End User Feedback: A Discussion, Lessons Learned, and Recommendations for Managers of R&D Programs

LCDR John Witte, United States Navy

Abstract: This reflective case study was generated from an evaluation of the Navy's underperforming Advanced Seal Delivery System (ASDS) program. Two main systemic issues were revealed: insufficient systems engineering and a mismatch of requirements and resources. These issues were illustrated by analyzing three significant engineering issues: the main propulsion battery, the vehicle's acoustic quieting, and the tail assembly hydrodynamic performance. An evaluation framework was developed revealing that end users (ASDS operators and submariners) have substantial knowledge resources that can provide significant benefit to all program stakeholders. Engineering managers can capitalize on the recommended methodology to drive organizational change by more tightly coupling skill sets possessed by the end users to key points in a program's development.

Keywords: System Engineering, Project Management, Project Evaluation, End Users

EMJ Focus Areas: Building Engineering Management Actionable Knowledge, Systems Engineering, NPD

The Advanced SEAL Delivery System (ASDS) is a mini-submarine designed for clandestine delivery and recovery of special operations forces in a hostile environment. Designed to be launched from a Los Angeles Class nuclear submarine, it represents one of the largest investments ever made by the U.S. Special Operations Command. When the program was conceived in 1994, it called for the construction of 6 ASDS hulls and 2 support facilities (GAO, 2001). By 2003 one ship had been partially delivered, the program was 6 years behind schedule, and had almost tripled original budget estimates. In 2006, all orders for additional ASDS hulls were cancelled and acquisition was suspended until several reliability and design issues were corrected (GAO, 2006). This flagship program, despite strong support from several organizations and significant financial investment, had failed to deliver. The engineering management knowledge needed to avoid this failure was resident within the organizations involved in the program. As discussed below systems engineering shortcomings and a mismatch between requirements and resources were key factors in the program's underperformance. Enhanced communication through improved end user feedback could have mitigated these common project management issues.

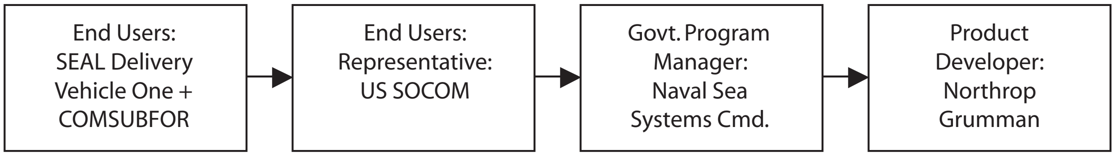
The ASDS was to be the future of undersea Naval Special Warfare. Its main mission, like similar vehicles before it, was to deliver SEAL commandos and equipment from a submerged submarine to land while remaining underwater and undetected. The previous vehicle used for this purpose was the Seal Delivery Vehicle (SDV). It had been in service for over 20 years and has been quite successful; however, the SDV is suboptimal in several areas. First, it has limited range and cargo capacity. It is also open to the ocean environment, requiring all personnel onboard to use SCUBA gear. This subjects the crew to fatigue, especially in colder water. Finally, the SDV requires several divers to work out on the deck of a submarine to deploy and retrieve it, increasing the complexity of launching evolutions. These evolutions are conducted from a Dry Deck Shelter (DDS), a large hangar-like structure attached to the deck of the submarine.

The ASDS was designed to overcome these limitations. At 65 feet long and 8 feet wide, it has a significantly larger payload. It also utilizes a dry interior with a lockout chamber, allowing divers to exit and enter through a lower hatch. It was designed to lock on to the exterior of a host Los Angeles Class submarine, needing simply to disengage its latches to launch. No divers would be required to operate outside the submarine. Its increased range and power would allow it to accomplish additional missions, including intelligence collection, underwater ship attack, and offensive mining (GAO, 2003).

There are five major players in the development of the ASDS program. The end users are Seal Delivery Vehicle Team One (SDVT-1) and Commander Submarine Forces (COMSUBFOR). The primary mission of SDVT-1 is to covertly employ SEALs using DDS and ASDS. COMSUBFOR provides the nuclear powered attack submarines that host the ASDS and DDS units. SDVT-1 employs over 100 Navy personnel to operate 3 DDS and 1 ASDS. COMSUBFOR has 9 submarines capable of hosting DDS, and 2 capable of ASDS operations. U.S. Special Operations Command (SOCOM) is the end user representative. They are the operational commander for SDVT-1, and drafted the Operational Requirements Document that specified what performance parameters the ASDS was required to meet. Naval Sea Systems Command (NAVSEA) is the government program manager for ASDS. Their mission is to materially certify the ASDS for at sea operations and ensure the program adheres to Navy quality assurance standards. The final player is the product developer – Northrop Grumman. Northrop Grumman is a large defense contractor, supplying a variety of systems to the Department of Defense ranging from aircraft to torpedo fire control systems. When Northrop Grumman was selected as the product developer for ASDS, they had never designed a submersible vehicle before. The ASDS development and construction occurred in a specialized facility owned by Northrop Grumman in Annapolis, Maryland. Exhibit 1 illustrates the relationship between the major players and their roles in setting requirements for the program. Northrop Grumman assigned an experienced project manager to be overall responsible for the ASDS program. The project

