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# LEARNING FROM EXPERIENCE

— VOLUME I —

Lessons from the Submarine Programs of the  
United States, United Kingdom, and Australia

Prepared for the United States Navy, the United Kingdom's Ministry  
of Defence, and Australia's Department of Defence

Approved for public release; distribution unlimited



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The research described in this report was prepared for the United States Navy, the United Kingdom's Ministry of Defence, and Australia's Department of Defence. The research was conducted within the RAND National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, the Unified Combatant Commands, the Navy, the Marine Corps, the defense agencies, and the defense Intelligence Community under Contract W74V8H-06-C-0002.

**Library of Congress Control Number: 2011939404**

ISBN: 978-0-8330-5895-9

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Published 2011 by the RAND Corporation

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## Summary

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Designing and building naval submarines are complex tasks that require organizations with unique skills and expertise. Technical personnel, designers, construction tradesmen, and program managers gain knowledge and experience by working on successive programs during their careers. This will prove difficult in the future as the long operational lives of submarines and the constrained defense budgets of most countries will likely create future gaps in new submarine design and build programs.

Recognizing the importance of past experiences for successful program management, the Program Executive Officer (PEO) for Submarines from the United States, the Director Submarines of the United Kingdom's Defence Equipment and Support organization, and the Director General Submarines from Australia's Department of Defence asked the RAND Corporation to develop a set of lessons learned from previous submarine programs that could help inform future program managers. The research examined the *Ohio*, *Seawolf*, and *Virginia* programs of the United States; the *Astute* program of the United Kingdom (UK), and the *Collins* program of Australia. We developed the lessons from those programs through an extensive review of the appropriate literature in addition to numerous interviews with government and private-sector personnel involved in the programs.

When considering the lessons from the five programs, we must remember that the programs were conducted in different threat and budget environments and with evolving industrial bases for designing and building the submarines. Decisions were made based on the environment at the time, so decisions varied by country and by program.

It is also difficult to judge the success or failure of program decisions. Views change during the conduct of a program and are based on the perspective of individuals. The important point is that the decisions were not necessarily “good” or “bad.” Rather, they were or were not fully informed by knowledge of the risks and consequences.

Some lessons are unique to specific programs; others are unique to specific countries. We have tried to identify lessons that apply to all programs and all countries. In some cases, lessons have been identified but not really learned. In other cases, lessons have been learned but forgotten (or ignored). Not only must the United States, the UK, and Australia identify appropriate lessons, they must also heed and remember them. Since cost is typically the metric for judging program success, the majority of the lessons focus on controlling program costs.

## **Top-Level Strategic Lessons**

The top-level strategic lessons apply across all programs and are appropriate for the principal submarine organizations in the government:

- Ensure the stability of the program.
- Be an intelligent and informed partner in the submarine enterprise.
- Establish the roles and responsibilities of the government and private-sector organizations.
- Develop knowledgeable and experienced managers.
- Take a long-term, strategic view of the submarine force and the industrial base.
- Involve all appropriate organizations in any new program.
- Adequately support a new program and make it open and transparent to all.

## **Lessons When Setting Operational Requirements**

Setting the operational requirements will determine the amount of technology risk in a new program. Understanding the cost and sched-

ule impacts of using different technologies or extending operational requirements is important for making informed decisions. Important lessons include the following:

- Remember that the submarine is an integration of various systems.
- Understand the current state of technology to control program risks.
- Involve all appropriate organizations when setting operational requirements.
- Clearly state operational requirements as a set of performance goals.
- Determine how to test for the achievement of desired operational requirements.

## **Lessons When Establishing an Acquisition and Contracting Environment**

An interactive relationship between the government and the prime contractor is necessary for the success of a program. Key lessons for establishing an effective acquisition and contracting environment include the following:

- Consider a single design/build contract for the first-of-class.
- Use a contract structure with provisions for handling program risks and incentivizing the contractor to achieve cost, schedule, and performance goals.
- Develop realistic cost and schedule estimates.
- Decide on government-furnished equipment.
- Develop a timely decisionmaking process to manage change.
- Establish an agreed-upon tracking mechanism and payment schedule.
- Include an adequate contingency pool.

## **Lessons When Designing and Building the Submarine**

To some degree, lessons for the design/build process overlap the lessons that emerged from the programs' earlier stages. These lessons include the following:

- Involve builders, maintainers, operators, and the technical community in the design process.
- Complete the majority of the design drawings before the start of construction.
- Ensure sufficient oversight at the design and build organization.
- Specify and manage adequate design margins.
- Develop an integrated master plan for design and build.
- Track progress during the design/build process.
- Design for removal and replacement of equipment.
- Conduct a thorough and adequate test program.

## **Lessons When Establishing an Integrated Logistics Support Plan**

Operating and supporting new submarines after they enter service account for the vast majority of their total ownership costs. Therefore, it is imperative to establish an integrated logistics support (ILS) plan for the new submarines.

- Establish a strategic plan for ILS during the design phase.
- Consider ILS from a navy-wide perspective rather than a program-specific vantage point.
- Establish a planning yard function and a maintenance and reliability database.
- Plan for crew training and transition to the fleet.
- Maintain adequate funding to develop and execute the ILS plan.