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**REDUCING DON TOTAL OWNERSHIP COST:
WHY RECENT REFORM INITIATIVES WILL LOWER
SUSTAINMENT COSTS AND INCREASE
AFFORDABILITY**

September 2021

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SUSTAINMENT COSTS AND INCREASE AFFORDABILITY**

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Submitted in partial fulfillment of the
requirements for the degree of

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September 2021**

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ABSTRACT

Sustainment costs are the largest portion of total ownership cost (TOC) for ships across the Department of the Navy. Driving down these costs through innovative approaches both in sustainment and acquisition will free up vital resources. This is important to enable reprogramming to support the Navy's shipbuilding goal. With budget constraints, efficiencies must be realized to deliver the battle force required to maintain our naval advantage. This thesis assessed Government Accountability Office findings for Navy ships to determine how improved portfolio management in accordance with Section 809 panel recommendations will improve accuracy of sustainment costs that result in reduction of planned TOC. We found that primary contributing factors of increased TOC are concurrency in technology development, design, and construction, and a lack of advocacy for TOC considerations early in the acquisition process. Accordingly, though Navy ships will always have concurrency as a system of systems, establishing a sustainment program baseline of equal standing with the acquisition program baseline would positively impact TOC through equivalent governance for acquisition and sustainment functions and would ensure sustainment had equal advocacy with acquisition. Improved flexibility and autonomy for reprogramming would help apply funds directly to the Navy's sustainment challenges. When combined, Navy ships can positively influence TOC.

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LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|--------|------------------------------------|
| APB | acquisition program baseline |
| ASN | Assistant Secretary of the Navy |
| BTR | below threshold reprogramming |
| CAIV | cost as an independent variable |
| CASREP | casualty report |
| COTS | commercial off the shelf |
| DAG | Defense Acquisition Guidebook |
| DAU | Defense Acquisition University |
| DOD | Department of Defense |
| DON | Department of the Navy |
| FFG | guided missile frigate |
| FMR | federal management regulation |
| FRP | full rate production |
| FY | fiscal year |
| GAO | Government Accountability Office |
| KPP | key performance parameter |
| LCC | life cycle cost |
| LCCE | life cycle cost estimate |
| LCS | Littoral Combat Ship |
| LCSP | life cycle sustainment plan |
| MDA | milestone decision authority |
| MDAP | major defense acquisition program |
| MS | milestone |
| NAVSEA | Naval Sea Systems Command |
| NDAA | national defense authorization act |
| OMN | operations and maintenance, navy |
| OPN | other procurement, navy |
| OWLD | obligation and work limiting date |
| PEO | program executive office |
| PM | program manager |
| PMS | program management shop |

| | |
|------|---|
| PPBE | planning, programming, budgeting, and execution |
| PSM | product support manager |
| RDTE | research, development, test and engineering |
| SPB | sustainment program baseline |
| TLCC | total life cycle cost |
| TOC | total ownership cost |

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I. INTRODUCTION

A. BACKGROUND

Recently, there has been greater emphasis placed on total ownership costs (TOC) of systems and ships. While a large amount of attention and emphasis remains on the procurement and acquisition of systems and ships, the Navy is beginning to also look at how to reduce total ownership costs. This specifically applies to surface ships that continue to see service life extensions to meet missions and to require new capabilities they were not originally designed to support.

While it is acknowledged that operations and sustainment (O&S) account for a large majority of the TOC of a ship, decisions that can impact the sustainment costs over a ship's life cycle are often made extremely early in the acquisition process. The disconnect between when these decisions are made and when the impacts are felt makes it even more difficult to use TOC as a decisions-making driver. Because sustainment is such a large part of TOC, an understanding of the challenges faced in the longest part of a ship's life cycle is needed. In addition, the relationship between decisions in the earlier phases of the acquisitions process and their impact to sustainment needs to better be understood.

Navy ship sustainment requirements have grown significantly over the past decade because of a variety of factors—from issues with system reliability to extended duration of ship availabilities to increased operating tempo that leads to increased wear and tear on ships. This increased requirement has grown to over \$25B annually over the past three fiscal years and the trend continues to increase with projections growing to \$40B annually, as shown in Figure 1 (Office of the Chief of Naval Operations, 2019).

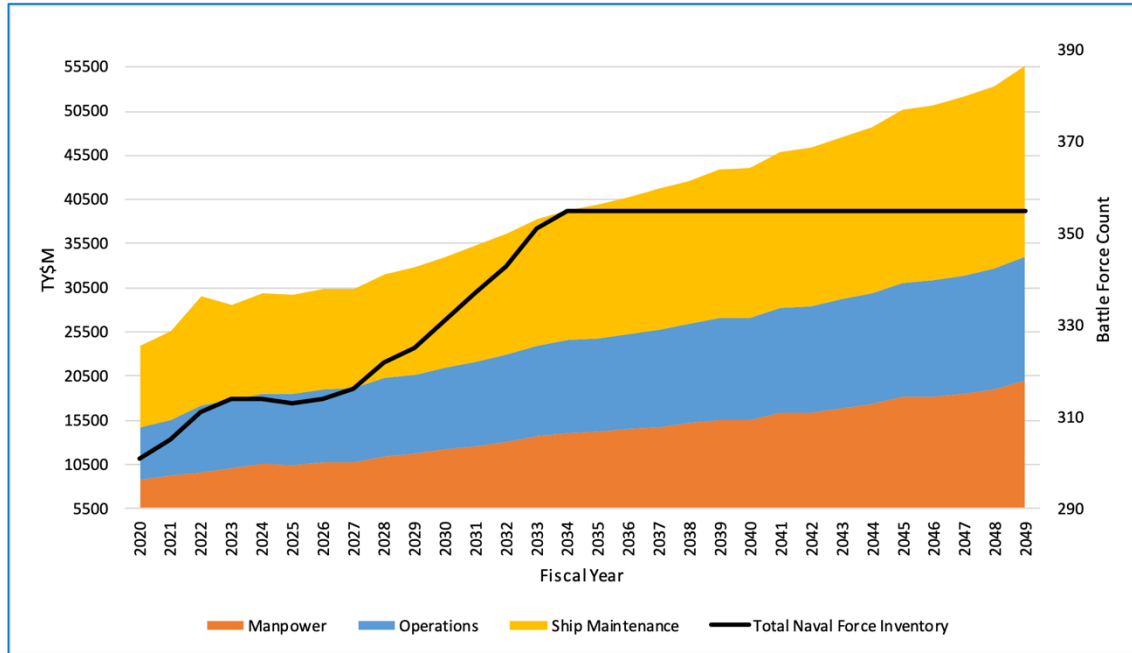


Figure 1. Annual Funding for Sustainment (FY2020-FY2049). Source: CNO (2019).

The current state drives program decisions on life cycle sustainment early in the acquisition process. Congressional constraints on unit cost drive program office behavior and, as a result, when ship construction costs exceed estimates, long term sustainment costs become marginalized in the interest of future milestone decision approval to continue the program.

During acquisition, Navy programs are measured at various points called Gate reviews and, more formally, at traditional DOD acquisition milestones (e.g., Milestones A, B, C). This alignment of Navy review is shown in Figure 2 (Office of the Secretary of the Navy, 2019). At formal milestones, the primary measure of program viability is the Program Acquisition Cost that is often driven by unit cost. Programs are subject to Nunn-McCurdy legislation and a breach may lead to program cancelation. As a result, ensuring unit cost is as low as possible is a significant goal for the program manager.

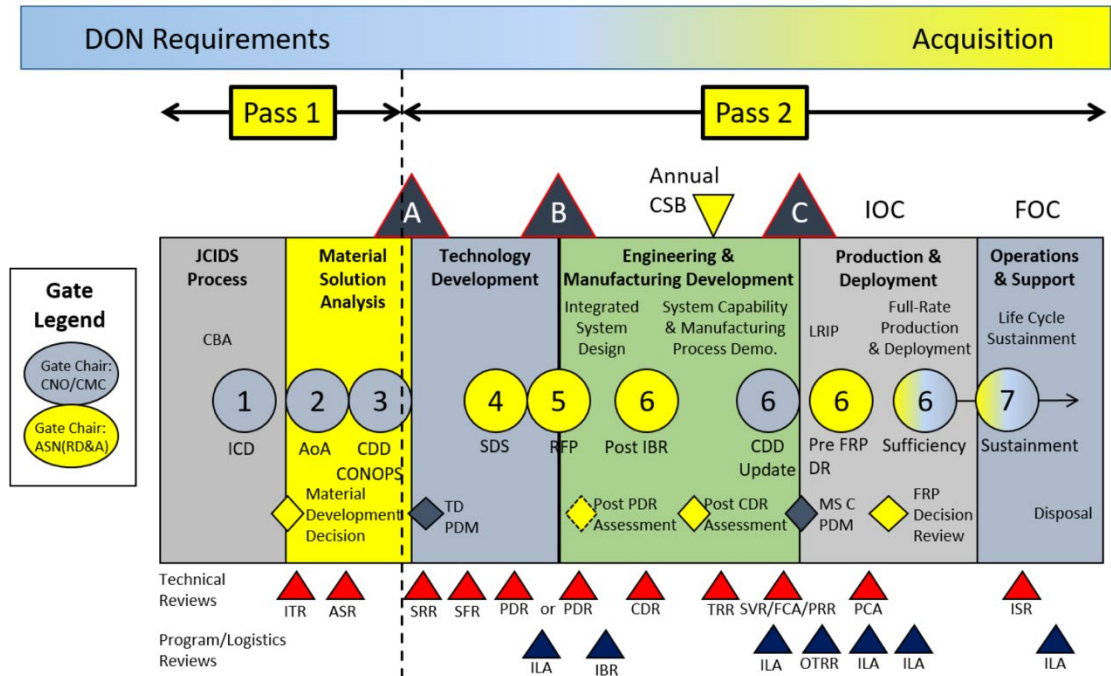


Figure 2. DON Requirements/Acquisition Two-Pass Seven-Gate Process with Development of a System Design Specification. Source: ASN (RD&A) (2019).