Refereed management tool manuscript. Accepted by Associate Editor Landaeta.

Exhibit 1. Organizations Involved in Requirements Setting Process (Adapted from GAO 1-288)



End Users: SEAL Delivery Vehicle One + COMSUBFOR	End Users: Representative: US SOCOM	Govt. Program Manager: Naval Sea Systems Cmd.	Product Developer: Northrop Grumman
Members of the warfighting community who use the weapons to perform combat missions. They understand what it takes to perform the mission.	Members of the warfighting community who analyze current deficiencies, decide what NSW capabilities will be required in the future, and translae them into requirements.	Members of the acquisition community who work the the end user representative to translate requirements into an initial design and estimate resource requirements.	Defense firm that works with the project manager to deisgn and build the product.

manager's equivalent at the Government Program Office is the Program Lead. The program lead acted as the single government procurement point of contact and overall coordinator of the relationship with Northrop Grumman.

A key component of the ASDS design was its carrying position on the Los Angeles Class host submarine. The SDV's are carried inside the DDS, which is hard-mounted to the submarine hull and can be sealed and drained, effectively shielding the SDV from turbulent flow forces when not deployed. The ASDS, unlike its predecessor, is designed to latch down on the hull, meaning that the entire body of the ASDS and the latching mechanisms are exposed to the hydrodynamic forces of a fast moving submarine. The ASDS must be able to meet the special warfare requirements of mobility, endurance, and stealth while operating independently, while also meeting the submarine force requirements of stability and strength while mated to a transiting submarine. This dichotomy of requirements calls for specific input from the perspective of each shareholder. In examining the ASDS program, it will become evident that better management of both perspectives would have allowed significant improvement. It is the goal of this study to develop a framework and methodology to facilitate this process in future projects.

The ASDS program can offer many lessons to future development programs. The program ended up exceeding its budget by over 300%, and cost almost $2 billion (GAO, 2006). Much of the cost overruns were diverted from other programs, detracting from the overall capability of U.S. naval forces. The schedule delays experienced by the program also prevented the end users from exploiting the ASDS's capabilities to conduct missions. By building knowledge about the root causes of the program's shortcomings, it may be possible to prevent this loss of capability in the future.

Research Methodology

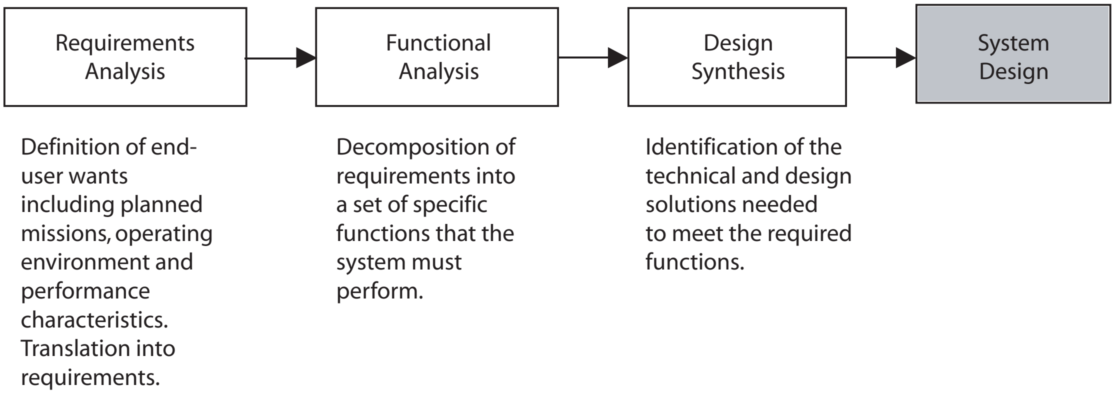
The specific purpose of this study is to examine the programmatic and contextual issues that led to the underperformance of the ASDS program, and apply the results to a framework for evaluating new projects. This study also developed a methodology for collecting and implementing input from end users into the project life cycle. To achieve this purpose, the following objectives were accomplished:

- The ASDS program's progress was examined in detail. This was done by document review and site visits to operating bases. The examination focused on context issues (i.e. conceptual design of ASDS systems and their performance while operating independently versus mated to the host) and programmatic issues (i.e. subsystem level testing and tradeoff management).
- The issues discovered in the program examination were broadened to apply to future programs. This was done by examining three key engineering issues as examples of systemic issues in the program. The key issues analysis formed the basis of the framework by which future programs will be evaluated.
- The framework was effectively combined with the project life cycle to form a methodology for implementing end user level input. Key skill sets were matched with specific end users, and the project life cycle was examined for the points and milestones where their input would have the greatest effect.

