NPS-AM-26-060

ACQUISITION RESEARCH PROGRAM SPONSORED REPORT SERIES

Constellation: A Case Study of the Effective Use of the Triple Constraint Model & Understanding Cognitive Biases for Navy Acquisition Management

December 2025

CPT Stephen A. West, USA
LT Marshall X. Grimm, USN
CPT Marcienne A. Anderson, USA

Thesis Advisors: Dr. Robert F. Mortlock, Professor
Jeffrey R. Dunlap, Lecturer

Department of Acquisition, Finance and Manpower

Naval Postgraduate School

Prepared for the Naval Postgraduate School, Monterey, CA 93943.

The research presented in this report was supported by the Acquisition Research Program of the Department of Acquisition, Finance and Manpower at the Naval Postgraduate School.

To request defense acquisition research, to become a research sponsor, or to print additional copies of reports, please contact the Acquisition Research Program (ARP) via email, arp@nps.edu or at 831-656-3793.

ABSTRACT

The triple constraint model is a tool to help program managers and decision makers understand tradeoffs between schedule, cost, and performance during Department of Defense acquisitions. Given the cost and schedule slippages, and scope drift during several Acquisition Category (ACAT) 1 shipbuilding programs, it is important to understand whether these Major Defense Acquisition Programs (MDAPs) effectively use the triple constraint model, the cognitive biases present in the application of this model, and how this model could have been enhanced during these acquisitions. This study examines the Constellation-class frigate program, its implementation of the triple constraint model, and any cognitive biases that prevented the delivery of the frigate on time and at a fair and reasonable cost. Using case study analysis and deductive content analysis, the study investigates GAO reports and Congressional Research Service reports to determine the use of the triple constraint model and cognitive biases within the Constellation-class frigate program. The analysis finds evidence of six cognitive biases within the Constellation-class frigate program. These include the anchoring, availability, planning fallacy uniqueness, overconfidence, and optimism biases. The authors suggest using a modified triple constraint model, education programs for program managers, extending program managers' formal networks, and including commercial project management methodologies within MDAPs.

THIS PAGE INTENTIONALLY LEFT BLANK

ACKNOWLEDGMENTS

We would like to express our deepest gratitude to the professors and mentors in the Defense Program Management program at the Naval Postgraduate School. Their expertise, guidance, and unwavering support have been invaluable throughout our research and thesis development. We would like to thank Dr. Robert F. Mortlock, Professor Jeffrey R. Dunlap, Professor Keith A. Hirschman, and Professor Kelley Poree for their dedication to our academic growth and their insightful feedback, which greatly enhanced the quality of our work.

Additionally, we are profoundly grateful to our families for their love, patience, and understanding during our studies. Their support has been a constant source of strength and encouragement, allowing us to balance the demands of this graduate program with the importance of family. To our loved ones, we extend our heartfelt thanks for their sacrifices and unwavering belief in us.

This thesis is the result of collaborative effort, and we would like to acknowledge each other's contributions. It has been an honor to work together, and this accomplishment reflects our shared commitment to the field of Defense Program Management and the Department of Defense.

THIS PAGE INTENTIONALLY LEFT BLANK

NPS-AM-26-060

ACQUISITION RESEARCH PROGRAM SPONSORED REPORT SERIES

Constellation: A Case Study of the Effective Use of the Triple Constraint Model & Understanding Cognitive Biases for Navy Acquisition Management

December 2025

CPT Stephen A. West, USA

LT Marshall X. Grimm, USN

CPT Marcienne A. Anderson, USA

Thesis Advisors: Dr. Robert F. Mortlock, Professor
Jeffrey R. Dunlap, Lecturer

Department of Acquisition, Finance and Manpower

Naval Postgraduate School

Prepared for the Naval Postgraduate School, Monterey, CA 93943.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

LIST OF FIGURES

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

ACAT	Acquisition Category
AOR	Area of Responsibility
ASW	Antisubmarine Warfare
CVN	Aircraft Carrier Nuclear
CBO	Congressional Budget Office
CDRL	Contract Data Requirements List
CRS	Congressional Research Service
DAU	Defense Acquisition University
DDG(X)	Next Generation Guided Missile Destroyer
DoD	Department of Defense
EMALS	Electromagnetic Aircraft Launch System
FREMM	Fregata Europea Multi-Missione
FY	Fiscal Year
GAO	Government Accountability Office
GWOT	Global War on Terror
HII	Huntington Ingalls Industries
ICD	Initial Capabilities Document
LCS	Littoral Combat Ship
MARAD	Maritime Administration
MDAP	Major Defense Acquisition Programs
MM	Mission Module
MP	Mission Package
NAVSEA	Naval Sea Systems Command
NDAA	National Defense Authorization Act
OECD	Organisation of Economic Co-operation and Development
OPNAV N9	Director, Warfighting Assessment and Readiness (US Navy)
PACOM	Pacific Command
PEO	Program Executive Office
PMP	Project Management Professional
PgPM	Program Management Professional

PfPM	Portfolio Management Certification
PoR	Program of Record
RAT	Resource Advantage Theory
RBV	Resource-Based View
RCA	Root Cause Analysis
RDT	Resource Dependency Theory
ROI	Return On Investment
SUW	Surface Warfare
TRIJECT	Triple Constraint/Project Management
TOC	Theory of Constraint
USC	Unmanned and Small Combatants
VTC	Value Triple Constraint

EXECUTIVE SUMMARY

This thesis explores the application of the triple constraint model in the Department of Defense (DoD) acquisition process, focusing on the Constellation-class frigate program, and examines the cognitive biases that influence decision-making in large-scale naval acquisitions. The triple constraint model, comprising cost, schedule, and performance, is a central tool for program managers to balance trade-offs in complex projects. In the context of DoD acquisitions, especially major defense acquisition programs (MDAPs), these constraints are crucial for ensuring that projects meet their strategic goals while staying within budget and on schedule. Previous shipbuilding programs have frequently encountered cost overruns, schedule delays, and performance issues, raising the importance of understanding the interplay between these constraints and the impact of cognitive biases in decision-making.

The study's central aim is to assess how well the Constellation-class frigate program has applied the triple constraint model, the cognitive biases involved, and how these biases may have hindered the timely and cost-effective delivery of the frigates that meet the warfighting performance requirements. The research is based on case study analysis, drawing from publicly available sources such as Government Accountability Office (GAO) reports and Congressional Research Service (CRS) studies.

U.S. Navy shipbuilding has faced persistent challenges, including schedule delays and cost overruns in several recent programs like the Littoral Combat Ship (LCS), the Zumwalt-class destroyers, and the Ford-class aircraft carriers. These programs have experienced significant issues integrating new technologies, maintaining schedules, and controlling costs. The Constellation-class frigate program, designed to meet specific naval needs while being more affordable than destroyers, has been delayed by design changes, skilled labor shortages, and other unforeseen factors. Despite starting with a proven foreign design, Fregata Europea Multi-Missione (FREMM), the U.S. Navy's modifications to this design have led to delays and increased costs, with expectations for the lead ship's delivery now set for 2029, three years behind schedule.

The research methodology used for this study includes deductive case study analysis, or directed content analysis, and examination of decision-making biases impacting the program. This study also emphasizes the significance of applying cognitive bias awareness to improve acquisition decision-making and the use of the triple constraint model in future shipbuilding programs.

The study highlights several cognitive biases in the management of defense acquisitions. Optimism bias, planning fallacy, availability bias, anchoring, overconfidence, and uniqueness bias have been particularly influential in the Constellation-class frigate program. Program managers overestimated the feasibility of adapting the FREMM design without encountering significant delays or cost increases. Overconfidence in the ability to manage these challenges, despite incomplete designs, further compounded the delays. Moreover, uniqueness bias led decision makers to view the Constellation program as distinct from past shipbuilding failures, which resulted in insufficient risk management.

The findings underscore the importance of balancing the triple constraints in a realistic manner, considering not just the technical aspects but also the psychological factors influencing decision-makers. Addressing cognitive biases can help mitigate schedule slippages, cost overruns, and performance shortcomings. This study provides a foundation for improving future defense acquisitions and strategic shipbuilding decisions within the U.S. Navy.

I. INTRODUCTION

U.S. Naval shipbuilding has faced challenges surrounding the foundational cornerstones of program management: cost, schedule, and performance for the past twenty-five years (Oakley, 2025). These barriers have created tension between the U.S. Navy and Congress. Both entities have failed to understand why many new classes of ships constructed have faced budget overruns and schedule delays. These delays result in mission-critical platforms being delivered past their intended timeline, causing further difficulties with contract management and asset delivery to the Navy. The Navy needs new ships to deter rising threats and maintain U.S. strategic interests worldwide. This capstone project report aims to determine how Navy program managers structure their decision-making through the lens of the triple constraint model and how cognitive biases influence decision-making as they manage these persistent issues within the defense industrial base and the Navy.

The U.S. Navy faces an increasingly complex, diverse, and overwhelming strategic outlook, including the looming threat of an expanding Chinese naval power, broad geographic strategic deterrence responsibilities, a turbulent Middle East, and novel operations within the Arctic Ocean. These challenges are exacerbated due to eroded shipbuilding capacity within the U.S., reducing sea-power advantages over adversaries (Oakley, 2025). The U.S. Navy has maintained a global presence due to its ability to project sea-power when and where it pleases. Power projection is becoming more challenging as the fleet shrinks with a growing list of aged and decommissioned ships, while replacement ships are years behind schedule and over budget (Oakley, 2025).

Understanding how program managers operate when their project undergoes a shift in priorities to include cost, schedule, and performance and when their project's scope is adrift with new global contingencies is critical to correcting the shortfalls within U.S. shipbuilding.

A. PROBLEM STATEMENT

The triple constraint model is a tool to help program managers and decision-makers understand tradeoffs between schedule, cost, and performance during Department of Defense (DoD) acquisitions. Industry has enhanced this model through the inclusion of other important constraints. Given the cost and schedule slippages and scope creep during several Acquisition Category (ACAT) 1 shipbuilding programs, it is important to understand whether these Major Defense Acquisition Programs (MDAP) effectively used the triple constraint model, the cognitive biases present in the application of this model, and how this model could have been enhanced decision making during these acquisitions. Specifically, given the design immaturity of the Constellation-class frigate, did the Navy effectively implement the triple constraint model to deliver the frigate's capabilities on time and at a fair and reasonable cost and was there evidence of cognitive biases in Navy's decision making with respect to the program's triple constraints?

