threat environment, if systems are designed and procured specifically for STOM applications. The Mine Countermeasures Program, with its procurement of an RMS, long-term mine reconnaissance systems, and CH-60 variant systems, is going in the right direction to provide the near-term capability. The far-term capability will require feasibility demonstrations, new starts, and some untried operational concepts.

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