The scope of this study is limited to the project design issues that impacted the ASDS program, and potential advantages to be gained by end user input. The study will not consider the technical data regarding specific material and design failures within the ASDS program. Instead, the focus will be on the systematic process that allowed the failure to occur; therefore, the study will not be interested in interpreting tensile stress data from a failure in the ASDS tail section. The concern will be how the program could have effectively utilized both the special warfare and submarine perspective to develop the best tail section design, and if input from the end user level could have improved the design before the component eventually failed.

The general approach of this study consisted of three phases: document collection and site visitation, framework development, and methodology synthesis. The key document sources are General Accounting Office reports on the ASDS acquisition program (GAO subsequently changed to Government Accountability Office), ASDS semiannual program review reports, and doctrine regarding the ASDS concept of operation. The document review and site visit portion of this phase focused on the interaction between the major stakeholders in the program, conducted by reviewing correspondence between the commands and visits to ASDS operation and support sites. The framework phase compiled the lessons learned from the first phase and organized them into a more general framework that can be applied to assist in planning future projects. The methodology phase consisted of

Exhibit 2. Systems Engineering Process (Adapted from GAO 1-288)



applying the data collected in the first two phases and synthesizing an integrated approach to incorporating user level insight into development projects like ASDS.

Results

The ASDS program's failure to deliver the desired results can be attributed to two major root causes: insufficient systems engineering and a mismatch between resources and requirements. These root causes are exemplified by three major engineering issues that had a significant impact on the program: the main propulsion batteries, acoustic quieting, and tail assembly hydrodynamic performance. Detailed examination of the root causes yields the perspective necessary to analyze the three major engineering issues. Each of the three issues will contribute key points to the analysis framework for projects of this type, summarized in Exhibit 2. The resulting framework will be synthesized into a new methodology for utilizing end user feedback and knowledge to facilitate greater weapons system outcomes.

Systems Engineering

Systems engineering in this context refers to the process of translating customer or end user requirements (i.e. transit speed, payload capacity) into the technical and design solutions necessary to meet them (GAO, 2001). This includes estimating the resources and schedule required to successfully deliver the system. Exhibit 2 illustrates this process.

Ideally, the majority of systems engineering would be completed prior to the launch of the program, for two main reasons. First, the engineering process is the first "reality check" on the system's specifications. The three main tradeoffs in project management are resources, schedule, and performance. The system's specifications represent the performance area, and the systems engineering breakdown of the specifications should result in an estimate of the resources and schedule necessary to deliver the desired performance. If the resulting resource or schedule requirements are unacceptable, it is difficult to make tradeoffs in performance once the program is launched. Secondly, the product developer must be able determine if they have the expertise and resources necessary to successfully execute the program as desired. Detailed systems engineering will reveal gaps in the company's resources (i.e. proprietary technology or specific technical skills) that could expand the company's costs beyond an acceptable level. In this situation, all stakeholders lose out because the product developer may have to utilize cost cutting measures (such as limiting overtime) that will delay the delivery of the system.

Detailed systems analysis yields decision points that are much easier to negotiate prior to the launch of the program, after which the specifications, schedule, and budget are difficult to change. Although the Department of Defense acquisition procedures make this kind of collaboration difficult prior to program launch, it can be done with sufficient engagement by all parties. As we will see, the systems engineering process was not completed for ASDS until the program was well underway and had already run into difficulties.

Resource and Requirement Matching

Unless a weapons program is cancelled, the developer's resources and the end user's requirements are eventually met. It may be after millions of dollars in cost overruns and years of schedule delays, but the end user eventually gets the system they want. In successful programs, the end user's requirements are negotiated with a realistic view of the product developer's ability to meet them. In problematic programs, a common flaw is that the end user's requirements are set and unmovable, while the product developer expends an ever-increasing amount of resources to meet them. It is incumbent upon all stakeholders to understand the price of meeting each requirement. The product developer must know what costs will be incurred to meet the requirement and what alternatives are available. For instance, a lower host submarine transit speed might lessen the hydraulic stress on the ASDS enough to use a commonly used metal for structural components instead of a more expensive material. It is up to the developer to present this information to the end users and government representatives. All parties must then evaluate the operational impact of the lower transit speed versus the savings to the program. These types of trade-offs require thorough systems engineering by the developer and proactive communication by the end user representatives.