B. RESEARCH LIMITATIONS AND ASSUMPTIONS

This study focuses on the Constellation-class frigate acquisition program within the confines of decision-making biases and the triple constraint model. Prior shipbuilding programs are used for background reference and comparison. Although important to the success of a program, environmental and contextual factors that may impact the program will not be examined. This study is concerned with individual decision-making processes that may impact the program within the context of the triple constraint model. Due to the project's scope, conclusions and recommendations will be limited to the decision-making processes in shipbuilding programs rather than broad program-wide recommendations.

Research into the Constellation-class acquisition program was limited to publicly accessible documentation, Government Accountability Office (GAO) reports and Congressional Research Service (CRS) reports. The research team was limited to unclassified information to maintain the classification level of this research at the unclassified level with unlimited distribution. Additionally, the research team included credible non-government source documents (e.g., research articles) to inform the background of the U.S. Navy shipbuilding programs, U.S. shipbuilding industrial base, triple constraint research, and biases that impact program manager decision-making.

C. METHODOLOGY

The present study utilizes case study directed content analysis to examine the triple constraint model and cognitive biases in defense acquisition programs. Case study research can be used to set foundational understanding necessary for future research (Stake, 2005). In selecting a case, consideration should be given concerning the suitability and representativeness of the case. The Constellation-class frigate provides insight into defense acquisitions due to the recency and scale of the program. Additionally, given continuing shifts to the triple constraint model of cost, schedule, the Constellation-class frigate program provides framework to understand interactions between the triple constraint model and cognitive biases. Directed content analysis uses a priori use of theory to analyze qualitative data. The present study used the triple constraint model and past cognitive bias research to guide content analysis of GAO and CRS reports. Potential findings from the directed content analysis can provide a foundation to further explore the triple constraint model and cognitive biases within defense acquisition programs.

D. SUMMARY

This case study explores how U.S. Navy program managers apply the triple constraint model in managing shipbuilding projects, particularly in the Constellation-class frigate acquisition program. It examines how cognitive biases influence decision-making in the face of shifting priorities. Through case study analysis as the research methodology, the study aims to provide insights that could help resolve the challenges in U.S. shipbuilding, focusing on improving acquisition management practices and enhancing future outcomes to address rising global threats, particularly from China, and maintain U.S. strategic interests.

The background chapter focuses on the Constellation-class Frigate and other shipbuilding programs, providing background on classes such as the Littoral Combat Ship (LCS 1), Ford-Class Aircraft Carrier (CVN-78), and Zumwalt-class Destroyer (DDG 1000). The literature review dives into the triple constraint model highlighting its evolution and application in project management, as well as exploring behavioral biases that affect decision-making in defense acquisitions. The analysis chapter examines how these biases influence naval shipbuilding decisions and impact program outcomes. The document concludes by offering recommendations to improve acquisition practices and addressing the superficial application of the triple constraint model, while proposing areas for further research to enhance understanding and decision-making in defense acquisitions.

II. BACKGROUND

Over the last twenty years, U.S. Navy shipbuilding has faced significant challenges in producing ships that meet capability requirements, cost estimates, and schedule goals (Mackin, 2017). Background assessment of three U.S. Navy shipbuilding programs in different phases of completion was conducted on the Littoral Combat Ship (LCS), the Zumwalt-class of destroyers, and the Ford-class of nuclear-powered aircraft carriers. Each of these classes of ships has faced challenges meeting defined programmatic outcomes as the realities of the current state of U.S. warship construction have inflicted cost overruns, schedule delays, and missed marks on capabilities (Oakley, 2025). Given the recent strategic pivot to the Indo-Pacific and costly historic acquisition failures, the U.S. Navy is headed toward uncertain waters (Barndollar & Mai, 2024).

The future does not look bright for additional shipbuilding capacity (Oakley, 2025). The defense industrial base, which includes shipyards and suppliers, faces a capacity shortfall, creating a risk that cannot be ignored. Specifically, the defense industrial base does not have the manufacturing capacity to fulfill the U.S. Navy's strategic shipbuilding requirements (see Figure 1). The civilian shipbuilding industrial base is too small to be leveraged for the nuclear-powered shipbuilding demand (Oakley, 2025). This capability further restricts the ability of the private sector to create dual-purpose shipyards to gain efficiencies. The two private shipyards currently operational and certified to construct nuclear-powered ships are at capacity for the next two decades, building Columbia-class ballistic missile submarines, Virginia-class attack submarines, and Ford-class aircraft carriers (OPNAV N9, 2022).

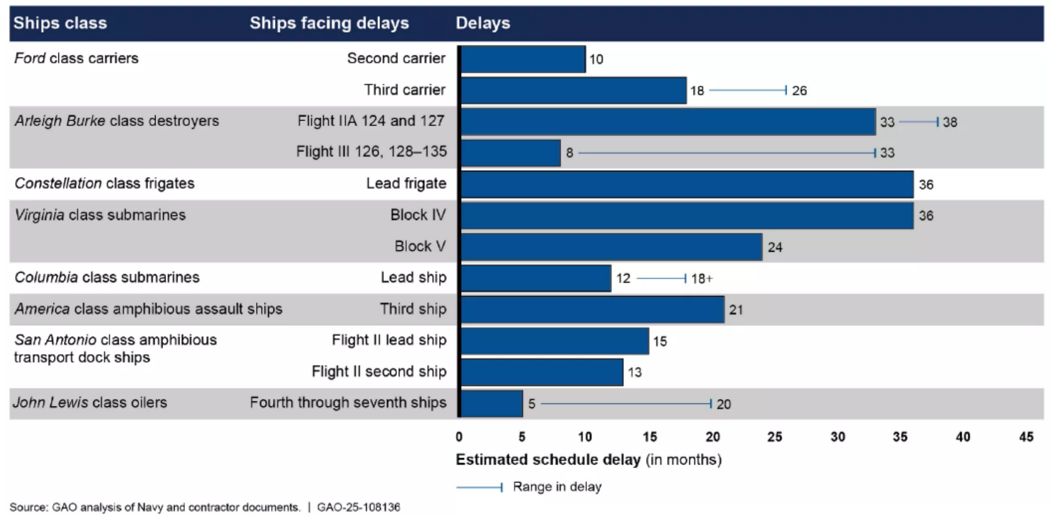


Figure 1. Schedule Delays for Navy Ships Under Construction as of September 2024. Source: Oakley (2024).

The previous Secretary of the Navy, Honorable Carlos Del Toro, mandated a shipbuilding progress review in 2024 to capture what programs were experiencing shipbuilding delays (Katz, 2024). This review highlighted delays across the fleet of new ships, including the USS Enterprise (CVN 80), the Virginia and Columbia-class submarines currently under construction, and the Constellation-class frigates. The aircraft carrier USS Enterprise is currently delayed 16–18 months, and the Block IV Virginia-class attack submarines are estimated to have a three-year delay (Mackin, 2017). The Block V Virginia-class submarines that contain the new Virginia Payload Module have been behind schedule for approximately two years. Delays for the new T-AGOS(X) ocean surveillance ship awarded last year have yet to be constructed (Shelbourne & Lagrone, 2024). Several large major shipbuilding programs such as the CVN 80, LCS, and Zumwalt all faced delays that have considerably impacted the U.S. Navy's mission and national defense (Oakley, 2025).

For 30 years, the DoD has emphasized the importance of reigning in cost and schedule overruns within its shipbuilding programs. The most recent classes of ships the U.S. Navy has constructed are the LCS, Ford-class aircraft carriers, and the Zumwalt-class destroyers. These programs have faced cost and schedule issues and were chosen for this research for those reasons. While all three programs have faced significant scrutiny from

Congress and the DoD to rein in costs and retain a reasonable delivery schedule, these three programs have fallen short of their goals of achieving their initial cost, schedule, and performance parameters (Oakley, 2025). The LCS gained the most notoriety of the three as new ships continued to be built, and the first two ships of the class were decommissioned prematurely. The Ford and Zumwalt classes have faced challenges in integrating new technologies in their ship design (Oakley, 2025). These friction points have resulted in delays equating to a decade of lost time for the Ford program. In the case of the Zumwalt class, further construction has been canceled.

All three programs have challenged their program executive offices and program managers to deliver a quality weapons system for the U.S. Navy while competing against other significant modernization priorities within the DoD (O'Rourke, 2023). The three programs have faced challenges with integrating immature technologies into the baseline architecture of their respective class ships. For the Zumwalt class, this integration has led to cost overruns, resulting in billions of dollars spent and only three ships being built, rather than the original 30 identified to fill the needed requirements (O'Rourke, 2024b).

A. LITTORAL COMBAT SHIP

The LCS was designed to perform missions with modular system packages to address different theater requirements to allow the Navy to operate closer to shore during the Global War on Terror (GWOT) (see Figure 2). The LCS was meant to replace an aging mine-sweeping capability and bolster shallow water capabilities where the Arleigh Burke class of destroyers were too large to operate effectively. The LCS program was unveiled in 2002 with the first delivered ship, USS Freedom (Executive Services Directorate, 2022). In December of 2004, the detailed design and construction contract option for LCS 1 was awarded to Lockheed Martin (Executive Services Directorate, 2022). In October of 2004, the second shipyard, Bath Iron Works, was awarded a contract for two ships that were later terminated by the Navy. In December 2010, Austal USA was awarded the task of building ten ships of trimaran hull design of the LCS (Executive Services Directorate, 2022). Freedom was constructed by Lockheed Martin in the Marinette Marine Corporation's shipyard in Marinette, WI. USS Independence (LCS 2) was commissioned in 2010

(Executive Services Directorate, 2022). With two competing shipyards, the LCS program managed two designs to quickly meet the U.S. Navy's requirements. However, this created variances within the program and challenges with both ships' designs, ultimately leading the class to be delayed or laid up in shipyards for maintenance. The contracts for both ship vendors were firm-fixed prices with incentives to aid the U.S. Navy in keeping costs reined in but also provide the shipbuilders with the incentive to build the class quickly (Mackin, 2017).

Figure 2. Littoral Combat Ship 29. Source: Lockheed Martin (2024).

With an ever-changing operational environment, the LCS was intended to increase the total number of ship end strength goals for the U.S. Navy to operate near the littorals. The U.S. Navy fell below 300 battle force ships in August 2003 and has not recovered above a 300-ship count since then, with the fleet size ranging between 270 and 300 (O'Rourke, 2023). As of September 25, 2023, the U.S. Navy has 295 ships in its fleet (LaGrone, 2023). The LCS allowed the U.S. Navy to increase lethality by procuring cheaper mission-centric platforms with modular design, providing a cost-effective increase to fleet size. Despite this, the U.S. Navy is retiring two of the first LCS class ships, which will ultimately hinder the ability of the U.S. Navy to meet the end strength goal of the fleet (O'Rourke, 2025). This resulted in applied pressure on the LCS program to perform. However, the technical issues within the powerplant of the Freedom-variant design hindered operational availability for the Lockheed design variant (O'Rourke, 2023).

