U.S. Department of Defense:
The Virginia Class Submarine Case Study

Background

The Virginia class attack submarine is one of the most powerful and complex naval combatants ever created. But firepower and enhanced stealth were not the only considerations facing the U.S. Navy when it needed to update the fleet with the post-Cold War security environment in mind.

The cost of building nuclear powered submarines is vast, each ship running into the billions of dollars. At the same time, budgetary pressures are significant. Obviously, developing new efficiencies in design, production, and ongoing maintenance offers the potential for tremendous cost savings on such large-scale projects.

From the beginning, the Virginia class submarine program was chartered to develop a less expensive alternative to its predecessors. Conceived as a replacement for the Seawolf class of submarines, the Virginia class program was challenged to deliver a cost effective, yet robust solution to meet the Navy's broad spectrum of open-ocean and littoral missions around the world.

Problem

Historically, nuclear submarine shipbuilding development and construction focused on custom designs because of the relatively limited number of ships being built in this category. Over time, this practice resulted in a proliferation of functionally similar or nearly identical parts and specifications. In chronological order of development: the Trident class submarine required 28,000 procured parts, the Los Angeles class called for 29,000 procured parts, and the Seawolf class escaladed to 45,000 parts. Standardization received little or no consideration based on traditional practices.

As can be expected, the expense of procuring and managing thousands of complex parts was immense. These costs included parts definition, configuration management, test maintenance, spares, vendor selection, and warehousing. Clearly, a new focus on acquiring component products, construction, and maintenance processes without reducing mission capabilities would be a win-win outcome for everyone.

Approach

In a major cooperative initiative, the U.S. Department of Defense, the Navy, the industrial shipbuilding community, and academia identified two key areas to improve: parts standardization and process standardization. The Virginia class program became the Navy's first major program to fully implement acquisition reform. The team began by creating integrated product and process development (IPPD), modular construction, parts reduction, and the aggressive insertion of advanced commercial off-the-shelf

(COTS) technologies. The IPPD concept ensured the most efficient and effective designs were incorporated into the overall design process early on.

For parts standardization, the empowered IPPD teams began by combining the experience of the shipbuilders, vendors, designers, engineers, and ship operators to coordinate the overall ship design, parts, and deployment. Involvement of production and design personnel early provided an excellent match between the submarine's design and the shipbuilder's construction processes and facilities. The smooth transition from design to production reduced the number of engineering change orders typically required during lead ship construction.

The program established a Parts Standardization Board more than two years before completion of the ship's specifications to identify, implement, and maintain a parts standardization program. As the gatekeeper of allowable parts, the board includes members from the engineering, design, materials, planning, quality, and operations departments—all under the direction of program management. A team leader reports directly to the program manager to ensure that standardization goals are maintained. Additionally, the shipbuilder's president signs and supports the standardization policy and procedures. The shipbuilding specification directs the use of standard parts which is tracked as a technical performance measure throughout design and construction.

The Virginia class is the first submarine program to use electronic data as its primary data format. The new digital environment makes extensive use of computer-aided design, facilitates digital sharing of design data amongst the teams, and controls part selection.

Integrated electronics systems with commercially-off-the-shelf components not only contributed to parts standardization, but also it facilitates the introduction of state-of-the-art technology throughout the life of the class, thereby avoiding obsolescence. The command, control, communications, and intelligence electronics packages, as well as the combat systems package, promote maximum flexibility for growth and upgrade.

Under the category of process standardization, the Virginia class program focused on the major processes involved in sparing, training, technical data support, and maintenance.

The team developed a reliability-based sparing method for critical systems: a standardization method of computing critical onboard repair parts based on single-point-of-failure criteria and desired system reliability. Wisely, the focus is on preventative—rather than corrective—maintenance, which is so obviously critical in the submarine environment. The process is used on both government and contractor-furnished equipment, reducing the overall number of spares carried and maximizing storage capacity, while maintaining organic repair capability.

In concert with the Naval Submarine School, Submarine Learning Center, and Naval Sea Systems Command (NAVSEA) Human Systems Integration Division, the program ensures that Virginia class interactive multimedia instructional materials are standardized to the latest requirements driven by Shareable Content Object Reference Model

specifications and the Learning Management System selected for use throughout the Navy. All were integrated into Virginia class products early in the development cycle. Standardized instructional material reduces or eliminates the need for shore based training.

The management of technical data and support is also standardized for the Virginia class. The user interface for more than 600 interactive electronic technical manuals is now standard, allowing sailors to work easily across multiple systems and ships within the class—a first for submarines. Also, standardized technical documentation, including all of the ship's drawings, is integrated with the supply-ordering process and with onboard training products. This effort culminated in the publication of the Web-Based Interactive Electronic Technical Manual (IETM) Common User Interface Style Guide, which is available now to all Department of Defense agencies.

Reliability-centered maintenance efforts with NAVSEA drove the producers of preventative maintenance products (the prime contractor and the government) to a standard method of deriving submarine maintenance requirements that melded with NAVSEA's efforts to reduce maintenance actions. This practice reduced overall maintenance requirements for ship equipment and systems without sacrificing operational availability.

In addition, continuous self-audits ensure ongoing compliance with program requirements. Conducted monthly, the audits identify non-standard material use, facilitate standardization evaluations, and provide a vehicle for continual standardization training.

Outcome

The benefits of the Department of Defense standardization program are outstanding across the board. The number of procured parts was reduced by 60 percent. The initial issue of drawings for the Virginia class ship construction called for 17,963 procured parts--versus the 45,000 parts called out for its predecessor, the Seawolf class lead ship. The Virginia class parts library at delivery was 80 percent less than the Seawolf .

Maintenance process standardization reduced the complement of test gear onboard Virginia class submarines by 32 percent—from 148 items with Seawolf to just 101 with Virginia. Standardization also minimized the program's overall logistics footprint and reduced the parts library.

The bottom line: over the life of the Virginia class program, an investment of $27 million in parts standardization is projected to lead to $789 million in cost avoidance. The USS Virginia lead ship was launched ahead of her threshold delivery requirement determined ten years earlier. Moreover, the USS Virginia is already showing a marked improvement in crew readiness and cost-effective onboard parts support. Lessons learned from the standardization program are being shared and benefiting additional Navy construction projects. # # # #