When a program's requirements begin to outstrip its resources, the developer will be encouraged to utilize less mature, developmental technologies. For instance, if the total weight of a system is required to be low, the developer may pursue experimental alloys that promise higher strength for lower weight, but the alloy may be expensive, hard to obtain, or have performance issues that have yet to be resolved.

This introduces additional risk into the project. The key is to realize what is possible with existing technology and compare it to the end user requirements. The risk of using immature technology in a weapons system design should be fully understood and acknowledged by all stakeholders. In the ASDS program, immature technology was introduced as a reaction to the program's failure to meet initial expectations.

Main Propulsion Batteries: Testing Opportunities Lost

The ASDS's central power source for propulsion and auxiliary power was to be a large bank of silver-zinc batteries. This type of battery had been used in combat submersibles (such as the SDV) for several years, and was considered to be a mature technology; however, the ASDS design called for a much greater power output. Compared to the SDV, the ASDS was to have a greater top speed and operating range. It also required greater auxiliary power to maintain the atmosphere within the vehicle. The initial engineering analysis conducted by the product developer indicated that the silver-zinc batteries would be able to produce the required power output. During the first test of the battery when installed on ASDS, electrical shorts rapidly developed causing premature battery failure. Instead of the required 20 charge discharge battery life cycle, the battery needed to be completely replaced after only 2-3 cycles (GAO, 2003). Battery replacement for ASDS entails removing the vehicle from the water and conducting extensive maintenance. The silver-zinc battery as initially designed did not meet the vehicle's endurance requirements and would not support its intended mission.

Analysis of the silver-zinc battery's development showed that subsystem-level testing was very limited. The premature failure of the ASDS battery was attributed to the high temperature environment in which the battery must operate. This high temperature condition was not anticipated by the design engineers, who did not include extreme temperatures in the test plan. Also, the majority of the battery testing was not completed until the battery was installed in the vehicle. By not pursuing a more rigorous component-level test plan, the ASDS program missed the opportunity to make engineering adjustments to the battery without drastically impacting the schedule and budget.

When the silver-zinc battery issues first surfaced, the program office began looking into lithium-ion battery cells. Although this type of battery is widely used in electronic devices, it had never been utilized in this type of large-scale application. The initial lithium-ion development work showed promising signs of better high temperature performance and extended reliability, but the technology was immature and needed more development. This was a critical crossroads in the ASDS program. Two main courses of action were possible: correct the deficiencies of the silver-zinc battery or devote more resources to developing the lithium-ion battery. The program ended up pursuing the lithium-ion battery. At this point, it may have been advisable to put the program on hold until the battery technology was mature. This was not possible due to political pressure from mounting budget overruns and schedule delays. The lithium-ion battery was not installed in ASDS for another three years.

Acoustic Quieting: An Unassessed Weakness

The acoustic signature of the ASDS vehicle was designated as a key performance parameter. The ability to operate stealthily was considered essential to the conduct of future ASDS missions. This capability was required both to prevent the ASDS from being detected while operating in hostile waters and to ensure the host submarine remain undetected while launching and recovering the vehicle. When examining the main stakeholders involved in the program, it is evident that there was a shortage of experience in this area. The product developer, Northrop Grumman, had never designed a submersible vehicle. The end user representative, U.S. Special Warfare Command, had only recently become involved with combat submersibles requiring this level of acoustic security. This knowledge deficit constituted a mismatch between requirements and resources from the beginning stages of the program. This deficit could have been overcome by hiring additional personnel with acoustic engineering experience, or by subcontracting an experienced vendor to provide acoustic modeling and analysis. Another stakeholder, Commander Submarine Force (COMSUBFOR), had extensive experience with acoustic quieting through years of operating nuclear submarines, but this experience was not utilized in ASDS's development. The product developer used company engineers to conduct some limited acoustic modeling, the results of which the developer deemed adequate to proceed with the current system design.

In initial acoustic trials, the ASDS proved to be too noisy to meet the program requirements. The main offender was the propeller, which required extensive redesign to reduce radiated noise. The program office assembled a team of government experts and private contractors to correct this deficiency. A composite propeller with improved quieting properties was produced after a year of design work, but the sound levels were never measured at sea due to schedule constraints. The program stakeholders ended up deferring the acoustic quieting requirement to future boats (GAO, 2003).