Certainly, low acquisition cost is of importance to the taxpayer, as well; however, the average American would recognize that purchasing something at a lower cost may lead to higher operating and maintenance costs (due to lower quality) and that may drive them to spend for higher quality up-front to lower future long-term costs. That concept is one that Navy may not always be able to follow as acquisition unit cost goals and Nunn-McCurdy restrictions influence program manager behaviors.

Recognizing the issue around ballooning costs to operate and maintain ships and other DOD systems, Congress introduced legislation to formally assess acquisition. The FY16 National Defense Authorization Act (NDAA) established an Advisory Panel—heretofore referred to as the Section 809 panel—charged with making recommendations to streamline and codify Acquisition Regulations. Additionally, the Government Accountability Office (GAO) is responsible for executing routine reviews and audits of government programs. In both 2018 and 2020, GAO analyzed Navy shipbuilding and

generated two reports that examined acquisition process, outcomes, and risks that aligned with our area of interest (Oakley, 2018 and Oakley, 2020)

B. PROBLEM STATEMENT

Navy sustainment costs continue to increase over the life cycle of ships (OPNAV N9, 2019). Disjointed acquisition management, focus on unit acquisition cost, and a lower emphasis on sustainment costs result in either the inability to identify long term sustainment issues, inadequate planning for sustainment requirements, or ill-informed decisions to be made. Sustainment accounts for 70% of the total ownership cost over surface ship life cycle (Section 809 Panel, 2019).

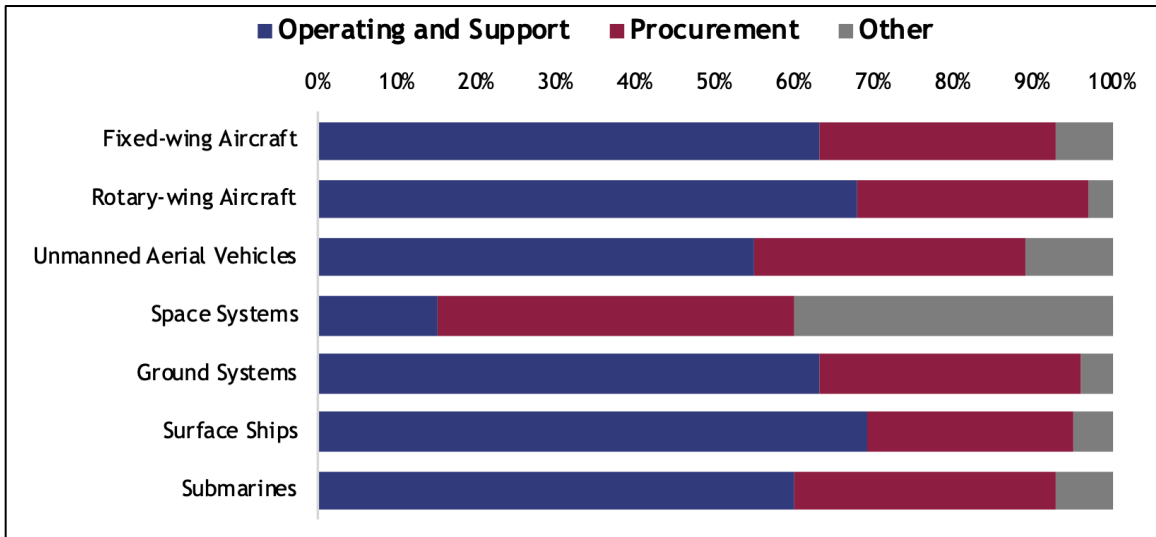


Figure 3. Percentage of Program Life cycle Cost Average for MDAP Categories. Source: Section 809 Panel (2019).

C. RESEARCH OBJECTIVES

Our research aims to identify the main causes of inadequate sustainment planning and to determine how addressing them would reduce total ownership cost (TOC) over the life cycle of Navy ships.

D. RESEARCH QUESTIONS

The following research questions will help us to determine the reasons for increased sustainment cost as we seek to analyze the gaps and assess potential solutions. This is important because of increasing focus on controlling costs in the current climate where budgets will, at best, remain flat. As sustainment costs can represent up to 70% of the total life cycle cost of surface ships, we believe it to be an important area of focus.

- How do the Section 809 panel and GAO recommendations regarding sustainment costs as part of TOC apply to Navy ship acquisition and support?
- What are the primary contributing factors to increased sustainment costs for ships?
- How can the Navy reduce or eliminate external influences?

E. PURPOSE/BENEFIT

This section defines sustainment costs, as identified in acquisition, and identifies why reducing cost benefits the Navy. The *Defense Acquisition Guidebook* (DAG) defines sustainment as the phase where planning occurs “to maximize readiness by delivering the best possible product support outcomes at the lowest Operating and Support (O&S) cost.” (DAU, 2020, chapter 4). Furthermore, it states that “programs that emphasize sustainment early in the system life cycle deliver designs with the highest likelihood of achieving operational performance requirements and reduced demand for sustainment.” (DAU, 2020, chapter 4). Our experience as program managers, primarily executing projects in the sustainment phase, drives us to wholeheartedly concur with the preceding statement, leading to our research. We understand there are not enough resources to fully support the current requirements and believe there are impactful actions that will provide benefit as the Navy changes acquisition.

F. SCOPE/METHODOLOGY

This research provides an analysis of recommendations made by the Section 809 panel and GAO to determine the potential benefit regarding total ownership cost for Navy

ships. Data, findings, and recommendations from these sources will be analyzed and assess for their impacts and potential to affect TOC. Data and analysis for this research will result in suggested recommendations for improvement.

G. THESIS STATEMENT

This thesis determines the most impactful Section 809 and GAO recommendations as determined through careful analysis related to TOC of Navy ships. Additionally, external contributors to cost will be reviewed and recommendations provided as to the factors that, if eliminated or reduced, would provide additional benefit, and recommend areas of further research.

H. REPORT ORGANIZATION

Chapter I provided the background, research questions, and overall scope of this research. Chapter II provides a detailed overview of the references used in the analysis. Chapter III summarizes relevant data and provides detailed analysis. Chapter IV presents the findings of this research project, and Chapter V provides conclusions and recommended areas for further study.

I. SUMMARY

This section provided an overview of life cycle sustainment and the challenges facing the Navy related to total ownership costs. It also identified the problem statement and discusses the benefit of addressing these challenges. Lastly, it bounded the scope of research and presented the thesis statement.

II. LITERATURE REVIEW

There have been several recent efforts to better understand the acquisition and sustainment of Navy ships. To identify objective data, three independent analyses were selected—two from the GAO and one from the Advisory Panel on Streamlining and Codifying Acquisition Regulations commonly known as the Section 809 panel.

In 2018, the GAO released a report, *Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments*, investigating surface ships procured within the last decade (Oakley, 2018). This report emphasized shipbuilding challenges including cost overruns, accumulation of risk, and performance prior to and immediately following delivery of the ships. Following the 2018 report, the Section 809 recommendations were released in 2019. The 2018 GAO report and the Section 809 panel results were published in the same timeframes, with the scope of the 809 Panel being significantly broader in its recommendations as it assessed acquisition reform across the DOD. While the panel did not focus solely on Navy ships, some of the recommendations stood out as being particularly impactful to TOC and sustainment of surface ships.