LCS was conceptualized as a modular ship design to be able to conduct mine-sweeping operations, surface warfare (SUW), and anti-submarine warfare (ASW) mission modules (MM) or mission packages (MP) that would be plug-and-play to enable the LCS platform to conduct multiple mission sets with one ship class (O'Rourke, 2019). The LCS MM program has begun fielding incremental capabilities to the LCS class as approved within the budget. This has aligned with the continued delivery of LCS-class ships and aligned with the planned decommissioning of the earliest iteration of the LCS ships. For fiscal year (FY) 2023, the Navy changed the LCS MM program quantities to meet the future planned fleet size of the LCS class of 25 total ships (Executive Services Directorate, 2022).

The LCS program has missed the mark in all three categories of the triple constraint (cost, schedule, performance) and its mission scope creep from the outset of the program in 2002 has resulted in the first ships of the class being decommissioned before the last ships of the class are built. Technology maturation, critical for program success, was not fully achieved before the first keel was laid. The LCS class has faced significant issues with its multiple combining gear system in its propulsion system within the Freedom-variant of the LCS ship design (Executive Services Directorate, 2022). The U.S. Navy and industry conducted a root cause analysis (RCA) to determine the root cause of the failing combining gear transmission. The RCA identified a design issue with LCS 5 and beyond due to an issue with the high-speed clutch bearings (Executive Services Directorate 2022). The builder of the Freedom variant, Marinette Marine, redesigned the combining gear and implemented a retrofit solution that was tested on the land-based propulsion testing environment. The new design was implemented in LCS 21 and 23 and passed sea trial testing successfully. (Executive Services Directorate 2022). The program office facing delays had to strike a balance between cost, schedule, and performance of the program and the development of the ship. In retrospect, with the triple constraint methodology applied, the balance tilts in favor of cost and performance. The schedule was the first leg of the triad to slip within the LCS program. Extensive complex shipbuilding acquisition processes are incremental and iterated upon, and that often causes scope creep within the triple constraint methodology that caused program prioritization issues within the LCS program. The impact of mission scope creep within the LCS acquisition process has had ramifications that began at program inception and will continue to be felt for the decades of its remaining operational life span.

B. FORD-CLASS AIRCRAFT CARRIER (CVN-78)

Ford-class nuclear-powered aircraft carriers (see in Figures 3 and 4) are the replacement class for the Nimitz-class aircraft carriers (shown in Figure 4). The Ford class is an entirely new ship design incorporating many new technologies. These technologies include the Electromagnetic Aircraft Launch System (EMALS), which replaced the Nimitz class's more simplistic yet slower steam-driven system. The Ford class design used the basic Nimitz-class aircraft carrier hull design (O'Rourke, 2024). However, it made significant technological advancements throughout the ship, including the ability to generate more aircraft sorties per day, more electrical generation capacity, reduced manpower requirements by several hundred sailors compared to the Nimitz. It reduced the 50-year life cycle operating cost of new aircraft carriers by excluding the midlife refuel. The U.S. Navy plans to procure at least five Ford-class carriers CVNs: 78, 79, 80, 81, and 82 (O'Rourke, 2024).

Figure 3. Ford-Class Aircraft Carrier (CVN-78). Source: CRS (2024).

Figure 4. Ford-Class Aircraft Carrier (CVN-79). Source: The National Interest (2024).

The Ford-class carriers initially had a two-ship block buy contract to lower the cost of the overall purchase price. This would allow the contracted shipbuilder Huntington

Ingalls Industries (HII) to have enough orders to create additional efficiencies within their material procurements to save the U.S. Navy money (O'Rourke, 2024b). Congress and the Navy are still determining whether to place under contract CVNs at a rate of two at a time or procure one ship incrementally with their end state to build 10–12 ships in total of the class (O'Rourke, 2023). The U.S. Navy and HII have applied lessons learned iteratively throughout the construction of the Ford class but have faced shortages in the skilled labor force (O'Rourke 2024). This created pressure on PEO Aircraft Carriers to produce aircraft carriers on time as there are end-of-life considerations for the oldest Nimitz-class carriers with planned decommissioning starting in FY2025.

The GAO warnings regarding cost and schedule overruns have continued as each subsequent ship in the Ford class has fallen behind cost, schedule, and performance key parameters (O'Rourke, 2023). The Ford class has had issues maintaining schedule and cost estimates as each carrier within the first five planned have been delayed. A June 2017 GAO report states:

> The cost estimate for the second Ford-class aircraft carrier, CVN 79, is not reliable and does not address lessons learned from the performance of the lead ship, CVN 78. As a result, the estimate does not demonstrate that the program can meet its $11.4 billion cost cap. Cost growth for the lead ship was driven by challenges with technology development, design, and construction, compounded by an optimistic budget estimate. Instead of learning from the mistakes of CVN 78, the Navy developed an estimate for CVN 79 that assumes a reduction in labor hours needed to construct the ship, unprecedented in the past 50 years of aircraft carrier construction. (Mackin, 2017, p. 19)

The Ford class is a pivotal focus for the FY 2025 Defense Budget Overview as it outlays that the Ford-class nuclear-powered aircraft carrier contributes to the "Integrated Deterrence Air Power, Naval Power, and Land Power" (O'Rourke, 2024a). The Ford class has attempted to reduce costs and schedule overruns to meet the national defense objectives that the defense budget aims to achieve. The HII Newport News shipyard is the only shipyard currently capable of building nuclear aircraft carriers in the United States (O'Rourke, 2023). As the key facility to produce the Ford class, no industrial base slack is built into the U.S. shipbuilding industry to produce carriers from multiple shipyards. Labor shortages and COVID-19 supply chain logistical issues have plagued the USS Ford and subsequent future USS John F. Kennedy (CVN-79) from meeting program cost and schedule objectives (O'Rourke, 2024). This has produced a problem for the U.S. Navy and PEO Aircraft Carriers regarding addressing these issues while meeting shipbuilding timelines to replace the first decommissioning Nimitz-class aircraft carriers.

C. ZUMWALT-CLASS DESTROYER (DDG 1000)

The Zumwalt-class of destroyers (see Figure 5) was initially designed to be a class of 30 ships in the initial design phase of the class. Unlike the LCS class, the Zumwalt's increasing costs and new technologies requiring maturation cut the program to three ships to be delivered (O'Rourke, 2025). This resulted in several significant impacts on the secondary systems of the ship's design. One was the new type of ammunition for the new deck guns utilized by the Zumwalt class. The initial contract was awarded to Bath Iron Works, Bath Maine, and all three remaining ships within the class were completed in the Bath shipyard (O'Rourke, 2025).

The contract vehicle for building the three ships of the class shifted to a firm-fixed price model for General Dynamics. General Dynamics agreed to build the second ship, the class for the U.S. Navy destroyers, under a fixed-priced contract (O'Rourke, 2025). The U.S. Navy enabled this to support a shipbuilding swap arranged by the DoD. The contract replaced a cost-plus fee agreement that was initially with Northrop Grumman. The Pentagon shifted a large portion of cost increase risk to the new General Dynamics-owned contract. The DoD cited the importance of cost controls for acquisition programs during the President Obama era. The DoD wanted to maintain costs at the current projections and shift cost overrun risk to the contractor. (Drew, 2009).

Figure 5. Zumwalt-Class Destroyer (DDG-1000). Source: U.S. Navy (2022).

To reduce risk within new weapons systems development, the GAO has repeatedly stated that maturing technology during the integration process within a new program is ineffective in controlling costs and schedule projections (O'Rourke, 2025). Maturing technologies before they are incorporated into a defense acquisition strategy reduces the programmatic risk associated with having too many new technologies attempt to integrate within one new weapon system. According to a March 2009 GAO report, the Zumwalt, five years into program development, was stated to have four of twelve DDG 1000 critical technologies fully mature, having been demonstrated in a sea environment. Six other key technologies were in various stages of maturity, with five unable to demonstrate full maturity until after installation on the ship (Sullivan, 2009). The remaining two technologies have not matured as the U.S. Navy had hoped: the volume search radar (one-half of the dual-band radar system) and the total ship computing environment. The land-based radar tests planned before the ship began construction were not scheduled to be completed for an additional two years, resulting in a two-year delay. The software development for the ship's internal computing system technology continued to face obstacles, and the U.S. Navy ultimately approved the next iteration of the system before it could pass over 50 percent of its stated objective goals. The U.S. Navy planned on completing 90 percent of the ship design before the ship began construction in a bid to keep construction schedules on track and discover issues before they are manifested during construction (Sullivan, 2009). However, at the program's production readiness review in October 2008, the shipbuilders had completed less than 35 percent of the product model, creating another delay for the U.S. Navy to manage as it was unable to meet its goal for a digital copy of the ship to be vetted before any steel was laid for the new class (Sullivan, 2009).

With the incorporation of new technologies, the Zumwalt class was at odds with how the GAO suggested the DoD initiates ACAT I programs. System integration with many new complex technologies has caused significant impacts on cost and schedule. The Zumwalt grew into an overly complex and expensive class of ships that can be attributed to the shifting requirements of the U.S. Navy. When it was first developed, the Zumwalt was meant to operate closer to shore and provide additional land attack capabilities for the U.S. Navy. However, with China's rise and shifting priorities within the U.S. Indo-Pacific Command (USINDOPACOM) area of responsibility (AOR) resulted in ships that do not provide the U.S. Navy with the ability to counter the Chinese naval threat within the South China Sea (O'Rourke, 2025). These constantly shifting geopolitical and military strategic goals created a problem for the PEO Ships to contend with, as they worked to balance research and development costs and integration costs for the Zumwalt.

The Zumwalt has provided three distinct benefits from the program: tumblehome hull with a degree of stealth capabilities, advanced electrical drive components throughout the ship, and the first class to be retrofitted to carry hypersonic weapons (LaGrone, 2023). The U.S. Navy is studying and scaling the lessons learned from the Zumwalt to integrate into future ship classes, including the Constellation-class frigate program. While the costs associated with building the Zumwalt are high, the money spent on developing the Zumwalt can be leveraged to save future shipbuilding programs' technology development cost. Due to the extensive Zumwalt technology development phase, reducing these costs can increase programmatic efficiency within the Constellation and future DDG(X) program. The DDG(X) program is working to incorporate a very similar propulsion system as Zumwalt to power the large internal electrical requirements and future weapons capabilities, specifically laser and hypersonic weapons systems (O'Rourke 2025). The DDG(X) hull design is not complete, and the class may incorporate a tumblehome hull design as the Zumwalt class (LaGrone, 2022).