The acoustic quieting deficiency was discovered very late in the program's development and resulted in substantial cost overruns and schedule delays. This could have been prevented by a thorough self-assessment of the program team's strengths and weaknesses before the program's launch. Both the end user representative (U.S. Special Operations Command) and the product developer (Northrop Grumman) had very little experience working with submarines. Since the ASDS was being paid for exclusively by the special warfare community, COMSUBFOR played only the supporting role of providing host services for the vehicle. The acoustic security knowledge and experience available to the submarine community was not engaged in meeting the acoustic signature key performance parameter.

Tail Assembly Hydrodynamic Performance: When Should Requirements be Changed?

Since the ASDS began mated host operations in 2003, there have been multiple material failures with tail assembly components. The stern planes, upper and lower rudder, main motor assembly, and main propulsion shaft have all failed while the ASDS was mated to the host submarine in a transit mode (GAO, 2004). These failures drastically reduced the vehicle's operational availability, and ultimately contributed to the program decision to cancel procurement of future ASDS hulls. Failure analysis indicated a fatigue mode of failure attributable to the hydrodynamic force of the host submarine propelling the ASDS through the water at high transit speeds. After this series of failures, the program office initiated in-depth hydrodynamic analysis of the forces the tail section is subjected to during mated host operations. This analysis included both computer modeling and at-sea testing with strain gages to measure the forces at key points on the tail section. The results indicated that the dynamic stresses seen by tail components were beyond the designed strength of the materials. The ASDS would not be able to meet the required host transit speed without major design changes. The product developer designed and installed a more durable titanium tail assembly at great expense. The maximum transit speed allowed for the host submarine was lowered, but failures continued to occur even with the addition of the titanium tail. After three more years of incrementally lowering the speed limit, the program was able to promulgate a transit speed that allowed mated host operations while preventing damage to ASDS. The host submarine was ultimately limited to approximately one third of its maximum submerged speed while ASDS was installed (US SOCOM, 2004).

Ideally, the tail section limitations would have been revealed in the systems engineering breakdown before the program's launch. Since this opportunity was missed, the best way for the program to recover was to critically examine the vehicle's requirements. In fact, the program revised the Operational Requirements Doctrine (ORD) in 2003 and again in 2004, reducing the number of key performance parameters (defined as parameters that could prevent mission readiness if unmet) from 16 to 8 (GAO, 2004). The lower transit speed for the host submarine was included in these revisions; however, the program could have reduced this requirement much more quickly and potentially saved significant resources. From a tactical perspective, COMSUBFOR was in the best position to validate the transit speed requirement. An extended host submarine transit would most likely be required when the host sub and ASDS would be making their initial deployment to the mission area from their home port. Having the ASDS flown to a forward operating base would allow the host submarine to transit to the mission area at its normal maximum speed. The submarine's speed would then be limited for a much shorter time period, and the ASDS would not be subjected to the stress of an extended transit. If the host speed requirement had been dropped to a conservatively low value in 2003 when the failures first occurred, it might have allowed the ASDS to become operational much more quickly, and saved millions of dollars in research costs. Increased transit speed could have been incorporated into the development of future ASDS hulls.

The program was missing one key factor that would have allowed smoother handling of the tail section failures: a clearly defined role for the submarine community. Since the special warfare community was the primary bill-payer, the submarine community fulfilled a supporting, advisory role. If the community would have been assigned an ownership role for the transit speed requirement, they may have been more proactive in analyzing the cost versus gain of the higher speed. A more team-based approach by all the program's stakeholders may have yielded a better result.

Recommendations and Implications to Managers of R&D Projects and Programs

The ASDS program has two main features that distinguish it from other weapons systems: it relies on two diverse communities for mission success (the submarine community and the special warfare community), and it utilized a relatively inexperienced contractor as a product developer. Neither of these features is inherently bad, but the additional risks they introduce necessitate a systematic method of dealing with them. Jointly-delivered weapons systems involving submarines and SEALs like ASDS are becoming more common, and it is important to prevent the same issues from arising. Exhibit 4 represents a synthesis of the key systematic issues revealed by analysis of the ASDS program that could be applied to future development projects.

The framework outlined in Exhibit 4 is designed to be completed prior to program launch. At this point, the product developer will have been identified and the initial budget will be set. The framework is not meant to be an all-inclusive list, and should be applied in addition to sound project management techniques. It is meant to prompt discussion of lessons learned from previous projects and to prevent similar mistakes from being made.