Following these recommendations, the GAO also released a follow-on report in 2020, *Navy Shipbuilding: Increasing Focus on Sustainment Early in the Acquisition Process Could Save Billions*, this time with an emphasis on the whole ship life cycle and sustainment (Oakley, 2020). GAO openly acknowledged that greater attention and emphasis should be paid to TOC. The shift in focus by GAO is particularly noteworthy and helps us better understand some of the challenges and issues surrounding TOC considerations for surface ships. This literature review highlights the results in both GAO Reports, the Section 809 Panel, and a few other relevant literatures that cover the TOC, total life cycle costs, and sustainment specifically for Navy ships.

A. NAVY SHIPBUILDING REPORT (GAO 2018)

In 2018, the GAO released the *Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments* report (Oakley, 2018). This report examined multiple ship classes that were delivered in the ten years preceding the report. The report

details many of the areas where risk was being accumulated and eventually realized which then impacted cost, schedule, and performance of the in-service fleet after delivery.

The report points out that first ship and follow-up ships are still more costly than anticipated, are delivered late, and are delivered with many deficiencies. It also identified some reasons for such situations. For example, the maturity of the technologies compared to design and construction heavily impacted the amount of uncertainty surrounding acquisition. Technology development, design and construction often occur concurrently. Particular emphasis was placed on accurately accounting for the uncertainty that this creates in the business case and cost estimates that support the shipbuilding acquisition programs.

B. NAVY SHIPBUILDING REPORT (GAO 2020)

The GAO released a follow-on report *Navy Shipbuilding: Increasing Focus on Sustainment Early in the Acquisition Process Could Save Billions in 2020* (Oakley, 2020). Interestingly, this report shifted focus to the impacts that acquisition decisions have on sustainment. This also aligned with increased focus from Congress on sustainment. The GAO again looked at ships delivered in the ten years prior to the release of the report, but also included two new acquisition programs not yet delivered at that time. The report acknowledges that the Navy struggles to sustain and maintain ships, and that often the resources and time required to meet capability requirements throughout the life cycle of a ship are significantly higher than expected.

In this report, key decisions in the early acquisition phase and their impacts to sustainment are investigated. Some of the main findings were that sustainment was not adequately discussed or taken into consideration in early acquisition. This was found to be partly due to the lack of appropriate requirements and knowledge to help the Navy make informed acquisition decisions. Sustainment requirements are lacking and can lead to emphasis being placed in the wrong areas or using metrics that do not accurately reflect or predict the sustainability of a ship. The Navy has challenges across the board, from defining requirements, to understanding of impacts, to reporting and assessing key factors and true indicators of sustainment.

C. REPORT REGARDING ACQUISITION REGULATIONS (SECTION 809)

The third piece of literature is the *Report of the Advisory Panel on Streamlining and Codifying Acquisition Regulations*. The fiscal year (FY) 2017 National Defense Authorization Act (NDAA) authorized creation of this panel which will be referred to as the Section 809 panel in the remainder of this report. The Section 809 panel analyzed fourteen (14) areas of interest. Many of the areas have a degree of tangential connection to TOC; however, our research focus is limited to the data and analysis the panel presented in the portfolio management section of their report.

Portfolio management is a relatively new concept to the Department of Defense (DOD) and Department of the Navy (DON). In fact, in routine engagements, program management still dominates the language of military and civilian acquisition professionals. Portfolio management, in the context of project management, involves managing a collection of programs so that organizational goals are met. Ideally, this would ensure individual project goals are not in conflict with each other. In the DON, this is a challenge as the organizational structure is disjointed and decisions can be fragmented. As an example, many major Program Executive Offices (PEO) are split across acquisition and in-service codes. For example, Naval Sea Systems Command (NAVSEA) 21 has multiple Program Executive Offices within the organizational structure. Conceptually, NAVSEA 21 would be responsible; however, in practice, Program Management Shop (PMS) 407 and 443 handle acquisition and sustainment separately and, apart from Life Cycle Sustainment Plan (LCSP) requirements, there is no continuous accountability across the life cycle. With no one entity accountable for integrated results across both, decisions made in acquisition have the potential to negatively impact items such as cost or maintenance when the equipment is in-service may be made.

Our review of the Section 809 panel report focuses on Recommendations 41 and 42. The first, Recommendation 41, is to “Establish a sustainment program baseline, implement key enablers of sustainment, elevate sustainment to equal standing with development and procurement, and improve the defense materiel enterprise focus on weapon system readiness.” (Section 809 Panel, 2019, Vol 3, p. 50). This recommends a fundamental shift in defense acquisition planning, oversight, and control by introducing a

sustainment program baseline (SPB) with equal weight and standing to the acquisition program baseline (APB).

The second, Recommendation 42, is as follows: “Reduce budgetary uncertainty, increase funding flexibility, and enhance the ability to effectively execute sustainment plans and address emergent sustainment requirements.” (Section 809 panel, 2019, Vol 3, p. 50). This recommendation considers the fact that sustainment costs “historically accounted for about 70 percent of total weapon system costs.” (Section 809 panel, 2019, Vol 3, p. 124). As individual programs sometimes exceed that figure, the panel recommends realignment of sustainment funds to investment accounts from the current annual methodology and suggests appropriation funding guidance is unclear leading to inaccuracies in life cycle cost estimates (LCCE).

We also reviewed budgetary recommendations to determine other barriers to effective sustainment planning that increase total ownership cost.

D. ADDITIONAL LITERATURE OF INTEREST

Further review of previously published literature revealed a paper by Michael Boudreau and Brad Naegle, *Reduction of Total ownership Cost*, written in 2003. Although written more than a decade prior to the GAO reports or the Section 809 panel, many of the ideas and concepts in the paper similarly revolve around efforts that can reduce TOC. Of particular note is the way in which the authors define TOC, commentary on cost as an independent variable (CAIV), and what tools a program manager (PM) might use to encourage TOC reductions.

The paper clearly recognizes that there is an inherent conflict associated with managing TOC and meeting acquisition cost, schedule, and performance expectations prior to operations and sustainment (Boudreau & Naegle, 2003). In addition, CAIV is only significantly applied during the acquisition phase prior to fielding of a system. While many of the specifics discussed involved individual weapons systems, the nature and struggles in managing TOC identified in the paper are still imminently applicable to the Navy, and shipbuilding even now.

III. DATA AND ANALYSIS

A. PRIMARY RESEARCH

Major Defense Acquisition Programs (MDAP) spend significant portions of their budget on sustainment activities. This O&S funding averages 70% (Section 809 Panel, 2019); therefore, controlling costs here is extremely important. That said, the fact that total life cycle cost (TLCC) estimates are made years prior to many of these costs being realized drives the need for improved sustainment planning.

Additionally, it may be true that the PM at program initiation when TLCCs are determined is usually different than the PM in the procurement and sustainment phases of the program when costs are incurred. In other cases, the sustainment program office is completely different than the acquisition program office as is the case with Littoral Combat Ship (LCS). The organizational structure and assignments mean accountability is challenging to uphold. This challenge also highlights the importance of accurate planning and the need for acquisition decisions that drive down costs over the entire program life cycle and avoid the trap of minimizing initial acquisition costs to ensure program approval at the expense of the TLCC. Figure 4 provides averages for procurement, O&S, and other costs by MDAP categories across the DOD.

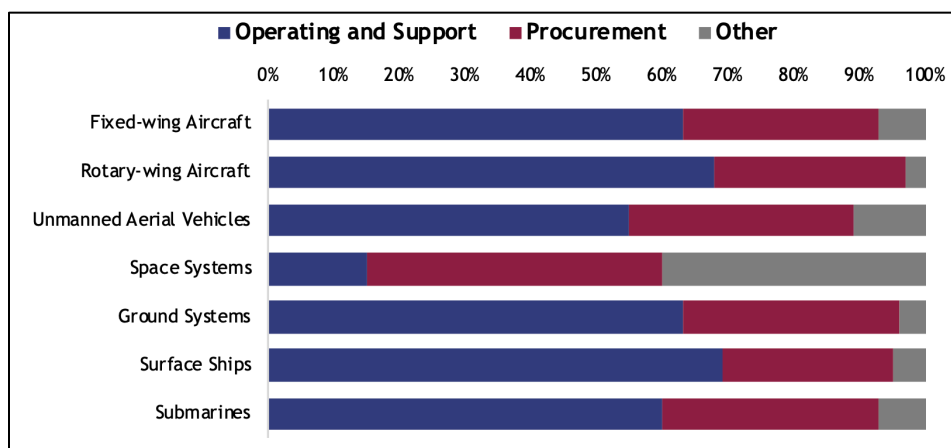


Figure 4. Percentage of Program Life cycle Cost Average for MDAP Categories. Source: Section 809 Panel (2019).