D. CONSTELLATION-CLASS FRIGATE (FFG-62)

The Constellation-class frigate program's genesis is to provide the U.S. Navy with a capable yet smaller ship than a destroyer both in costs and capabilities. As currently designed, it will be manned by fewer personnel than an Arleigh Burke-class destroyer and be tasked with missions that do not require a large destroyer to complete (see Figure 6). The program began procurement in FY2020 for the class and has grown to six ships on order in FY2024 (O'Rourke, 2024). The contract vehicle is a firm-fixed price with an incentive contract awarded to Fincantieri/Marinette Marine in Marinette, WI (O'Rourke, 2024).

Figure 6. Constellation-Class Frigate (FFG 62). Source: CRS (2024).

With the first keel laid in 2022, Fincantieri has changed its manufacturing process to alleviate the issues the shipbuilder faced during construction of the Freedom LCS-class variant (Shelbourne, LaGrone (2024). The shipbuilder also invested $350 million in new buildings to prevent Constellation class construction from being impacted by the large temperature variance experienced in Wisconsin year-round (Dent, 2024).

The Constellation class is based on the parent design of the Italian Fregata Europea Multi-Missione (FREMM) with the intent to modify the proven design to meet U.S. Navy standards and mission requirements while alleviating the need to create a clean sheet design. With the goal of cost and schedule savings, the FREMM parent design was intended to expedite the construction of the Constellation-class frigates and deliver much-needed capability to the U.S. Navy. The Constellation design process and modifications were intended to utilize 85% of the base FREMM design with some key changes: lengthening the hull by 23 feet, removing the sonar dome for stability, increased generator output, all of which resulted in a 500-ton displacement increase over the base design (O'Rourke, 2024). However, as the design has gone through modifications, there has been a decline in the percentage of use of the parent design. This is one of the leading causes of the program's delays, currently estimated to be three years behind schedule, with the lead ship now estimated to be delivered in 2027. Secondly, Fincantieri has struggled with hiring and retaining enough skilled tradesmen to perform the detailed construction of the Constellation class. This led to the shipbuilder's initial delay (O'Rourke, 2024a).

The U.S. Navy intends to minimize the inclusion of new technologies within the Constellation as a lesson learned from previous classes of ships built in the past and currently under construction. Congress has mandated in the FY21 National Defense Authorization Act (NDAA) that a land-based testing platform for the propulsion system and engineering plant be developed (O'Rourke, 2024a). Land-based testing of the power plant is rooted in the Arleigh Burke-class land-based testing platform's success. The benefits of a land-based plant are twofold: test systems and procedures in a controlled environment to determine root causes for failures and operational changes not discovered during design work and train crews of future Constellation-class ships on power plant operations (O'Rourke, 2024a).

Underestimated cost increases are a focus of the Congressional Budget Office and CRS for the Constellation class. Both organizations concluded separately that if Constellation is compared to all modern U.S. Navy shipbuilding programs specifically for the third and subsequent ships and beyond, it will cost significantly more per ship than estimated by the U.S Navy (O'Rourke, 2025). CBO estimates that cost growth could be between 10–20% per ship, which is essentially not accounted for within the U.S Navy shipbuilding program budget. With the current firm-fixed price contract, the burden of cost growth may largely fall on the shipbuilder. However, this will increase the cost of the eleventh ship of the class significantly as the shipbuilders competing will likely recast their projected costs higher to compensate (O'Rourke, 2024a).

The shipbuilding programs discussed in this chapter have faced differing challenges and obstacles, but it is important to understand the current state of U.S. Navy shipbuilding. Historical context is a lesson learned throughout this capstone project as program managers throughout the U.S. Navy shipbuilding industrial complex grapple with meeting the current standards of the triple constraint model and avoiding cognitive biases in decision making.

III. LITERATURE REVIEW

This literature review examines the various methods in which the triple constraint model has been implemented in program management, and various approaches and issues in the U.S. Navy shipbuilding. By analyzing both scholarly perspectives and industry reports, the review highlights the strategic objectives, the program's alignment with the U.S. Navy's broader modernization efforts, and the challenges faced in its development. Through this chapter, the review seeks to provide a comprehensive understanding of the program's potential impact on naval warfare and defense policy.

A. SHIPBUILDING INDUSTRIAL BASE

A foundational understanding of U.S. shipbuilding begins with the Merchant Marine Act of 1920, also known as the Jones Act. The main policy objective of the law was to protect U.S. shipping and industry from national security threats by maintaining a strong shipbuilding industry and merchant marine. Since the 1920s, the law has proven controversial as the imposition of the Merchant Marine Act has created a toll or tariff on U.S. shipping services. This act has not proven to protect U.S. shipbuilding capacity or provide substantial protection to national security (Grennes, 2017). The act mandates that intra-U.S. shipping be provided by U.S. flagged ships, including any shipments of U.S. humanitarian aid (Mercier & Smith, 2015).

The United States continued to lose its technological advantage in shipbuilding processes and systems due to offshoring of shipbuilding capacity to lower cost producers. The Organisation for Economic Co-operation and Development (OECD) which was founded in 1961 to encourage economic development in the world, benefited countries such as South Korea and Japan as they harnessed the newest technology and remained focused on shipbuilding expansion. The Merchant Marine Act protected shipbuilders within the United States that became laggards that did not modernize as quickly or implement process improvements to remain competitive with their Southeast Asian competitors (Andrews et al., 2015). As the U.S. private commercial fleet shrank, so too did the country's international trade, with U.S.-flagged ships responsible for just 1% of the global shipping trade by the early 2000s (Grennes, 2017). U.S.-based shipping companies shipping between the United States and other countries' ports have largely moved all shipping to offshore-flagged ships for commercial shipping requirements (Grennes, 2017).

The Japanese, South Korean, and Chinese multipurpose shipyards that produce large vessels build ships for the military and civilian sectors, resulting in increased industrial base support from orders for private and public entities. This creates opportunities for increased efficiency and cost reduction by implementing processes at a grander scale (Grennes, 2017).

Flags of convenience have contributed to the erosion of cost controls for U.S.-manufactured ships. Ships that fly foreign flags and operate out of countries with lower standards contribute to the procurement of ships from foreign builders, which can be the lowest-cost producers for merchant ships. U.S.-built ships that adhere to the Jones Act have been calculated to operate at twice the operating costs of foreign-built ships of a similar size and class (Maritime Administration [MARAD], 2011). MARAD calculated shipping companies' costs from 2009 and 2010. MARAD totaled the average daily operating cost of a U.S.-flagged vessel as $21,774 and $20,053, respectively (MARAD, 2011). During the same period, foreign-flagged vessels' operating costs were $7,410 and $7,454, respectively (MARAD, 2011). Because foreign-flagged vessels have significantly lower operating costs, the largest ocean freight carriers have continued to order foreign-manufactured ships. As a shipping fleet ages, it increasingly costs more to maintain. This has been a direct reflection of what has occurred with U.S.-flagged ships. With U.S.-based carriers operating an older fleet of U.S.-flagged ships, their profitability declines, as the Jones Act prohibits foreign-built ships from operating between U.S. ports.

The U.S. shipbuilding industrial base once had the largest shipbuilding capacity in the world. However, by the late 1970s, U.S. shipbuilding capacity began to decline, with incremental reductions in capacity and industry consolidation (MARAD, 1971). The number of U.S.-flagged ships declined from1,145 in the 1950s to slightly more than 600 by 1971, and most of those ships were at least 25 years old (MARAD, 1971). This meant the decline would not slow as the oldest ships were sold off or scrapped (MARAD, 1971). During the 1970s, several geopolitical issues arose within the Middle East, resulting in higher inflation and oil prices and U.S. economic stagnation. This created economic impacts on the industrial base of all U.S. manufacturing, including shipbuilding (Nelson, 2022). With a stagnating U.S. economy, orders for new ships from U.S. shipyards declined even further. This opened an opportunity for South Korean and Japanese shipyards to gain market share on a global scale.

As the United States progressed through the 1980s and 1990s, U.S.-flagged ships and the building capacity of American shipyards continued to decline. Asian shipbuilding countries, particularly Korea, Japan, and China expanded and emerged as dominate players in global shipbuilding capacity (see Figure 7). This led to longer lead times for U.S. ships to be constructed.

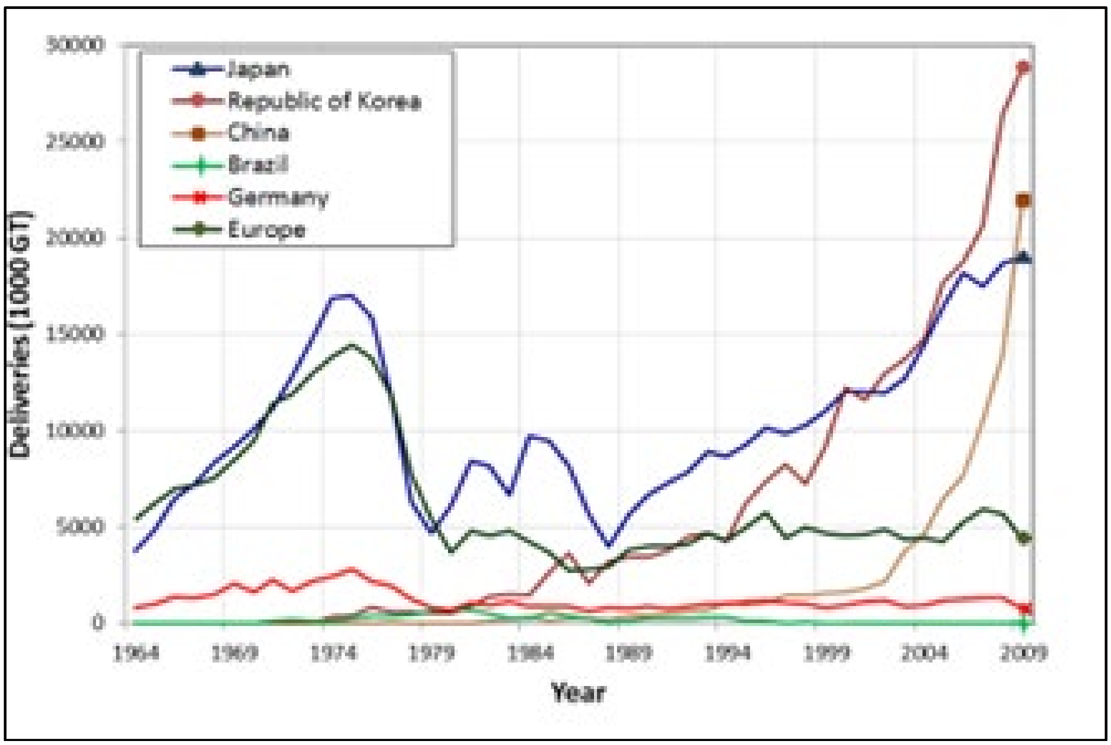


Figure 7. World Shipbuilding Deliveries (in 1,000 Gross Tons) by Countries from 1964 to 2009. Source: Wiess (n.d.).