If this approach had been applied to the ASDS program, many of the engineering issues could have been either predicted or mitigated. For example, a representative from COMSUBFOR could have been assigned as a sponsor for the host submarine transit speed requirement and continuously evaluated its progress. If the communication plan of Exhibit 4 had been established, a more coordinated and efficient response to the tail assembly failures would have been possible. By applying the Submarine-NSW Combined Project Evaluation Framework to future projects, the likelihood of a successful outcome can be increased.

The framework can also be used as an analytical tool to evaluate past projects. Engineering managers can assess the stakeholder interaction and project performance to facilitate process improvement. This systematic approach to project evaluation can be a powerful tool for change.

Methodology for End User Feedback

Many of the engineering issues encountered by ASDS can be traced to a lack of experience or knowledge within the project team. It is not always possible to rely on the product developer for

Exhibit 3. Summary of Key Systemic Issues related to the ASDS Program

Main Propulsion Battery	Acoustic Quieting	Tail Assembly Hydrodynamic Performance
The product developer did not have the technical knowledge to anticipate the high operating temperatures experienced by the battery.	The program team did not adequately assess the product developer's ability to meet the acoustic signature key performance parameter.	The systems engineering process did not identify the potential for tail assembly failure until very late in the program's development.
The program's stakeholders were slow to make tradeoffs when confronted with a significant technological failure.	The submarine community's experience in this area was not utilized to offset the lack of experience in the program team.	A breakdown in communications between the major stakeholders prevented decisive action to reevaluate the host transit speed requirement.

Exhibit 4. Submarine-NSW Combined Project Evaluation Framework

Requirements Analysis

Determine which community is best equipped to assess the validity of the requirement

Assign a program sponsor for the requirement from the appropriate community that will assess the project's progress towards the requirement

Rate the importance of meeting the requirement versus potential time and schedule delays

Determine the feasibility of shifting the requirement to future versions of the system

Evaluate effects of partially meeting requirement on system performance

Set "tripwire" criteria for re-evaluating system requirements

Program Team Assessment

Evaluate product developer knowledge base for weak areas

Develop mitigation plan to compensate for weak areas (subcontracting, additional hires, etc.)

Identify knowledge resources elsewhere in the program team (end user, end user representative) that can be utilized to enhance product developer knowledge

Evaluate systems engineering practices of product developer

Examine assumptions made in cost and schedule estimates utilizing input from program stakeholders

Evaluate product development timeline and budget for additional systems engineering opportunities

Communications Plan Development

Define each stakeholder's role in program decisions

Promulgate standard procedure for re-evaluating requirements

Develop a protocol for processing stakeholder input on program trade-offs

extensive experience or corporate knowledge when constructing a new system. The end users of the system usually have personnel with many years of technical and operational expertise with the types of missions and environments for which the system is intended. If this experience was able to be applied to key points in the system development process, knowledge deficits within the program could be corrected.

For the purpose of providing feedback, end users can be grouped into three major groups (summarized in Exhibit 5). Each group possesses a unique knowledge base and perspective that will add value to the project. The Strategic Thinkers have experience in managing and employing similar systems, and are well versed in the command-level decisions that must be made. The Operational Thinkers are familiar with what specific capabilities the system must have to accomplish the desired mission, and have operator-level experience in anticipated mission environments. The SEAL officer will have commanded a SEAL platoon in NSW missions, and the submarine officer will have driven submarines as Officer of the Deck in support of NSW missions. The Technical Experts have years of experience in maintaining and employing naval systems. The submarine electrician's mates are responsible for the ship's battery and electrical distribution system, and are uniquely qualified to evaluate a new weapons system's electrical reliability. The submarine auxiliaryman is an expert in hydraulic and mechanical systems, and also has extensive experience with submarine ship handling characteristics. The diving warrant officer will have served as DDS officer in charge, which entails close coordination and teamwork with the host submarine crew. The skill sets possessed by each of these groups can have a significant positive effect on a system's development.

Each group is required to be no more than three years removed from their last at-sea experience. This ensures that they are experienced with the most current operational doctrine. Even if the product developer employs a retired serviceman with the same qualifications, the real world mission requirement may have drastically changed since they were last in that position. A key distinction between the groups is the NSW experience requirement. For Group A, the NSW experience is optional, since the commanding officers will have had a considerable volume of experience and can quickly adapt their perspectives to the NSW mission. For Group B, the NSW experience is required since the specific goal of their input is to obtain operator level knowledge of potential mission conditions. For Group C, the submarine senior chiefs do not need NSW experience, since they are being utilized in an engineering capacity versus an operational capacity. The diving warrant officer must have NSW experience, since other areas of the diving profession (i.e. salvage, ships husbandry) are not applicable to this type of product development. It will also be cost effective to utilize these groups. Since they will all be active duty military, the only expenses would be travel expenses and incidentals involved with coordinating their participation;