Figure 4 identifies the percentage of cost across major categories of defense programs. These O&S costs are significant and may be funded by a variety of funding “types,” such as Operations and Maintenance (O&M), Research, Development, Test & Evaluation (RDTE), and Other Procurement, Navy (OPN). This disparate source of funding leads to a lack of clarity and clear traceability of program costs. Additionally, there are various definitions of cost that sometimes conflate meaning and lead to entirely different assumptions or conclusions based on the point of view of the cognizant PM. The Defense Acquisition University (DAU) defines program acquisition cost as “The estimated cost of development research, development, test, and evaluation (RDTE), procurement, and system-specific military construction necessary to acquire the defense system” and describes life cycle cost as “research and development (R&D) costs, investment costs, operating and support costs, and disposal costs over the entire life cycle.” (DAU, Glossary, 2021).

This difference is extremely important because the program acquisition cost is included in the APB and is subject to Nunn-McCurdy Act while the life cycle cost is not subject to the Nunn-McCurdy Act. Figure 5 identifies the thresholds for significant and critical breach for both original and current program baselines (Schwartz & O’Connor, 2016). Therefore, to avoid program cancelation due to a Nunn-McCurdy breach, cost per unit is strictly tracked and managed to during acquisition.

| | Significant Breach | Critical Breach |
|----------------------------|---------------------------|------------------------|
| Current Baseline Estimate | ≥15% | ≥25% |
| Original Baseline Estimate | ≥30% | ≥50% |

Figure 5. Nunn-McCurdy Breach Thresholds. Source: Schwartz and O’Connor (2016).

Unit costs on a life cycle basis are not subject to Nunn-McCurdy; therefore, tradeoffs can be made prior to acquisition that defer capabilities and costs into the sustainment phase of the acquisition life cycle. Additionally, systems can proceed through development that meet key performance parameters (KPP) and lower program acquisition

cost but are not the most cost-effective system over the life cycle. Lastly, systems may be selected that are, effectively, obsolete upon fielding leading the Fleet or sustainment program office to bear the brunt of funding replacements and/or upgrades in-service using O&M funding.

A shift in cost to the Fleet is perhaps the most detrimental effect of poor sustainment planning. Not only does the Navy cost increase but Operations and Maintenance, Navy (OMN) funding must be diverted from Fleet operations and maintenance requirements to either field upgraded systems or procure additional spares that were not anticipated. As Fleet operating tempo increases, this not only threatens unit operating costs but may have a very real impact to mission effectiveness.

The Navy also faces challenges with sustainment because of a lack of governance and equal standing with both development and procurement. Prior to full rate production (FRP), programs are governed by the APB. The APB is defined as “An agreement between the PM and the Milestone Decision Authority (MDA) that documents the program cost, schedule, and performance baselines, and is the fundamental binding agreement between the Milestone Decision Authority (MDA), the Component Acquisition Executive if applicable, the Program Executive Officer, and the PM.” (DAU, Glossary, 2021). The APB includes key performance parameters (KPP) and is the foundation for reporting program cost, schedule, and performance to the MDA.

While essential to acquisition execution and program viability, it is noted that the APB only applies “to less than one- third of the program’s life cycle costs” (Section 809 panel, 2019, Vol 3, p. 103). Approximately two-thirds of life cycle costs (roughly the entire sustainment phase) are not centrally governed and are, in fact, executed by multiple entities that provide solutions in a singular fashion without overarching coordination. This lack of coordinated oversight of execution increases cost.

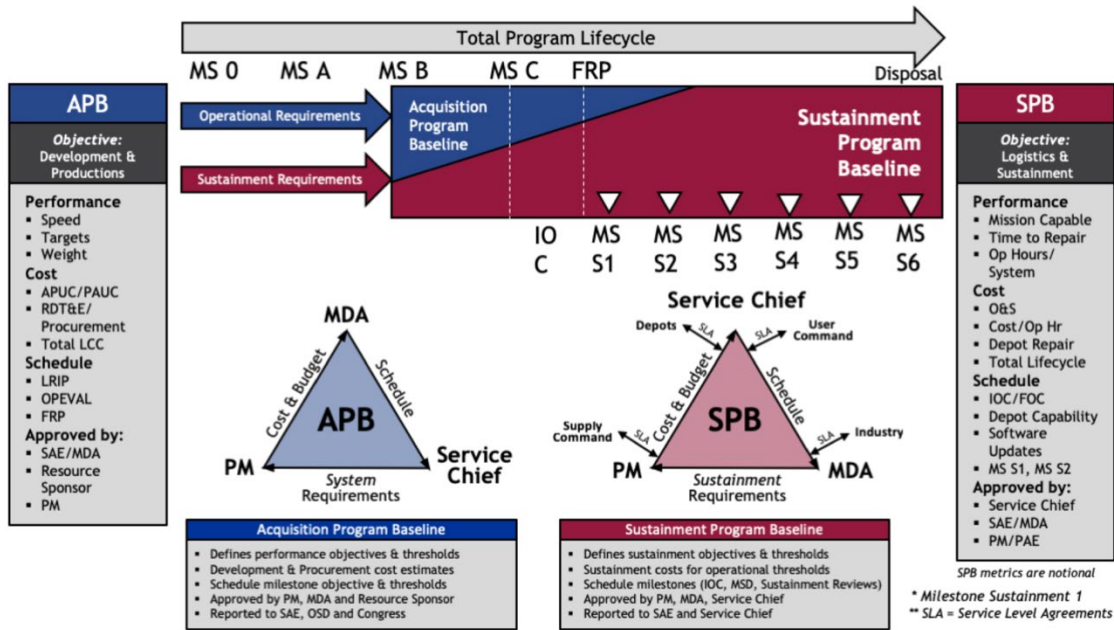


Figure 6. Sustainment Program Baseline in the Acquisition Cycle.
Source: Section 809 Panel (2019).

The Section 809 panel recommends establishment of a sustainment program baseline (SPB), as shown in Figure 6. The SPB concept is based on the acquisition program baseline that governs program execution prior to full rate production (FRP). It would drive a documented agreement between the PM and MDA who would transition from the service acquisition executive to the service sustainment executive. The PM would then be held accountable to sustainment milestones, thresholds and objectives, and costs in a similar fashion to review points (e.g., milestones and gate reviews) during ship acquisition. It is important to note that the PM would not receive all sustainment funding—for example, the Fleet would still directly receive operations and maintenance (O&M) funding—however, the PM would be responsible for aligning and balancing resources to achieve sustainment outcomes.

The SPB has unique roles pre and post milestone C (MS-C). During acquisition, the SPB would start early at concept development and formalize the requirements generated as part of the Life Cycle Sustainment Plan (LCSP). In the current process, the LCSP accounts for sustainment activities but does not necessarily budget for all of them.

The key to the Section 809 panel recommendation is the “budget and funding for all product support requirements and life cycle costs would be identified in the SPB” (Section 809 panel, 2019, Vol 3, p. 108) and the “APB and SPB would be reviewed and approved at program acquisition milestones.” (Section 809 panel, 2019, Vol 3, p. 108). This key change ensures the LCSP is not simply a required document without budget and funding identified and agreed to at all milestones. It forces the milestone discussion to not strictly focus on the acquisition unit cost and current fielding schedule.

In sustainment, the SPB takes on an even greater role. The governance provided by the SPB ensures clear PM authority and drives regular reporting. Specifically, the Section 809 panel states that the PM is authorized to govern “product support requirements, funding, and performance of the program in the sustainment system.” (Section 809 panel, 2019, Vol 3, p. 109). This authority enables the program to establish agreements with sustainment providers and the concept establishes reviews every two years through disposal. In effect, the SPB establishes regular decision points like those prior to milestone C to provide accountability and integrated decision making throughout the sustainment phase. The SPB concept strengthens the PMs position in integrating sustainment activities.

In addition to Executive Branch changes, the 809 panel examined the complexity of product support funding, as shown in Figure 7.

Figure 7 shows the numerous determinations that must be made and the complexities that are introduced after MS-C. Product support requirements are contained in the LCSP. These requirements evolve and develop between program initiation and MS C. However, full funding for the program remains the same. Milestone reviews ensure maturity and identification of products to be supported over the life cycle, but the cost focus is on the unit cost being delivered. This is important both because program funding is not increased as the LCSP matures and because product support over the life cycle is funded via a wide mix of funding types and sources. This makes it a challenge for product support managers (PSM), let alone PMs to navigate. This, specifically, is the challenge that would be solved by the SPB concept and regular sustainment milestones mentioned previously.