B. TRIPLE CONSTRAINT MODEL

The project management community defines the triple constraint model as the cost, scope, and time that impact every project (Kerzner, 2025; Rendon & Snider, 2019; Van Wyngaard et al., 2012). These are the three sides of every project that project managers must balance while managing a program or project. Project time illustrates the planned amount of time required to conduct the project (Kerzner, 2025; Van Wyngaard et al., 2012). Project cost incorporates the budget and any resources that require financial management. Project scope is defined as the limits of the performance of the required deliverables. These three variables are interconnected, and the positive and negative impacts on one variable will impact the other two to some degree (Van Wyngaard et al., 2012). How that is managed is determined by the project or program manager (Van Wyngaard et al., 2012).

The triple constraint theory, a foundational concept in project management, is a triangular framework built around three key elements: cost, time, and scope. While the triple constraint theory is widely used in general project management, its application in defense acquisition projects has unique challenges and implications, given the stakes involved in national security, budget limitations, and evolving technological threats. Despite these challenges, the theory provides the basis of the acquisition program baseline (APB) being used to manage defense acquisition programs, so it is imperative to analyze how cost (budget), scope (performance), and time (schedule) impact defense acquisition outcomes (Rendon & Snider, 2019). The triple constraint theory is often visually represented as a triangle, with each vertex symbolizing one constraint (see Figure 8).

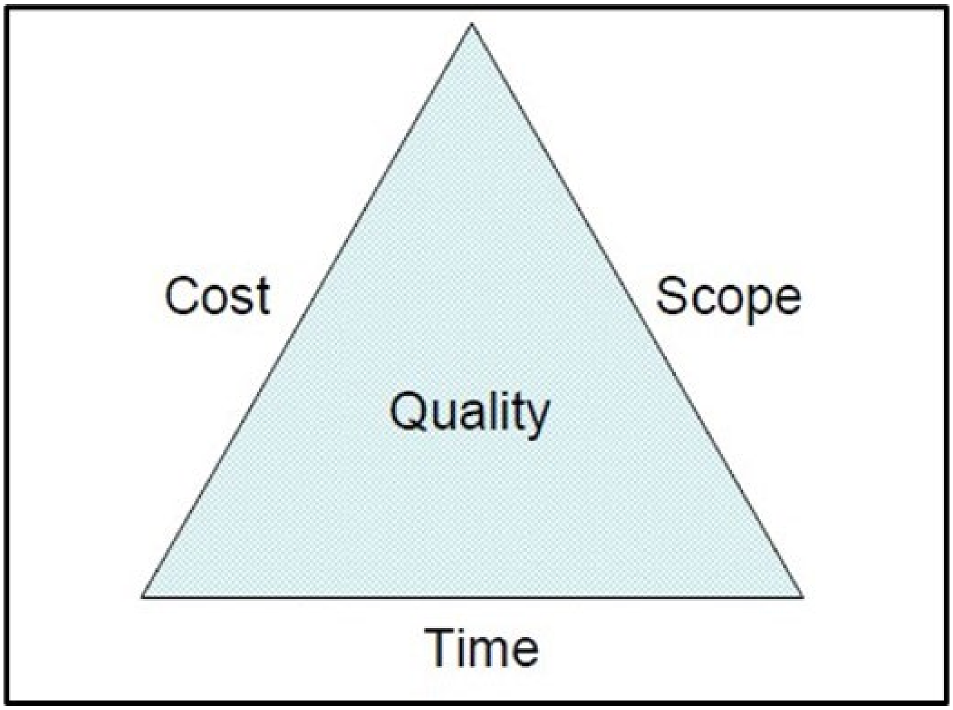


Figure 8. Triple Constraints Model. Source: Van Wyngaard et al. (2012).

Cost, synonymous with budget, can be defined as the financial resources that factor in the planning and production of a project. Time, synonymous with schedule, focuses on the planned and prescribed period in which the project would occur from conception to completion. Scope, sometimes called performance, is a project's proposed capabilities and boundaries. Quality, defined as "the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs the characteristics that meet expectations" (International Organization for Standardization, 1992) is often depicted in the center of the triangle as a core feature for a project. These three elements are seen as interdependent, where changing one constraint will impact the others. For example, expanding the scope of a project typically requires additional schedule time and funding, while compressing the schedule often increases costs or limits the achievable performance. The theory suggests that a balance must be achieved across three elements for successful project delivery.

In traditional project management, the triple constraint theory provides a simplified model for project managers in resource allocation, scheduling, and objective setting. This model is instrumental in project planning and decision-making by helping managers anticipate the trade-offs associated with changes in any one constraint (Kerzner, 2025).

Defense acquisition projects must align with specific milestones and testing phases that cannot be bypassed. The presence of multiple stakeholders, such as government agencies, defense contractors, military branches, and public interest groups, adds layers of complexity to the project life cycle. Defense acquisition projects also contend with unique challenges, including strict security protocols, rigorous quality standards, and evolving threats. In this context, traditional project management theories, like the triple constraint, face challenges in accommodating defense acquisition's long-term and multifaceted nature (Mortlock & Karnes, 2021).

In the context of defense acquisition, the scope constraint represents the specific deliverables and requirements that the project must meet. Scope and performance in defense projects often involve detailed specifications for quality, functionality, and security, all of which must align with national security objectives. Defining the project performance in defense acquisition is particularly challenging, as stakeholders frequently have differing priorities and interpretations of project requirements.

Scope changes are common in defense acquisition due to technological advances and evolving security threats. For instance, if new intelligence suggests a particular technology is obsolete, the project performance may need to be updated, impacting the schedule and cost. An example of scope constraints in defense acquisition is the F-35 Joint Strike Fighter program, which faced extensive delays and budget overruns partly due to the need to meet complex and evolving performance requirements (Flyvbjerg et al., 2018; Mortlock & Dew, 2021).

Time or schedule constraints in defense acquisition are particularly challenging due to the extensive development cycles required for high-tech military equipment. Time constraints can happen at every project stage, from initial research to final testing and deployment. Given the lengthy schedule associated with defense projects, delays are common and can arise from various sources, including technological obstacles, regulatory requirements, and the need for repeated testing phases.

The delayed schedule affects the project budget and has implications for military readiness and national security. For example, developing advanced missile systems is often delayed due to rigorous testing requirements to ensure reliability and safety. In some cases, delays can have far-reaching effects, as seen in the U.S. Navy's LCS program, which faced multiple schedule constraints due to technical issues and shifting project requirements (Department of the Navy, 2022; O'Rourke, 2023).

Cost constraints in defense acquisition are affected by economic conditions, government policy changes, and defense budget fluctuations. The cost constraint represents the budget allocated to each phase of the defense project, including research and development, procurement, testing, and final deployment. Managing cost constraints in defense projects can be challenging, as these budgets are subject to periodic reviews, changes in government administration, and fluctuations in the economy over the project's life.

Cost overruns are frequent in defense projects, often stemming from unexpected technical challenges, shifts in performance, or schedule delays (Flyvbjerg & Gardner, 2023). The financial management of defense projects requires flexibility and adaptability, as fixed budgets can limit the project's ability to respond to unforeseen challenges (Mortlock & Karnes, 2021).

1. What is the Iron Triangle, and How Has It Changed?

One of the difficulties in analyzing projects through the lens of triple constraint is the definition of the theory itself. Pollack et al. (2018) provide a comprehensive analysis of the iron triangle concept, also known as the triple constraint theory, in project management. They explore the historical evolution of the iron triangle over 45 years, examining its components of time, cost, and quality, (scope) and their relevance in measuring project success. The authors apply scientometric research methods, using quantitative techniques to analyze and measure scientific publications, trends, citation patterns, and the impact of research within a specific field or across disciplines. This review examines a large database of project management literature to track changes in the prominence and interpretation of these criteria. The study reaffirms time and cost as consistent components of the iron triangle, which are central to project success criteria. Quality, however, is less universally agreed-upon as a third vertex, with some researchers proposing scope or performance as alternatives.

Early literature from the 1970s emphasized technical aspects of the theory, primarily focusing on the operational efficiency of projects, especially in the construction and engineering sectors. Over time, broader project management dimensions have complemented the iron triangle criteria, including stakeholder satisfaction and strategic alignment, especially in complex or public-sector projects. While the iron triangle remains widely used, Pollack et al. (2018) note criticisms regarding its simplicity. The criteria often fail to capture comprehensive project success, such as stakeholder satisfaction and long-term benefits. Recent literature suggests supplementing or modifying the triangle to incorporate these qualitative aspects (Pollack et al., 2018).

Pollack et al. (2018) argue for recognizing the iron triangle as a flexible model rather than a rigid success framework, adapting components according to project context. Some researchers have argued that scope, performance, or requirements should be part of this trio instead of quality. The model also proposes maintaining time, cost, and quality as the most significant success criteria due to their interconnected nature in project management discourse. The techniques used to analyze the prevalence of iron triangle concepts in the project management literature created network diagrams for each period that highlight core themes and shifts, such as the importance of quality over performance and scope (Pollack et al., 2018).

The following concepts and reviews are important for understanding the complexity and logic behind the triple constraint theory in different project management environments. To ensure clarity in analyzing the triple constraint theory within the context of the Constellation program, cost, performance, and schedule will remain the primary factors, as they align most closely with the theory currently used in the defense acquisition system.

2. The Theory of Triple Constraint — A Conceptual Review

In the *Theory of Triple Constraint — A Conceptual Review*, Van Wyngaard et al. (2012) acknowledge the essential role of the triple constraint model in project management. The authors present an evolved understanding of the interplay between these constraints, proposing an integrated TRIJECT model. An acronym combining the terms triple constraint model (TRI) and project management (JECT), the model seeks to provide project managers with a structured approach to navigate the often-contradictory pressures of the triple constraint by emphasizing flexibility within constraints while aligning with the project's higher purpose.

The authors point out that the triple constraint model has received limited scholarly attention despite its practical significance (Van Wyngaard et al., 2012). They also explore the dynamics between the three constraints, explaining that successful project delivery often requires prioritizing and flexibly managing one or more constraints. In addition, they discuss the "good, fast, or cheap" principle, underscoring that only two can typically be achieved simultaneously (Van Wyngaard et al., 2012, p. 3). They argue for a deeper understanding of the triple constraint model's dynamics, noting that traditional project evaluations focusing solely on time, budget (cost), and target measures (scope) may overlook strategic alignment with project objectives.