Exhibit 5. End User Grouping and Description

Group A: Strategic Thinkers

Post Command Submarine Officer
- O-6 (Captain) or O-5 (Commander)
- No more than 3 years since command tour
- ASDS or DDS host submarine experience preferred

Post Command SEAL Officer
- O-6 (Captain) or O-5 (Commander)
- No more than 3 years since command tour
- Seal Delivery Vehicle team experience preferred

Group B: Operational Thinkers

Post Department Head Submarine Officer
- O-4 (Lieutenant Commander)
- No more than three years since department head tour
- ASDS or DDS host submarine experience required

Post Operations Officer SEAL
- O-4 (Lieutenant Commander)
- No more than three years since operations officer tour
- Seal Delivery Vehicle team experience required

Group C: Technical Experts

Submarine Electricians Mate Senior Chief
- E-8 (Senior Chief or above)
- No more than three years since last sea tour

Submarine Auxiliaryman Senior Chief
- E-8 (Senior Chief or above) Machinist Mate, Auxiliaries
- No more than three years since last sea tour

Navy Diver Chief Warrant Officer
- CWO2 or above
- Must have Seal Delivery Vehicle team experience
- No more than three years since SDV Team tour

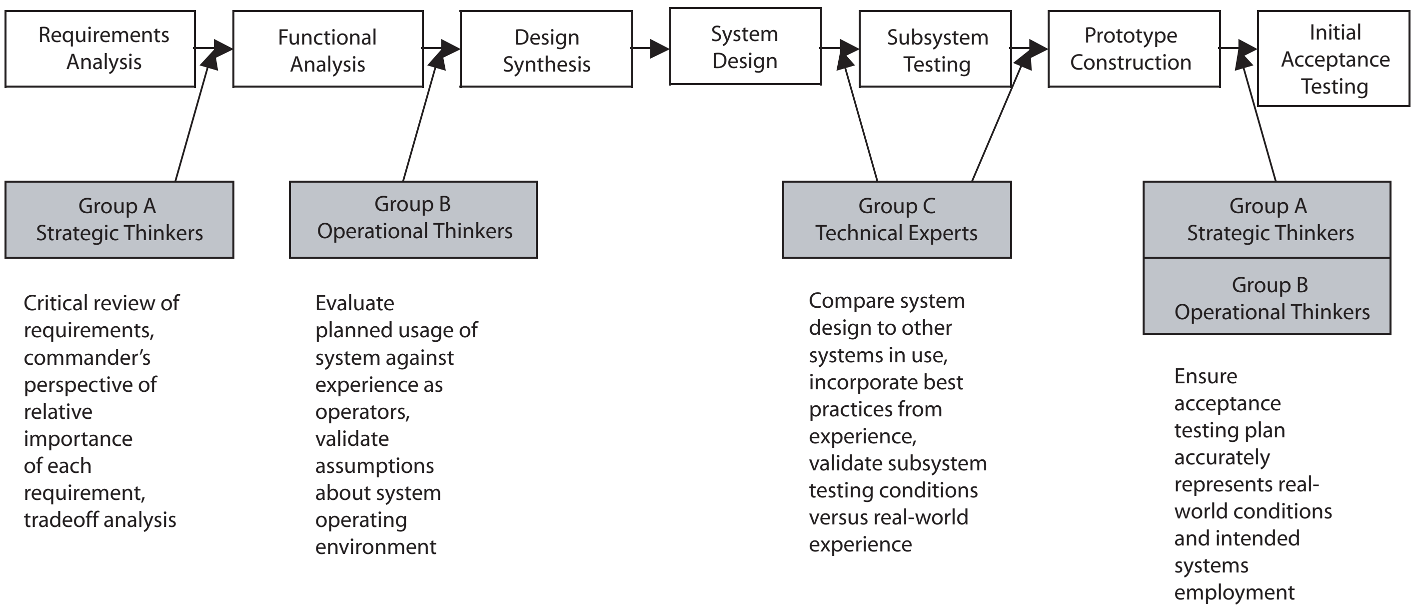
therefore, this sort of feedback would be more attractive to the product developer than more expensive consultants or subcontractors.