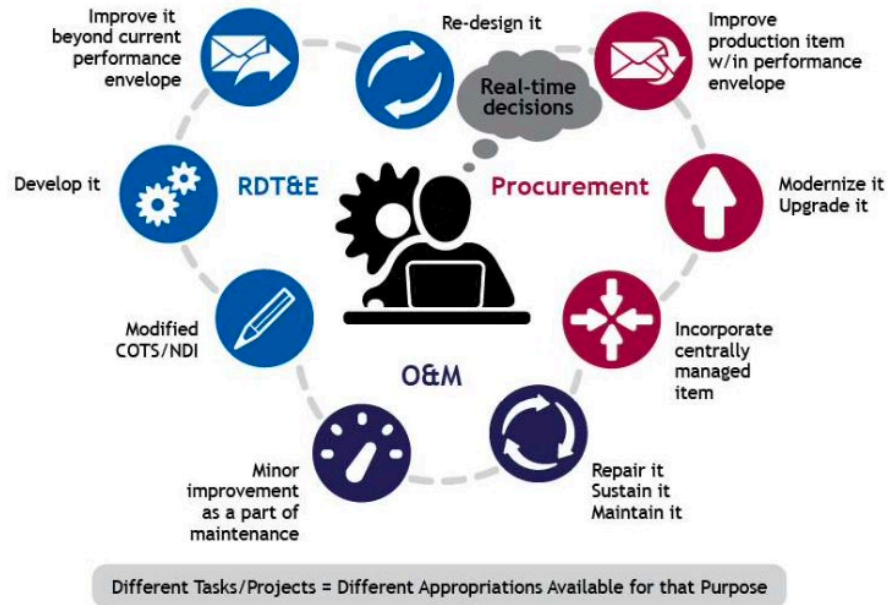


Figure 7. Complexity of Product Support Strategy Funding. Source: Section 809 Panel (2019).

As shown in Figure 8, the decision tree isn't necessarily complex, but its rigidity impacts efficiency as discrete types of funding must be planned and budgeted for to best execute the sustainment strategy. Flexibility is key and an improved ability to reprogram funds without congressional approval would provide funding flexibility. Legislative oversight is important, as is accountability; however, portfolio managers could improve execution of sustainment with added flexibilities in the Federal Management Regulation (FMR). A key recommendation of the 809 panel is to simplify the funding of sustainment activities.

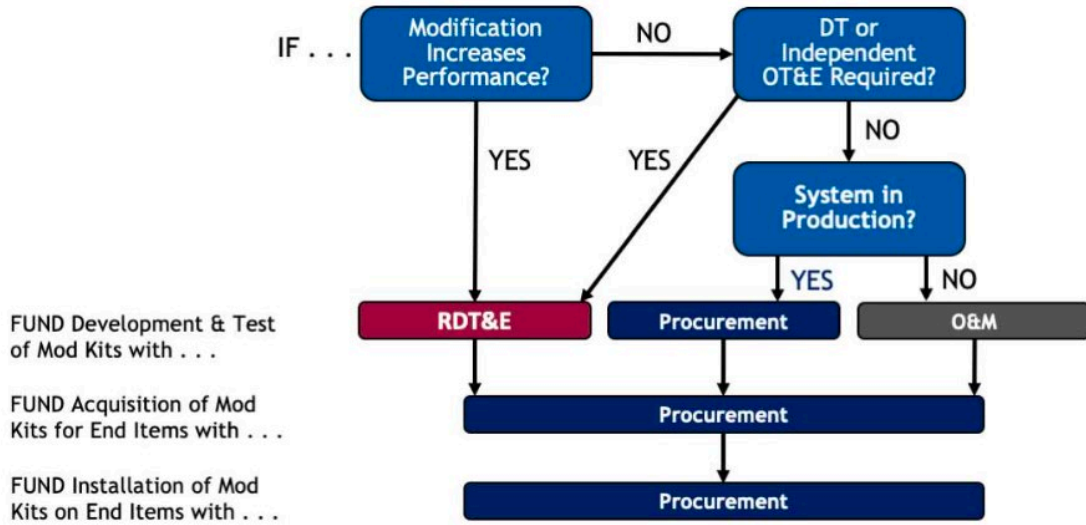


Figure 8. Current Product Improvement Funding Policy. Source: Section 809 panel (2019).

A simplified decision tree for sustainment funding would help to resolve confusion and consolidate the vast amount of sustainment accounts so they are adequately funded. When commercial off the shelf items (COTS) are available in the market, the panel recommends moving directly to procurement, even if the COTS solution requires modification. RDTE funds would only be used to develop a ground-up solution that needs to be developed because no market solution exists. This simplified flow for investments and expenses is depicted in Figure 9.

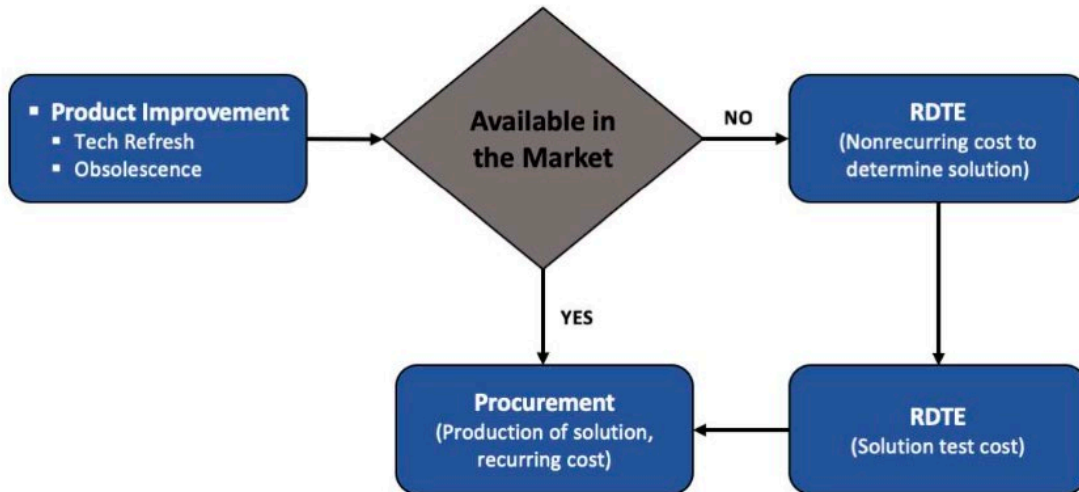


Figure 9. Proposed Product Investment Decision Tree. Source: Section 809 panel (2019).

This approach would maximize RDTE and procurement appropriations and increase separation between those accounts and operations and maintenance accounts leaving the latter to better focus on maintenance, repair, and operations. Budget flexibility to accomplish this is required. First, increased RDTE and procurement thresholds must be authorized as well as an increase in the ability for movement of funds, or reprogramming, within accounts. The Section 809 panel recommends both an increase and the ability for below threshold reprogramming (BTR) to be delegated as far down as the PEO/PM level—to the individuals with the greatest knowledge of the program to best apply resources and reduce approval time. This flow does not eliminate congressional notification but simplifies the authorities and improves response time, which is a concern as reprogramming tends to routinely occur late in the fiscal year. The proposed BTR authority flow driven by PEO/PM is shown in Figure 10.

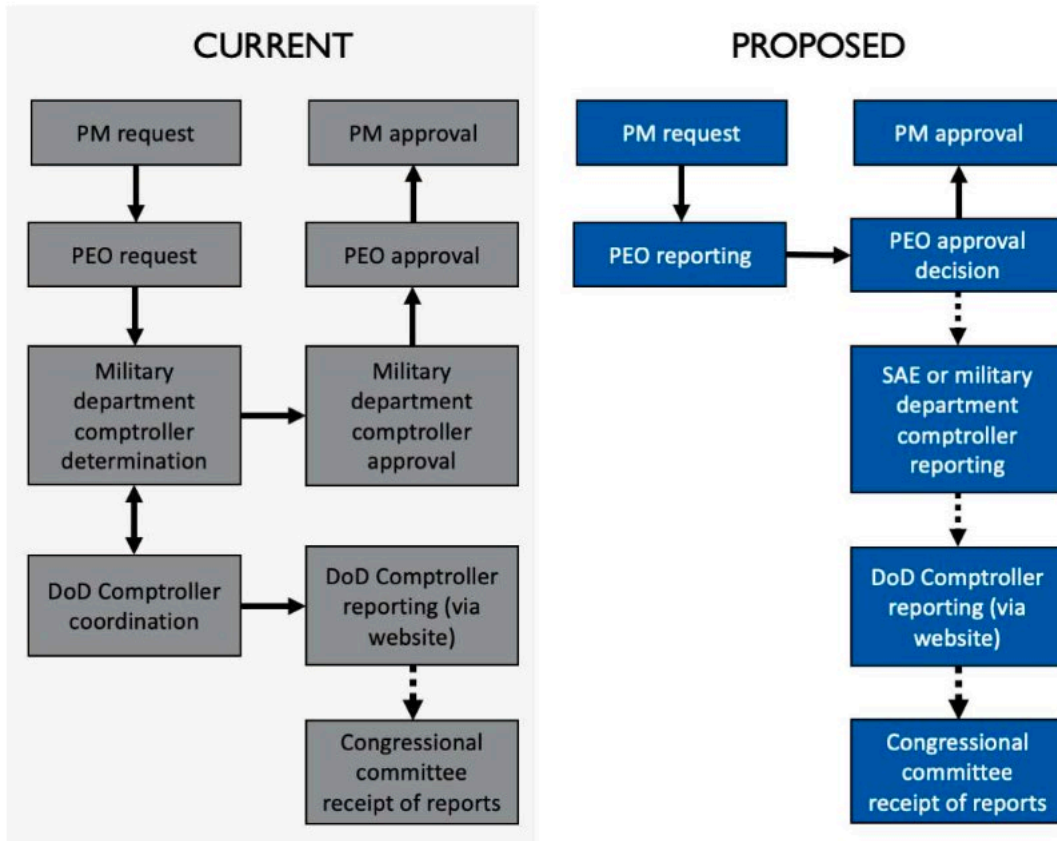


Figure 10. Current and Proposed Decision Authority Flowchart for BTR.
 Source: Section 809 panel (2019).