To overcome these shortcomings, Van Wyngaard et al. (2012) introduce the TRIJECT model, an integrated framework, as a tool for project managers. This model aligns project constraints with the higher purpose of the project, allowing managers to strategically prioritize constraints according to their flexibility and importance to project success. The TRIJECT model helps visualize and manage flexibility, fostering a dynamic equilibrium among constraints as project needs shift. Each constraint is interchangeable within the triangle. Based on the specific importance of the program and the stakeholder's interest, project managers identify which constraint is positioned at the top apex of the triangle. The path from the start of the model to the apex forms a letter "Q," describing how quality is a constant feature for all projects (see Figure 9).

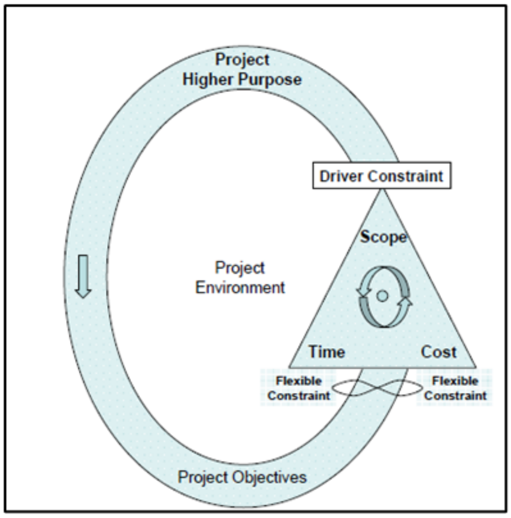


Figure 9. TRIJECT Model with Scope as Priority. Source: Van Wyngaard et al. (2012).

One of the article's most significant points is admitting the complexity of triple constraint without stating that the theory has been oversimplified. The authors provide their own physiology of the theory, which dissects how, when, and why each characteristic can be applied to a project. Van Wyngaard and colleagues (2012, p. 24) give the following attributes to serve as the baseline for constructing a TRIJECT model base on a project's specific focus:

1. Effective projects bring form and function to ideas or needs and yield beneficial changes or added value.
2. The higher purpose of a project is fundamentally the driver of the project.
3. The triple constraint constitutes a balance of the three interdependent project elements of scope, time, and cost as a function of the project's higher purpose.
4. The concepts of quality, customer satisfaction, performance, and risk have an impact on the triple constraint but do not inherently constrain the project.
5. The cause and effect of new or changing triple constraint requirements are constantly negotiated during all phases of a project.
6. Change within the triple constraint is compensated through proportional trade-offs.
7. Failure to deliver all three triple constraint variables on target does not necessarily imply project failure.

8. Flexibility is an indispensable triple constraint requirement to accommodate shifts in project emphasis and to ensure a beneficial project outcome.
9. The three key triple constraint relationships signify that at least one of the triple constraint variables must be constrained (otherwise, there is no baseline for planning) and at least one of the variables must have the capacity for exploitation (otherwise, quality may be affected).
10. The triple constraint can be prioritized into a power structure by ranking the variables into a hierarchy of flexibility (capacity for exploitation).
11. The power structure derives from project objectives and higher purpose and may be influenced by environmental change.
12. Capitalizing on the pliability of the two more flexible constraints can be used as a mechanism to achieve the essential demands of the primary triple constraint variable (the driver). (Van Wyngaard et al., 2012)

The authors used a case study of the Smithsonian National Air and Space Museum project, where the TRIJECT model's application demonstrated how constraint flexibility was managed to meet a critical deadline of the country's bicentennial celebration (Van Wyngaard et al., 2012). For the museum, time was prioritized, while cost and scope were flexibly adjusted to fulfill the project's overarching goal of completion by its initially planned date. The museum project was given a cost constraint of $40 million, a completion date of July 4, 1976, and the scope of the facility being a world-class museum (Van Wyngaard et al., 2012). A TRIJECT model specifically for the Smithsonian National Air and Space Museum project, depicts the familiar figure of the triangle with cost and scope as its base and an infinity sign representing how cost and scope are the variables of change to ensure the constraint of time is prioritized (see Figure 10).

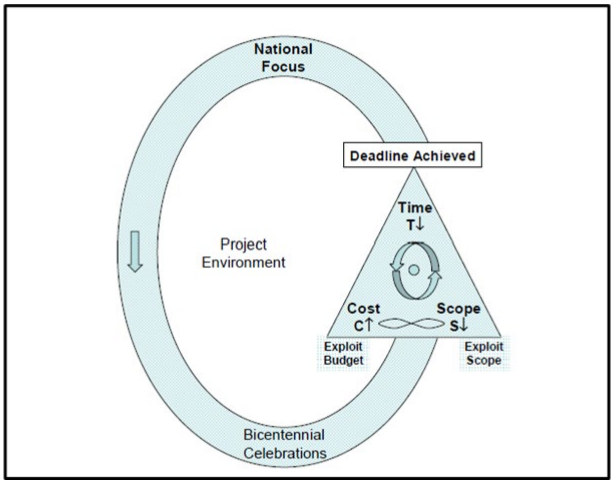


Figure 10. TRIJECT Model for National Air and Space Museum. Source: Van Wyngaard et al. (2012).

The authors conclude that managing the triple constraint as an interconnected system allows for more effective project delivery (Van Wyngaard et al., 2012). The TRIJECT model, supported by theoretical insights, facilitates strategic project management by enabling project leaders to make informed decisions on where to apply flexibility. In project environments where adaptive, balanced constraint management is crucial, the view of triple constraint in this article's lens allows current projects like the Constellation-class frigate to be re-evaluated and re-examined from a more dynamic constraint model.

3. The Triple Constraint, a Triple Illusion

In "The Triple Constraint, a Triple Illusion," Angela Baratta (2006) challenges the long-held model of project management's triple constraint, which suggests that scope, time, and cost are the primary interdependent factors governing project outcomes. Baratta (2006) argues that this model is flawed and insufficient for guiding modern project management. She points out that despite the belief that adjusting one constraint (e.g., time) will automatically impact the others (e.g., cost or scope), real-world project data often contradicts this assumption, with many projects ending up over budget, late, and under-delivered on scope.

Baratta (2006) critiques the classical model for reducing complex, multifaceted project dynamics to three factors, with time and cost being overly intertwined. She proposes a more nuanced model: the value triple constraint (VTC). This model replaces the cost–time–scope paradigm and focuses instead on value, scope, and capability (see Figure 11).

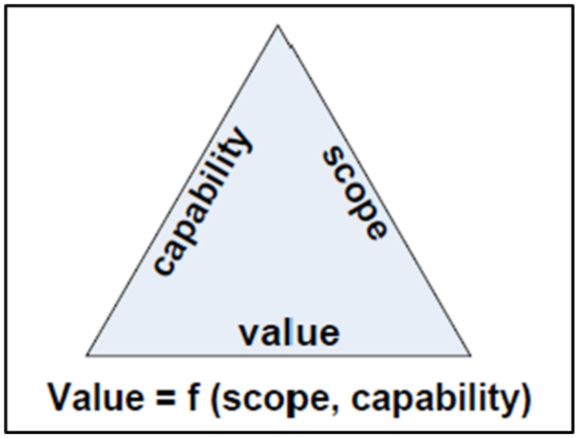


Figure 11. Value Triple Constraint Model. Source: Baratta (2006).

Baratta's (2006) *value* dimension incorporates direct project benefits and various opportunity costs, such as identification delays and decision-making lags. This reframing allows for a broader assessment of a project's return on investment (ROI), extending beyond budgetary or scheduling metrics to capture overall business impact. Baratta (2006, p. 12) describes an example of how program managers define value by stating,

> The delivery of value is why we undertake projects. Value is a compound metric which is the sum of the following major elements:
>
> 13. Project Benefit (+)
> 14. Identification Opportunity Cost (-)
> 15. Decision Opportunity Cost (-)
> 16. Project Schedule Cost (-)
> 17. Project Delivery Cost (-; p.). (Baratta, 2006, p. 12)

The VTC model emphasizes understanding and improving the *capability* of the processes supporting project delivery, thus driving value by optimizing project outcomes beyond cost or time savings. Baratta (2006) advocates that this approach will better support project managers, portfolio managers, and organizational leaders in making strategic decisions, helping to quantify the total value generated by a project relative to its anticipated impact on organizational objectives. This model also shifts some responsibility onto business users to validate benefits and enables a more accurate appraisal of project success by accounting for previously overlooked opportunity costs.

The current model the defense acquisition system utilizes for triple constraint differs from Baratta's (2006) model that encourages project managers and stakeholders to focus on enhancing value through effective capability and scope management, fostering long-term returns rather than short-term constraint adherence. It is recommended that the triple VTC notion of opportunity cost and return on investment be implemented into the initial planning of a program to align scope and mission objectives. *Value* adds agility, providing options early and often through programs.

4. Inclusion of Strategic Management Theories to Project Management

Discussing the idea of incorporation of concepts, Parker et al. (2015), in their paper "Inclusion of Strategic Management Theories to Project Management," describe integrating strategic management theories, the theory of constraints (TOC), resource-based view (RBV) or resource advantage theory (RAT), and resource dependence theory (RDT), into project management practices. The authors address the persistent challenges in project success rates by incorporating these strategic theories, which offer more dynamic resource management approaches than traditional project management techniques (Parker et al., 2015). Recognizing the triple constraint theory, the authors identify the limitations of conventional project management methodology—the iron triangle of time, cost, and scope—as being inadequate in complex, resource-intensive projects.

Parker et al.'s (2015) proposed integrated framework introduces strategic insights to supplement existing project management structures, emphasizing a more holistic understanding of project constraints, resource mobilization, and inter-organizational dependencies. The framework suggests that the triple constraint theory can help identify critical constraints and prioritize resource allocation. RBV/RAT focus on leveraging unique resources for competitive advantage, particularly intangible assets and core competencies. RDT offers strategies for managing dependencies and power dynamics related to resource scarcity and environmental uncertainties. The integration of these theories into project management has several effects. First, the TOC (triple constraint), focusing on bottlenecks and constraints in a project, supports project managers in identifying the most pressing limitations within plans and helps in resource prioritization. Introducing triple constraint principles into project scheduling, such as critical chain scheduling, can minimize delays through strategic buffer management, making projects more resilient to unforeseen resource shortages.

Next, the RBV and RAT frameworks contribute a competitive edge by encouraging project teams to recognize and build upon unique organizational resources, both tangible and intangible. For instance, the importance of knowledge-based resources and strategic assets—critical to sustained competitive advantage—aligns with project management's need for specialized skills and capabilities that are not easily replicable.