Exhibit 6 represents the primary deliverable of this study. The exhibit depicts a simplified project management flowchart showing key points where end user feedback should be utilized. Using the Strategic Thinkers during the initial requirement analysis phase makes the best use of their "big picture" perspective and also helps them become invested in the project. The same strategic thinkers could be used as program sponsors for requirements later on. The Operational Thinker's perspective can be most effectively utilized when translating the functional requirements to a system design. For example, the submarine officer could review the operating parameters of an active sonar detection system versus threat platforms in the anticipated mission area prior to the system's inclusion in the initial design. The Technical Experts are best utilized in evaluating the system's design against the anticipated test conditions. They can also use their experience to evaluate the realism of the testing conditions, potentially averting a situation like the ASDS silver-zinc battery tests. Their experience will also be an asset when integrating the subsystems into the construction of a prototype. Groups A and B are then brought in to ensure that the initial acceptance testing accurately simulates the anticipated mission employment of the weapons system.

The way that the end user feedback is obtained and utilized could be tailored to the program. It may be advantageous to provide the participants with data and test plans ahead of time, and then arrange for site visits and consultation with the engineers. The feedback could be tied to specific milestones in the program, and represent entrance criteria to the next stage of development. The sequence shown in Exhibit 6 represents a starting point, and is widely adaptable to fit established program management models.

End user feedback can be a powerful tool for positive change in any organization or program. The end user has a perspective and a knowledge base different than that of the engineers, managers, and even the customer representatives involved in an R&D program. This perspective can be seen as a resource, able to be applied at key points in a program to add insight and diagnose deficiencies. The same line of thinking applied to the ASDS program in this study is relevant to many other situations. If a company is developing a new type of bulldozer, end user groups A, B, and C of Exhibit 6 could be construction company owners (strategic thinkers), site foremen (tactical thinkers), and bulldozer operators and maintenance technicians (technical experts). Once the groups and their desired skill sets are identified, their

Exhibit 6. Incorporation of End User Feedback into the Project Management Process



feedback can be integrated into a program's management plan and development timeline. By properly leveraging the invaluable resource of end user feedback, managers can drive more successful program outcomes.

Conclusions

The Advanced SEAL Delivery System provides the U.S. Navy with a unique platform capable of accomplishing special operation missions not covered by any other weapons system. A reflective analysis of the underperformance of this project uncovered strategies that allow engineering managers to create a tighter coupling of stakeholder expertise with product development through a common evaluation framework. A method for end-user feedback is displayed. Engineering managers can use the knowledge built in this investigation to refine their production processes to incorporate strategically enhanced communication feedback.

Acknowledgments and Disclaimers

I'd like to thank the sailors of SEAL Delivery Vehicle Team One, whose assistance and insight were essential to the creation of this report. Their perseverance and belief in the ASDS program is a constant source of inspiration. I'd also like to thank my wife, Lisa, for her understanding and patience during the hours spent constructing this study.

I'd also like to emphasize that this report was written in a spirit of collaboration, aimed at improving the way the Navy does business. Its intent was not to single out any person or organization for criticism, but to communicate lessons learned and build a stronger process. The opinions expressed in this report are only that of the author, and do not represent the official views of the Department of the Navy.

References

Cole, William, "Costs Sink Navy Mini-Sub Program," *Honolulu Advertiser* (April 20, 2006), pp. 1.

Naval Sea Systems Command and Northrop Grumman, *ASDS Semiannual Program Review Minutes* (1998-2004).

United States General Accounting Office, "Better Matching of Needs and Resources Will Lead to Better Weapons System Outcomes," *Report to The Committee on Armed Services, U.S. Senate* (March 2001), pp. 1-33.

United States General Accounting Office, "ASDS Program Needs Increased Oversight." *Report to The Committee on Armed Services, U.S. Senate* (March 2003), pp 1-20.

United States General Accounting Office, "Assessment of Major Weapons Programs," *Report to Congressional Committees* (March 2004), pp. 23-24.

United States Government Accountability Office, "Assessment of Major Weapons Programs," *Report to Congressional Committees* (March 2005) pp. 27-28.

United States Government Accountability Office, "Assessment of Major Weapons Programs" *Report to Congressional Committees*, (March 2006) pp. 34-35.

U.S. Special Warfare Command and Naval Special Warfare Command, "ASDS Top Level Requirement Verification Matrix," *ASDS Operational Requirements Doctrine* (1994, 2003, 2004).

Whipple, John, 2002, "ASDS: The Future of Submarine Based Special Operations," *Undersea Warfare*, (Winter/Spring 2002), pp. 4.

About the Authors

John Witte is the Engineer Officer on the submarine USS Michigan. He received his BS in food science from Iowa State University and a Masters of Engineering Management from Old Dominion University. LCDR Witte has eight years of experience as a submarine officer.

Contact: LCDR John Witte, 6026 Peregrine Court, Bremerton, WA 98312; jwitte78@hotmail.com