Ultimately, for this to occur, legislative concurrence and action must occur. This must be followed by Executive Branch action, in response. The Section 809 panel recommends that FMR rules be modified by Congress to allow reprogramming at the portfolio level. Subsequently, the Navy must allow PMs to perform BTRs where equal offsets are identified within the same portfolio. These improvements would increase flexibility and drive down the number of decisions made simply to execute funding to meet benchmarks that are not necessarily in the best sustainment interests of the program.

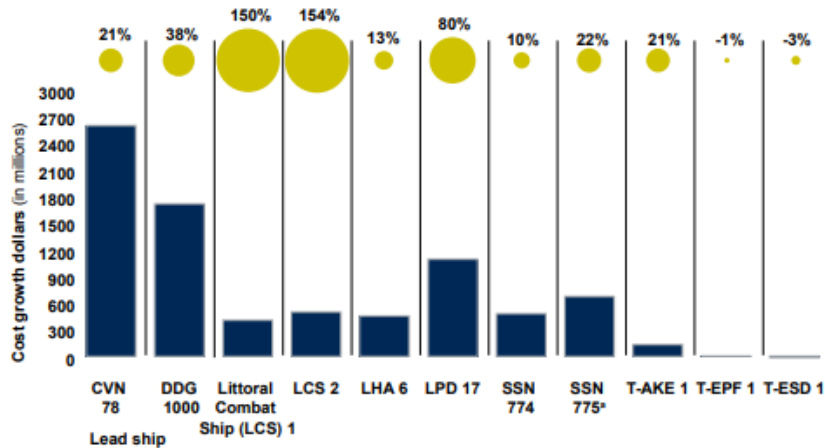
To summarize our analysis, the SPB provides the needed governance over life cycle decisions and helps to drive accountability regarding the balancing of requirements over the life cycle. It's equivalence to the APB ensures a sustainment review of acquisition decisions and could provide a check on the lowest cost acquisition decision if legislation

also changes to incentivize life cycle cost over unit procurement cost. Additionally, budget flexibility granted via legislative and, subsequently, Executive Branch change is important to improve the ability for PMs to quickly adjust to the environment.

In order to apply these recommendations and analyze their impact on Navy ships specifically, it is important to gain a better perspective on the issues with both acquisition and sustainment of the current Fleet. The following section attempts gain this perspective by examining the Navy Shipbuilding GAO reports from 2018 and 2020 (Oakley, 2018 and Oakley, 2020).

Of the two GAO reports being examined, the 2018 report focused on shipbuilding and the 2020 report focused on sustainment. While the largest portion of costs are realized in the sustainment phase, it is worthwhile to analyze the shipbuilding process and its contribution to both TOC up to delivery as well as impacts to sustainment.

The shipbuilding findings observed that ships cost more than estimated upon delivery and examined the causes for such overruns. This is true of first-in-class ships and follow-on ships. (See Figure 11 and Figure 12.) While it might be expected that first-in-class ships would cost slightly more as extensive verification and validation testing of all integrated systems may be more risk on the first full delivery, it does not follow that many of the risks and issues would still be delivered with follow-on ships. For the 11 ship classes examined, the Navy paid over \$11 billion more than budgeted upon delivery (Oakley, 2018). This indicates a more systemic issue, as costs were not driven down with successive deliveries as might be expected.

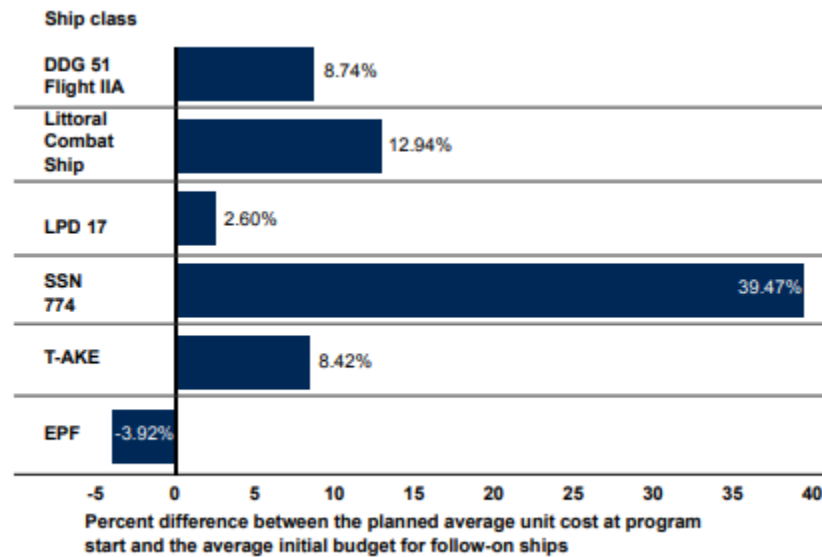


*SSN 775 is the second Virginia class submarine, but was the first hull delivered by Newport News shipyard. SSN 774, the lead ship of the class, was delivered by Electric Boat shipyard.

Source: GAO analysis of Navy documentation. | GAO-18-238SP

NOTE: Cost growth is measured as the difference between the initial cost estimate reflected in the Navy's budget request documents prior to ship construction (year in which the Navy requested authorization for the ship from Congress) and the cost estimate reflected in the Navy's fiscal year 2018 budget request documents or the actual cost. All cost estimates and cost growth calculations are in fiscal year 2018 dollars.

Figure 11. Cost Growth of First-in-Class. Source: Oakley (2018).



Source: GAO analysis of Navy documentation. | GAO-18-238SP

Figure 12. Cost Growth of Follow-on Ships. Source: Oakley (2018).

One of the causes for such cost increases was the concurrency of technology development, ship design, and ship construction phases—meaning technology was still maturing even as the ships were being designed and built (Oakley, 2018). This introduces

uncertainty and risk to the process. In addition, the report indicates unrealistic expectations and budgets built off such uncertainties also result in budgets and cost estimates that are much lower than needed. Additional analysis also saw the Navy taking on much of the cost risk during the ship construction phase. Figure 13 shows clearly how much overlap there is in between technology development, design, and construction during shipbuilding. Anywhere there is overlap in the phases, is an area of increasing risk. In Figure 13, it is also clearly shown that construction occurs even while the technology is still being matured.

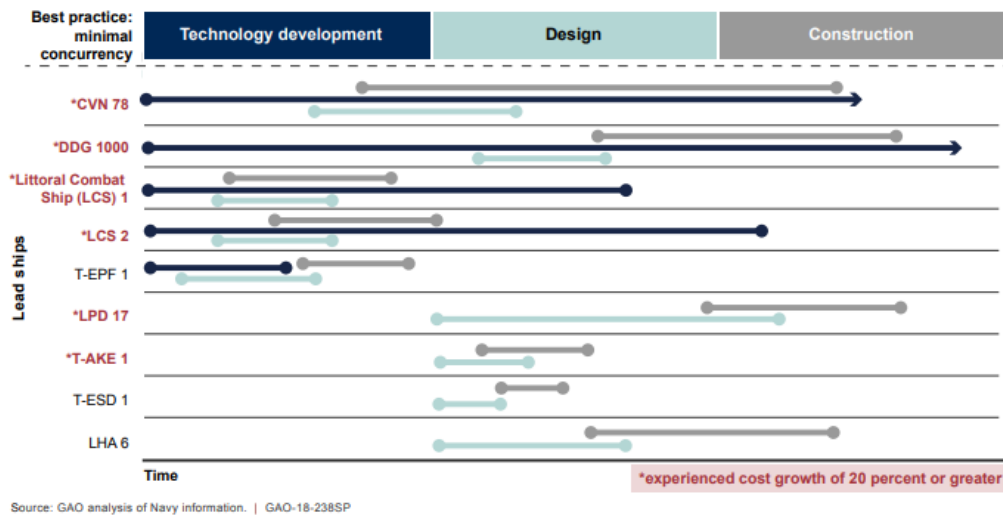


Figure 13. Technology Development and Production Concurrency.
Source: Oakley (2018).

