NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

SEA-19A SYSTEMS ENGINEERING ANALYSIS CAPSTONE REPORT

2024 UNMANNED UNDERSEA WARFARE CONCEPT

ABSTRACT AND EXECUTIVE SUMMARY

ABSTRACT

Potential adversaries throughout the world continue to acquire and develop sophisticated multi-layered, anti-access, area-denial (A2AD) systems. To maintain its maritime superiority, the United States must continue to innovate systems that are capable of operating in and defeating these A2AD environments. In particular, command of the undersea domain remains vital and will increasingly be critical in facing this future battle space.

The challenges our nation faces, however, are not limited only to the technological capabilities of the warfighters, but also include a myriad of confounding constraints. In addition to the expected shortfalls of mission-ready assets, the Submarine Forces also must address significant pressures in defense spending. Nevertheless, unmanned undersea vehicles (UUVs) remain one of the top priorities of the Chief of Naval Operations, as UUVs serve as effective force multipliers, while greatly reducing risk, in critical missions in A2AD environments.

This report presents the findings of analysis and assessment conducted by an integrated systems engineering and analysis team of military officer students at the Naval Postgraduate School. Their operationally driven tasking seeks to design a system-of-systems of unmanned and manned undersea vehicles to ensure undersea dominance both in the near term and into the next decade. The importance of the systems perspective to this study is reflected by the extensive engagement with many operational stakeholders, academic researchers, industry partners, and acquisitions programs across the Naval enterprise. The capability-based approach highlights the mission suitability of both currently fielded UUVs and also technologies realizable within the next decade. The capstone final report summarizes these critical insights and provides detailed recommendations to inform decision makers of the present to prepare for the undersea forces of the future.

EXECUTIVE SUMMARY

Ongoing research in the field of unmanned technologies led to the following 2013 Systems Engineering Analysis project tasking:

> **Design a system of Unmanned Undersea Vehicles (UUVs) that will provide an operational undersea force available for tasking over a range of missions by 2024. Consider current fleet structure and funded UUV programs as the baseline system of systems to conduct current missions. Include in your analyses attributes of the vehicles, payloads, projected costs, possible mission sets, and concepts of operations. The system may be a totally unmanned force or a combination force of manned platforms and unmanned undersea vehicles that can execute missions in an integrated fashion. A full range of alternatives should be considered. Of major importance in successfully deploying such a capability in the desired timeframe is acquisition strategy and DOTMLPF execution.**

In response to this tasking given by the Deputy Director for Warfare Integration and the Executive Director of Submarine Forces, **the SEA-19A project team recommends the following sustained UUV force structure**:

- 26 Large Displacement UUVs (LDUUVs)
- 120 Recoverable 21 inch UUVs
- 121 Expendable 21 inch UUVs

Total lifecycle cost for the proposed UUV fleet over its 20-year program is $3.65B (in FY13 dollars). This conservative estimate accounts for the entire lifecycle, including procurement, continuous operations, maintenance, and training.

Four high-level decision drivers, based on the extensive concept generation modeling, simulation, analysis, lead to the above recommended UUV force structure:

1. **UUVs are essential to maintaining undersea dominance**. Increased operational capability and reduced risk for personnel and high value platforms are provided by unmanned systems. UUVs provide greater operational reach to both subsurface and surface manned combatants.
2. **Employment of multiple UUVs** provides a significant increase in successful mission accomplishment.
3. **Utilization of expendable UUV variants provides unique capabilities and cost savings**, especially for missions where probability of survival is low, or there is no need to recover the UUV.
4. An appropriate **balance of critical unmanned capabilities is required for effective** mission performance. All UUVs must have the capability to maneuver, survive, and persist in challenging environments. However, the cost vs. benefit

analysis of advanced mission functionality often shows negligible gains in mission success, at a relatively disproportionate increase in cost.

Using a systems engineering methodology, SEA-19A addresses problems related to increasingly complex anti-access area denial (A2AD) environments. These environments require stealthy vehicles to execute critical mission sets. Stakeholder, functional, and mission-based analyses lead to the selection of the following four missions for inclusion in the proposed 2024 A2AD UUV concept of operations:

1. Intelligence, Surveillance, and Reconnaissance (ISR)
2. Information Operations (IO)
3. Mine Countermeasures (MCM)
4. Offensive Attack Operations (including ASW, ASUW, and offensive mining)

These operations are assessed to be the most likely missions that benefit in the near-term from UUV technologies by 2024. These assessments are based upon current programs of record and technology readiness levels across the Navy, and in industry and academia.

LDUUVs are a critical component of the proposed force structure due to the inherent capabilities of larger and more capable sensors, greater payloads, and longer endurance. Specifically, LDUUVs are required for persistent ISR and various offensive attack operations, but face operational and cost effectiveness constraints Only 60 inch diameter and smaller LDUUVs are included in the analysis due to the operational constraints of the Universal Launch and Recovery Module in development for the Virginia Payload Module. To provide maximum operational flexibility, the Littoral Combat Ships are assessed to be feasible launch and recovery platforms for LDUUVs of this size.

Twenty-one inch and smaller diameter UUVs provide substantial capability for all proposed missions. The 21 inch UUVs are capable of being launched from all manned platforms, with the size only being constrained by current torpedo tube diameters. This effectively turns any manned platform into a UUV launch and recovery vessel. Analysis also shows that significant cost savings can be realized by designing several 21 inch variants as exclusively expendable.

Robust autonomous collision avoidance capabilities are key technology enablers which are necessary to reduce unanticipated UUV losses due to circumstances such as grounding and entanglement in fishing nets. Continued research needs to be conducted to develop innovative ways to overcome these operational issues. Until these technologies mature, the

employment of multiple UUVs in squads provides an advantageous solution to maintain acceptable probabilities of mission success. This concept factors significantly into the proposed force structure.

To maintain the proposed sustained UUV force levels over the projected 20-year period, **a total of 35 LDUUVs, 167 21 inch Recoverable UUVs, 440 21 inch Expendable UUVs are to be procured**. The proposed acquisition strategy accounts for operational and training losses, while maintaining sufficient force levels for large-scale maritime battlespace preparation in an A2AD environment.