Finally, RDT provides valuable insights into external resource dependencies, guiding project managers to establish partnerships, alliances, or outsourcing arrangements to mitigate risks associated with resource unavailability. The emphasis on managing dependencies also underscores the importance of strategic resource control, helping project managers reduce vulnerabilities to external factors.

Parker et al. (2015) used a Channel Tunnel and Heathrow Terminal 5 case study to examine how the proposed integrated model shared similarities in the approaches used for these projects. The Heathrow Terminal 5 project showcased how pre-assembly techniques and strategic collaboration allowed on-time project completion by mitigating resource constraints and improving resource flow. TOC-, RBV/RAT-, and RDT-integrated models share similarities to the Channel Tunnel and Heathrow terminal projects, showing how the concept facilitates the navigation of resource constraints, execution of timely mobilization, and optimization of project outcomes. Below is a conceptual model embedded in project management processes, highlighting the relationships between key project resources, project success factors (scope, time, cost), and various project phases (initiating, planning, executing, and closing) (see Figure 12).

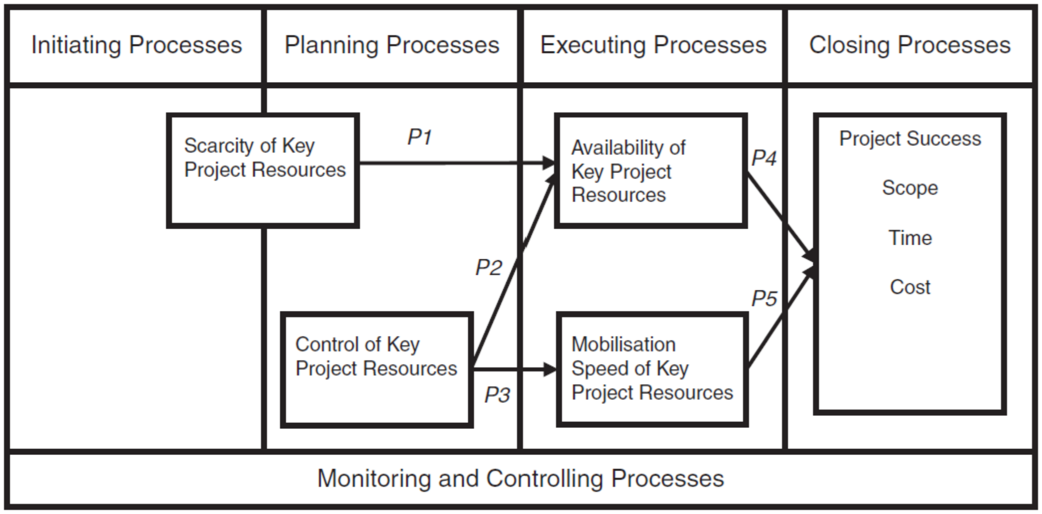


Figure 12. Conceptual Model Embedded in Project Processes. Source: Parker et al. (2015).

The framework's theoretical foundation remains conceptual and had limited practical testing at the time of publication. Surveys and case studies must validate the framework's robustness in varied project environments. While the model presents a broad approach to strategic resource management, it may be challenging to implement in organizations with rigid structures or limited strategic autonomy. The theory also fosters better alignment between project execution and strategic objectives. Introducing the approach to current defense acquisition programs, like the Constellation-class frigate program, may address resource scarcity, dependency, and mobilization challenges.

5. Triple Constraint Conclusion

While the triple constraint theory provides a valuable foundation, its application in defense acquisition has limitations. One major critique is that the theory's rigid structure does not always account for defense projects' complexity and adaptive requirements. Another important concept is in the definition itself. Time, cost, and scope are insufficient in describing the factors driving the concept in detail. In response to these limitations, defense organizations have increasingly adopted alternative frameworks, such as TRIJECT and VTC, to complement the traditional model. These frameworks provide more flexibility, allowing defense projects to adapt to evolving requirements and technological advancements.

The triple constraint theory remains a foundational tool in project management, providing valuable insights for managing performance, schedule, and cost in defense acquisition systems. By integrating complementary methodologies from private industry and previous defense projects, the defense acquisition process can better respond to the challenges and unpredictability inherent in this critical field. Analyzing the Constellation-class frigate program through the lens of the triple constraint theory allows for a more comprehensive study of the project.

C. BEHAVIORAL ACQUISITIONS

Tversky and Kahneman (1974) introduced the idea of cognitive biases to explore behavioral economics. Kahneman (2011) argues that human decision-making occurs through two systems. The first system is the brain's automatic and intuitive thinking mode, which uses heuristics and biases to make decisions (Kahneman, 2011). The second system is a slower mode of thinking that is deliberate, logical, and reasonable (Kahneman, 2011). Tversky and Kahneman (1974) argued further that although this two-system approach is helpful in many cases, there are instances in which the first system leads to undesirable decisions that could have been better handled using the second system. These biases have been well-documented in many diverse fields, including farming, economics, ecology, policy-making, and artificial intelligence (Burkart & Huber, 2021; Dessart et al., 2019; Fanning et al., 2022; O'Neill et al., 2018). These biases have also been documented in acquisition and project management (Flyvbjerg & Gardner, 2023; Mortlock, 2022). They have been labeled "behavioral acquisition" within the context of defense program management (Mortlock, 2022).

Behavioral acquisition describes the cognitive and behavioral biases that may influence decision-making and resource management during an acquisition program (Mortlock, 2020; Mortlock, 2022; Mortlock & Dew, 2021; Rowlands, 2024; VanderPlas & Watson, 2024). Defense acquisition research has called for examining behavioral acquisition within the context of defense acquisition programs (Mortlock, 2020). Within the project management field, there has been staunch recognition that behavioral and cognitive biases influence the execution of programs and projects (Chen et al., 2023; Cornelio et al., 2023; Fernandes et al., 2023; Flyvbjerg, 2007b, 2016, 2021, 2024; Flyvbjerg & Gardner, 2023; Flyvbjerg et al., 2018, 2024; Machiels et al., 2023; Patrucco et al., 2024). Thus, recognizing and addressing behavioral and cognitive biases in defense acquisition programs becomes imperative to the success of these programs. Flyvbjerg (2021) suggests that 10 biases are prevalent in project management. These include strategic misrepresentation, optimism bias, uniqueness bias, planning fallacy, overconfidence bias, hindsight bias, availability bias, base rate fallacy, anchoring, and escalation of commitment. Past research findings highlight the preeminence of eight biases: strategic misrepresentation, optimism bias, uniqueness bias, planning fallacy, overconfidence bias, availability bias, anchoring, and escalation of commitment (Chen et al., 2023; Cornelio et al., 2023; Fernandes et al., 2023; Flyvbjerg, 2007b, 2016, 2021, 2024; Flyvbjerg & Gardner, 2023; Flyvbjerg et al., 2018, 2024; Machiels et al., 2023; Patrucco et al., 2024). Given the mounting evidence of these biases within past project management research, the present study focuses on these eight. Due to the pervasive nature of these biases, it is important to understand them within the context of defense acquisition programs and explore how behavioral acquisition impacts the success of these programs.

1. Strategic Misrepresentation

Strategic misrepresentation is the calculated altering of information for advantage or gain and is often expressed by lying about or deliberately misrepresenting of information (Flyvbjerg, 2021; Jones & Euske, 1991). Flyvbjerg (2007a) found that strategic misrepresentation during the initial stages can eventually lead to cost overruns and benefit shortfalls in major projects. As an example, Flyvbjerg and Gardner (2023) show how government officials can use cost estimations to gain public support for projects with the understanding that these initial cost estimations may be inaccurate and are a down payment to get public projects started. Past research has shown that strategic misrepresentation can play a significant role in the performance of large projects (Flyvbjerg et al., 2009; Pinto, 2013, 2014; Shore, 2008; Stingl & Geraldi, 2017). Building upon past research, Love (2011) suggests that organizational and project factors, like governance and pressured schedules, can influence strategic misrepresentation in a project. Follow-up research supports Love's (2011) findings (Pinto, 2014; Love et al., 2011). These findings suggest that program managers and stakeholders are not maliciously using strategic misrepresentation but rather are motivated to use strategic misrepresentation due to contextual factors. In defense acquisitions, where schedule, cost, and quality are matters of life and death to potential end-users, it is imperative to examine how contextual factors may lead to strategic misrepresentation.

2. Optimism Bias

Optimism bias is the cognitive tendency for individuals to be overly optimistic or zealous in the estimation of outcomes (Flyvbjerg, 2021). Optimism bias is a nondeliberate or unintentional expectation of the ideal future outcome (Flyvbjerg, 2021). In a systematic literature review, Prater and colleagues (2017) found that optimism bias is a significant cause of project schedule overruns. Additionally, Meyer (2014) found that optimism bias is often a barrier to terminating failing projects. There is a plethora of evidence to suggest that optimism bias can influence a range of project aspects. This includes schedule and cost estimation, appraisals of the project characteristics, and risk management (Chadee et al., 2021; Chen et al., 2023; Shalev et al., 2014). Love (2011) suggests that, like strategic misrepresentation, optimism bias can also be influenced by project and organizational factors. Indeed, Son and Rojas (2011) suggest that optimism biases work through organizational dynamics to cause unrealistic schedules and cost estimations. Due to the routine schedule and cost underestimations that occur in defense programs, optimism bias and the contextual dynamics that influence it must be examined.

3. Uniqueness Bias

Uniqueness bias is the tendency for individuals to see themselves as singular and more capable entities (Flyvbjerg, 2021). For example, individuals may perceive themselves as more intelligent, healthy, or attractive than the average population. In program management, managers and planners may perceive their program as singular (Flyvbjerg, 2021). Program managers may overemphasize the differences between their programs and past failures, focusing on their program's potential for success and disregarding evidence to the contrary. This tendency is highlighted by the Project Management Institute's (2017) view that all projects are unique and require unique strategies. While no two projects are exactly alike, all projects face potential setbacks and unknown unknowns that impact their success (Flyvbjerg & Gardner, 2023; Ramasesh & Browning, 2014). Future defense acquisition programs will likely benefit from examining their projects' perceived uniqueness and implementing historical and analogous information. Indeed, the DoD and Defense Acquisition University (DAU) both promote analogous estimation.