While these are key causes for cost overruns for ships at delivery, there was one additional finding that had significant implications for sustainment. The Navy also appears to be accepting incomplete ships. Ships delivered with numerous deficiencies are difficult and costly to sustain. This is exacerbated by the reduction of test procedures, inspections, and test requirements often experienced as ships approach the obligation and work limiting date (OWLD) and budget and schedule pressures increase.

It follows that the GAO also found the Navy lacking in our ability to assess sustainment cost growth and that many ships are delivered with degraded capabilities and

deficiencies. (See Figure 14). As long as the requirements are not there, ships will continue to be delivered with sustainment issues even as they officially meet the established operational availability threshold.

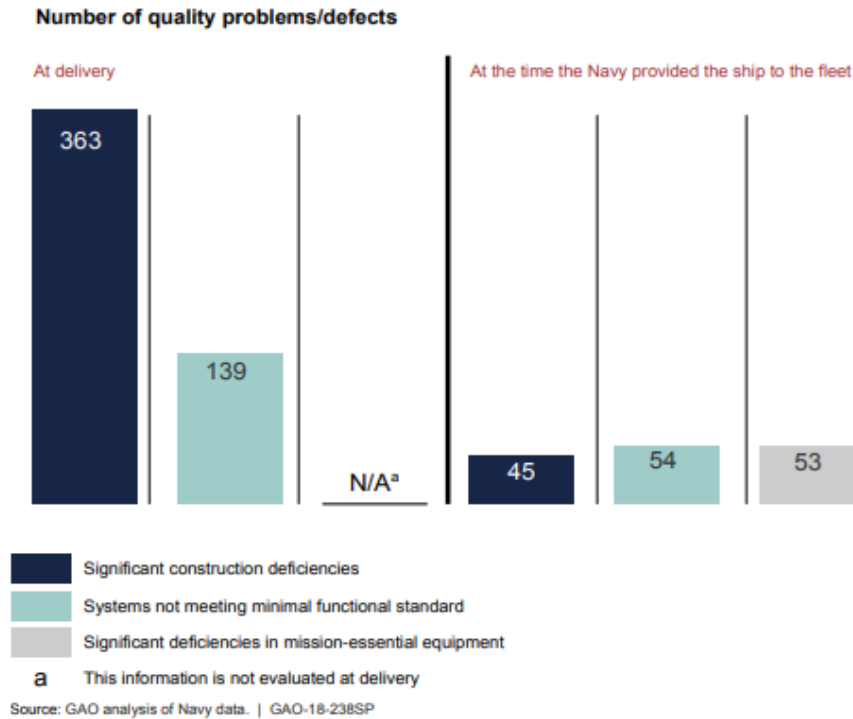


Figure 14. Deficiencies upon Delivery. Source: Oakley (2018).

Ultimately, these findings from the 2018 GAO Navy Shipbuilding Report focus upon delivery of ships. Whether it's risk in the concurrency of technology development, design and construction, and production, the process of defining requirements tied to sustainment, or the deficiencies the Navy received along with the ship, all were apparent upon receipt. And similar to how the Acquisition Baseline covers only a third of the TOC of a ship or system, further insights are needed to delve into the life cycle sustainment impacts and issues that a class may experience across its service life.

Two years after the initial GAO report, a follow-on report was released to do just that. The report, titled *Navy Shipbuilding: Increasing Focus on Sustainment Early in Acquisition Process Could Save Billions*, delves deeper into the full sustainment costs and

how early acquisition decisions have impacted not just delivery, but costs across the entire life cycle (Oakley, 2020).

This subsequent GAO report released in 2020 found that sustainment requirements and metrics established early in the acquisition process did not end up reflecting the state of the ships after delivery. Because operational availability was dependent only on the presence of category 4 casualty reports (CASREPS), many ships were meeting the defined operational requirement, when in fact they were not able to perform mission critical capabilities. Essentially, the requirements that acquisition managers are held to do not lead to optimal sustainment decisions.

Other reasons for the cost growth and misalignment between estimated O&S costs and actual costs included lack of accounting for the sustainment risks, and lack of sustainment information used to inform acquisition decisions. The GAO 2020 report general found that there were not requirements, incentives, or general practices for sustainment considerations to influence the acquisition process (Oakley, 2020). And the main avenue available, the requirement development process, was not able to adequately capture the impacts of acquisitions decisions on operations and sustainment accounts.. Combined with the knowledge that the APB truly only accounts for a third of the costs across the life cycle of the ship but is a critical document that guides the acquisitions of ships, systemic cost growths and significant re-work in the operations and sustainment of our ships is not surprising.

Essentially, the report found that sustainment considerations and how the Navy manages how assumptions, risks, and other acquisition decisions impact sustainment are underdeveloped. How they are captured, managed, and communicated as well as understanding how decisions early in the acquisition process impact sustainment, all are areas that require improvement to curb the growing costs, deficiencies upon delivery, and maintenance burdens being realized by the Fleet. As one footnote regarding the O&S cost estimates for a ship class compared to actuals states, “Due to Navy O&S budgeting and program processes, we could not calculate the total difference between these estimates and actual costs, and we were told by several Navy officials that such a comparison would be

impossible.” (Oakley, 2020, pp. 67). There are fundamental tools and processes lacking to be able to capture the data and build a full understanding of the cost growth.

Additionally, GAO also found that product support managers (PSM) are not involved early enough in the shipbuilding process. It was only as recently as 2019 that PSMs should be appointed by Milestone B, which is still relatively late to affect sustainment requirements (Oakley, 2020). Finally, GAO acknowledged the tension between PSM and sustainment considerations and cost/schedule drivers in the acquisition process. Often the sustainment priorities are found to be at odds with the acquisition managers cost and schedule goals. The emphasis on cost and schedule in the acquisition process can be seen from the historical gate review process and the command structure within the DON where sustainment is subordinate to acquisition. Exacerbating the issue of sustainment is that the system inherently incentivizes only acquisition until delivery to the Fleet. Therefore, any sustainment improvements that would impact cost and schedule are deferred until after delivery so as not to impact the acquisition baseline. The result of the current structure, based on the GAO’s findings, are gross cost and capability impacts past-delivery and throughout the life cycle of the ships.

B. ANALYSIS AND COMPARISON OF SECTION 809 AND GAO REPORTS

In combination, the Section 809 Panel, the GAO 2018 report, and the GAO 2020 reports all have similar messaging regarding TOC for ships and potential paths forward.

The Section 809 panel report provides broad acquisition and sustainment reform recommendations that apply across the Department of Defense (DOD) that apply to Department of Navy, specifically, given the context of the GAO reports that focus on acquisition and sustainment challenges the Navy has faced with respect to shipbuilding. Though the Section 809 panel report is broad, the Navy can apply these changes (or should press the DOD to apply and codify recommendations in guidance to allow the Navy to leverage improvements that would result). The Navy should also provide codified guidance to empower program managers and integrate acquisition with sustainment. Establishing an SPB and regular sustainment milestones would help to improve Navy ship sustainment throughout their life cycle.

Whether it is DOD, DON, or Navy shipbuilding specifically, the data shows there are systemic issues influencing how the Navy manages TOC and the influence sustainment considerations have in the early acquisition process. Recommendations from all parties center around the dynamic between how pre-delivery decision affect post-delivery costs.

IV. FINDINGS / RESULTS

A. PRIMARY FINDINGS

The major behaviors in acquisition that lead to increased sustainment cost are programmatic focus on average unit procurement cost for program approval and proper sustainment cost planning for Navy ship acquisition.

The main way to influence these behaviors is through the establishment of a Sustainment Program Baseline (SPB) that has equal standing with and accountability of the Acquisition Program Baseline. The SPB will help place sustainment and resulting total ownership cost on equal footing and standing with the Acquisition Program Baseline when it comes to MDAP program governance. Implementation of the sustainment role within the Navy should be done in a way that is organizationally equal to the role of acquisition. Without organizational equivalence, there is an inherent underemphasis on the SPB and its goals. It is not enough to establish a position, as the Navy has done. The Department of Defense has established an Undersecretary for Acquisition & Sustainment. This position is responsible for Acquisition and Sustainment equally, and names matter. The current structure where the Deputy Assistant Secretary of the Navy for Sustainment reports to the Assistant Secretary of the Navy for Research, Development, and Acquisition maintains a secondary, advisory nature of sustainment as related to acquisition.

Sustainment is the largest component to TOC and programs measured by average unit procurement cost alone, while important, places the focus on procuring affordable units that are often not sustainable from a cost perspective over the ship life cycle. Acquisition decisions made solely by the APB drive the Navy to cut costs and make tradeoffs that negatively impact long-term O&S costs and defer logistics impacts to the warfighter once fielded. It is vitally important to deliver the warfighter the key performance parameters they desire; however, a product that delivers warfighting capability with increasing operating and maintenance costs becomes unaffordable, not solely from those direct costs but from the costs of incremental modernization performed to overcome obsolescence or other maintenance and logistics issues that cause pain for the warfighter.

In this era of flat and slightly declining budgets it is critical to make acquisition decisions that consider the long-term affordability, and therefore, viability of fielded systems. The Navy cannot continue to field new ships without correcting this behavior.

Findings from the GAO reports were very similar. While there are some circumstances specific to shipbuilding, they should not prohibit proper sustainment planning from being implemented. While shipbuilding is somewhat unique in that there is likely no way to avoid having the technology development/maturation and construction be done concurrently, the amount of emphasis placed on pre-delivery versus post-delivery is disproportionate to the impacts each phase has on the TOC for the life of the ship. The GAO data clearly indicates sustainment planning and the influence of TOC on acquisition decisions is disconnected, which leads to cost growth not only upon delivery, but also in subsequent O&S costs in the out years. The magnitude of such growth warrants implementing reforms. Findings regarding how Sustainment requirements are set, how risk is accounted for, and how many deficiencies are passed on to the Fleet to correct after delivery are all symptoms of the disconnect between acquisition and sustainment.

Outside of the governance challenge previously highlighted, there are many external factors that lead to increased sustainment cost. Primarily, we found that the lack of flexibility in reprogramming hinders the ability for portfolio managers to rapidly adjust to changing environments. The Navy must appeal to Congress to allow it the increased flexibility to address sustainment challenges when they occur, where they occur without prior justification to Congress. This does not remove congressional oversight nor increase cost but allows more rapid adjustment than the current planning, programming, budgeting, and execution (PPBE) process allows. When successful in driving legislative change, the Navy must trust and delegate to the lowest level (PEO/PM). This improves efficiency and drives down cost by applying funds where they are needed when they are needed within the overall authorizations and appropriations made by Congress.

V. CONCLUSIONS, RECOMMENDATIONS, SUMMARY, AND AREAS FOR FURTHER RESEARCH

A. CONCLUSIONS

When combined, the findings from the Section 809 panel report and the GAO reports are very similar. While the Section 809 panel encompassed recommendations for all of DOD, and the GAO focused more on shipbuilding, the conclusions regarding TOC trends, needs, and recommendations are strikingly direct. The conflict inherent in the acquisition process with respect to sustainment cost planning requires tools, processes, and structure that will allow for the better prioritization of TOC and sustainment when PM and program offices are making acquisition decisions.

The sustainment-based recommendations of the Section 809 panel report would improve Navy ship sustainment significantly. The greatest impact is with respect to governance. A SPB with equal standing to the APB would improve accountability of the program manager by implementing a formal decision point that is focused on the sustainment of Navy ships as opposed to the current process. The life cycle sustainment plan (LCSP) is briefed, as required, to the MDA as part of the acquisition process; however, the APB is focused on unit cost and held to caps based on Nunn-McCurdy. While this is important, it can lead to a short-term vice long term focus. The sustainment program baseline would also help product support managers (PSM) to better integrate the myriad of tasks and competing priorities in sustainment. The Navy has adopted the sustainment role; however, it is advisory in nature.

The Section 809 panel report also discussed increased budgetary flexibilities, specifically with respect to reprogramming. We find those flexibilities to be critical in allowing better efficiency in management of Navy ship portfolios. We recommend that the Navy and DOD advocate for this legislative change. This flexibility would allow the Navy to apply funds to sustainment challenges directly within program budget without the need to specifically request authorization from Congress. It should be noted this has no impact to congressional oversight as reprogramming would still be reported to Congress and the

legislative branch may, at any point, request additional justification or rationale for, or block, the reprogramming of funds.

Key findings from the GAO reports include the large amount of concurrency in technology maturation, design, and construction as well as the lack understanding in how decisions early in acquisition affect TOC and lack of processes in place to evaluate TOC. The consequences of choosing concurrency, or deciding to delay an improvement, or measure “readiness” in a specific manner are so far delayed, and so difficult to trace, that the GAO may only evaluate them in aggregate. This further reinforces the conclusion that Navy shipbuilding can improve in long-term sustainment planning and cost estimating. This further reinforces the conclusion that Navy shipbuilding can improve long-term sustainment planning and cost estimating.

The references studied in this paper bring no surprises, but perhaps some solutions. Considering TOC impacts early in the acquisition process, increased awareness and accountability for risks taken and realized, better ways to analyze and quantify TOC and measure how a ship or class is truly performing for greater accountability will all help move us towards a more sustainable Navy.

B. SUMMARY

Overall, there is general recognition by the community that acquisition and sustainment are challenging to balance. Recent indications from the Section 809 Panel and both GAO reports show that a closer look at how acquisition impacts sustainment and TOC should be taken. The Section 809 panel and GAO recommendations regarding sustainment costs as part of TOC both emphasized a greater need for the latter stages of the life cycle to influence the preceding ones. For example, the recommendations from the Section 809 Panel regarding the SPB with equal standing to the APB and the GAO report findings tracing cost growth post-delivery to pre-delivery decisions mark a shift in recent discourses across the community to the sustainment part of TOC. Enacting the SPB would also provide governance and accountability and regularly establish milestones in the sustainment phase.

Primary contributing factors to increased sustainment costs include the large amount of concurrency in technology development, design, and construction combined with lack of emphasis on the impacts to TOC early acquisitions decisions may have down the line, and lack of advocacy for TOC considerations early in the acquisition process as well. While the factors that have contributed to increasing TOCs for many of the recently procured and delivered ships classes have been recognized, reforms such as those recommend by the Section 809 Panel are needed to have lasting and impactful change. Ships will always need to overlap technology development, design, and construction, but understanding of the risks involved and the ability of the acquisition professionals to manage TOC early in the process can make a significant difference. The caveat is that the tools, processes, and framework need to be in place to support them. Because the Section 809 Panel findings closely aligned with the GAO reports, many of the recommendations would be effective in controlling TOC costs and assisting with TOC management throughout the shipbuilding process.

With regard to external influences, additional budget flexibility is key. For the Navy to gain additional flexibility and efficiencies they should advocate for legislative branch changes to reprogramming authority. Specifically, the Navy should request Congress grant the ability to increase BTR thresholds and allow for reprogramming at all thresholds with Congressional notification. This external flexibility will allow the Navy to apply funds across Navy ship classes directly to sustainment challenges as they manage Navy ship programs as a portfolio.

C. RECOMMENDATIONS

After review of the Section 809 panel and GAO reports, we recommend that the DON modify the current structure to establish an Assistant Secretary for Research and Development and a separate Assistant Secretary for Acquisition & Sustainment, as the latter demands accountability for both elements and does not imply precedence to acquisition alone. Alternatively, the Navy could maintain the current Assistant Secretary of the Navy for Research, Development, and Acquisition but elevate the sustainment position to Assistant Secretary of the Navy for Sustainment. Either option would make

sustainment equivalent and not secondary to acquisition. We recommend the former option as this drives a single point of accountability for both acquisition and sustainment and has the best opportunity to drive program manager accountability for total life cycle costs (TLCC). This organizational equivalence is important especially when transitioning from the current two-step, seven gate process. The sustainment position should not simply advise the acquisition lead with no discrete authority. We also recommend the DON implement the SPB as soon as practical to provide biannual portfolio review and decisions regarding appropriate sustainment requirements. The combination of these recommendations would provide equal decision-making authority with respect to sustainment. Any less will still cause sustainment to continue to take a secondary position to acquisition that negatively impacts Navy ships over their total life cycle.

D. AREAS FOR FURTHER RESEARCH

The *Report of the Advisory Panel on Streamlining and Codifying Acquisition Regulations* (Section 809 panel, 2019) provides many recommendations that impact sustainment of Navy ships. While we examined the main sustainment recommendations related to portfolio management and below threshold reprogramming budget recommendations, we recommend further research regarding the Section 809 panel budget recommendations and their impact on sustainment.

Additionally, modernization outside of mid-life upgrades is a method of sustaining Navy ships over their life cycle. Additional capability aside, an examination of a more structured, streamlined, programmatic approach to incremental modernization in sustainment could be considered.

We also suggest research regarding how acquisition incentives such as unit cost drive program managers and decision makers to make trade-offs that negatively impact the long term to ensure program success over the short-term.

Finally, while there are many published works such as that of Boudreau and Naegle's paper on TOC that discuss weapons system acquisition in depth, further research on the specific ship classes previously investigated by the GAO and even new ones such as guided missile frigate (FFG) 62 could be used to build upon the growing body of work

related to Navy ships specifically. While many concepts translate well to ships and other programs, any nuances involved with Navy shipbuilding and systemic issues and paradigms unique to the Navy may lead to new paths as well.

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