4. Planning Fallacy

Planning fallacy is related to optimism bias and is the tendency to base estimations on the best-case scenario (Flyvbjerg, 2021). This cognitive tendency suggests that program managers use the most fortunate, rather than the most realistic, outcome to plan projects. Although there are dissenting views (Ika & Pinto, 2022; Love et al., 2015, 2019), many researchers have found evidence to suggest that planning fallacy can influence decisions and estimations regarding cost, schedule, and performance (Buehler & Griffin, 2015; Buehler et al., 1994, 2002; Moreno & Peters, 2016; Pinto, 2013; Prieto, 2006; Shmueli et al., 2013). Ika and colleagues (2022) suggest that although program managers can be influenced by planning fallacy, idealist planning can sometimes be used creatively to lead to program success. These findings, along with others, suggest that the planning fallacy impacts program success but that these impacts depend on project and organizational contexts. Given these findings, an examination of how planning fallacy and the interaction of planning fallacy with contextual factors impact the success of DoD programs is essential.

5. Overconfidence Bias

Overconfidence bias is related to optimism bias, but it focuses explicitly on optimism related to individual ability while disregarding uncertainty and potential ignorance (Flyvbjerg, 2021). Program managers who rely on overconfidence bias overestimate how much they understand and underestimate how much chance or unknowns will impact program success (Flyvbjerg, 2021). Past research suggests that overconfidence bias can lead to poor risk planning and management, cost and schedule estimation, and project specification and evaluation (Ika et al., 2022; Fabricius & Büttgen, 2013, 2015; Khan & Stylianou, 2009; McCray et al., 2002; Shore, 2008; Zíka & Koblovoský, 2016). Khan and Stylianou (2009) found that overconfidence leads managers to underestimate risk and add additional risk to programs through their follow-on estimations, decisions, and actions. This finding suggests that overconfidence bias can lead program managers to plan and execute their programs ineffectively. Ika and colleagues (2022) found that initial overconfidence is exacerbated by follow-up errors throughout a project life cycle. Additionally, Shore (2008) suggested that overconfidence can combine with other systematic issues to derail project outcomes exponentially. Past research highlights the importance of discovering how overconfidence bias may operate with other systemic and contextual factors to lead to failings in DoD acquisition programs.

6. Availability Bias

Availability bias is the tendency to emphasize information that quickly comes to mind (Flyvbjerg, 2021). Individual memories can be influenced by recency and emotions, making it possible that the recalled information may not be the best. Flyvbjerg (2021), Flyvbjerg and Gardner (2023), and Kahneman (2011) refer to this bias as all you see is all there is. They suggest that availability bias leads individuals to disregard or fail to seek information contrary to their recalled and available memories. This bias can lead to program managers failing to account for risk, misestimating cost and schedule, and minimizing planning, leading to errors throughout the program's life cycle. There is sparse examination of this bias in past research, but Hester and Calida (2010) found that availability bias hindered program managers' decisions, especially managers with less experience. Other research has suggested that program managers are susceptible to availability bias (Cunha et al., 2014; Virine et al., 2018). Shore (2008) suggests that, like other biases, availability bias is impacted by and interacts with contextual factors within which the project is executed. Due to the sparsity of research and its impact on DoD programs, it is important to examine availability bias within DoD programs.

7. Anchoring

Anchoring is the tendency to rely heavily on one piece of information during decision-making (Flyvbjerg, 2021). Anchoring suggests that a program manager may not thoroughly examine all available information and, much like in availability bias, focus on the primacy of a single piece of information when making decisions. An oft-used example is individuals perceiving terrorist attacks or plane crashes as more likely due to the primacy of news reporting of these events rather than their actual probability. Past research has linked anchoring and decision-making in project management (Aranda & Easterbrook, 2005; Barbosa et al., 2019; Lorko et al., 2019; McCray et al., 2002). Lorko and colleagues (2019) found that anchoring impacts schedule estimates, even when a task is continuously planned and executed. Aranda and Easterbrook (2005) found that anchoring leads estimators to be too confident, no matter the estimation tool being used. These findings suggest that as new estimation and planning methodologies and tools are developed, anchoring will still influence them. Given the permeance of anchoring, regardless of the planning methods and tools being used, examining its impact on defense acquisition programs is warranted.

8. Escalation of Commitment

Escalation of commitment (sometimes referred to as commitment bias or sunk-cost fallacy) is the tendency to justify increased costs with previous investments in the project (Flyvbjerg. 2021). Program managers influenced by this cognitive bias will continue programs, justify cost overruns, and make decisions based on the significant time and money investments that have already been made, even if these investments have no bearing on the current and future decisions of the program. For example, a program manager may believe they should pay increased production costs (a decision that may not have been made in isolation) due to the significant investments in design and development. There is a significant amount of research that shows the link between the escalation of commitment and decision-making in project management (Cunha et al., 2014; Dijkstra & Hong, 2019; Jani, 2011; Keil et al., 2000; O'Brochta, 2017; Perignat & Fleming, 2022; Schmidt & Calantone, 2002). Perignat and Fleming (2022) found that escalation of commitment played an important role in determining when to terminate a project. Such research indicates that organizations may continue to invest money, time, and resources in projects that are no longer viable. Flyvbjerg and Gardner (2023) gave an example of the California Rail project, which has run millions of dollars over budget and is still incomplete. Planners and decision-makers have continued to build this rail system despite these setbacks, arguing that discontinuing the project would waste taxpayer money that had already been invested. Keil and colleagues (2000) found that escalation of commitment plays a significant role in decisions to continue a project, but decision-makers' perception of risk influences these decisions. Jani (2011) built on this research, suggesting that risk factors and self-efficacy interact with the escalation of commitment to impact project decisions. Defense programs are routinely over budget and schedule. Due to the mission-critical nature of these acquisitions, the risk of failing programs can be substantial. The failures can exacerbate the impact that escalation of commitment can have on a program. As such, it is necessary to explore how escalation of commitment influences these programs.

9. Behavioral Acquisitions Conclusion

Past research shows how cognitive biases can impact various aspects of a project. However, there is limited research on how they impact DoD-specific acquisition programs. These programs do not happen in a vacuum. Behavioral, affective, and cognitive factors influence these programs. Expansive knowledge concerning behavioral acquisitions is needed within the DoD. These cognitive biases, along with the triple constraint model, greatly influence the outcome of DoD acquisition programs. As such, this research explores the triple constraint model and cognitive biases in acquiring the Constellation-class frigate program.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. RESEARCH METHODOLOGY

A case study analysis of the Constellation-class frigate is used to examine the triple constraint model and cognitive bias in defense acquisitions. In case study research, researchers are meant to reflect on and interpret meanings within contexts and experiences (Stake, 2005). This aligns with the theoretical framework (cognitive biases and triple constraint model) and the purpose of the present study. By reflecting on and interpreting the meaning of cognitive biases within the context and experience of the Constellation-class frigate program, the present study sets a foundation for future defense acquisition work.

In designing a case study, careful case selection is imperative to obtain rich and meaningful data. Past qualitative work (Stake, 2005) has suggested that the case should be selected to represent the larger group of interest. The present study is designed to examine the triple constraint model and cognitive biases in defense acquisitions. Given procurement issues with U.S. Navy shipbuilding and the contemporary nature of the Constellation-class frigate, it was determined that this program would provide great insight into the broader interest of defense acquisitions. To get the most meaningful data, a defense acquisition case that is mature enough to highlight aspects of the triple constraint model but recent enough to explore the dynamic nature of contemporary acquisitions should be used. The case should also reflect defense acquisition's more extensive and general makeup. The Constellation-class frigate program began in FY2020 with the procurement of six ships and plans to procure at least 20 more. The program has seen significant schedule slips and potential cost increases after procuring the initial 10 ships of the class (Oakley, 2024). Due to shifts in the triple constraint model and the maturity of this relatively new defense program, the Constellation-class frigate provides an excellent case study into the larger context of defense acquisitions and U.S. Navy shipbuilding programs.

The data used for the present study is derived from open-sourced documents and reports. Specifically, GAO and CRS reports provide detailed information concerning DoD acquisitions without releasing sensitive technical and other program-related information. From programming inception to the present day, these reports provide data on how the

Constellation-class frigate program has been managed and changed throughout its lifespan. Open-sourced data limits insights into official program artifacts, but GAO and CRS reporting allows access to information and perspectives central to the program without compromising national security.

The present study is designed to deductively examine the themes of cognitive bias and the triple constraint model within the Constellation-class frigate program. This method allows the investigators to examine themes within a larger theoretical framework (Hsieh & Shannon, 2005). Directed content analysis uses existing theoretical frameworks, where investigators identify key concepts or variables to code themes within qualitative data (Hsieh & Shannon, 2005). This type of a priori content analysis allows for the deductive use of theory when analyzing qualitative data (Hsieh & Shannon, 2005). Doing so allows for simultaneous understanding of the data and validation of theory (Hsieh & Shannon, 2005). The present study utilizes the themes of cost, schedule, and performance from the triple constraint model and optimism bias, uniqueness bias, planning fallacy, overconfidence bias, availability bias, and anchoring from the cognitive bias literature. These themes were chosen because they (a) have the most substantial evidence in project management literature and (b) are the most pertinent to the individual management of acquisition programs. Strategic misrepresentation and escalation of commitment are not included in this study because they are more pertinent to organizational or structural biases than the individual biases of those managing the program.

Cognitive biases may significantly impact the outcomes of defense acquisition programs within the context of the triple constraint model. According to project management literature, individual biases that impact programs include optimism bias, uniqueness bias, planning fallacy, overconfidence bias, availability bias, and anchoring. This is especially true for defense acquisition programs due to the mission-critical nature of their procurements. The present study's findings can advance knowledge on defense acquisition and U.S. Navy shipbuilding programs. The potential findings also set the foundation for larger-scale studies to continue to inform the best defense acquisition practices.

V. ANALYSIS

This chapter is an analysis of behavioral acquisition by searching for evidence of the following six different biases: optimism, overconfidence, uniqueness, planning, availability, and anchoring. Additionally, this chapter analyzes how the triple constraint model was used to manage the Constellation-class frigate program.

A. BEHAVIORAL ACQUISITION INDICATIONS

1. Indications of Optimism Bias

As defined by Flyvbjerg (2021), optimism bias is the cognitive tendency of individuals and organizations to overestimate the likelihood of favorable outcomes while underestimating risks and uncertainties. This trend is particularly evident in large-scale infrastructure and defense acquisition projects, where stakeholders, motivated by political, strategic, and financial incentives, often set overly ambitious timelines and cost estimates. The Constellation-class frigate program, examined in a May 2024 GAO report (Oakley, 2024) and a December 2024 CRS report (O'Rourke, 2024a), provides multiple examples of optimism bias in U.S. Naval procurement.

The U.S. Navy's decision to commence construction on the lead Constellation-class frigate before completing its design is the most prominent example of optimism bias. The GAO notes that design instability and delays in functional design completion have resulted in significant schedule slippage (Oakley, 2024). Despite leveraging a modified French-Italian FREMM design to reduce technical risk (see Figure 13), the U.S. Navy underestimated the time and complexity required to adapt the parent design to U.S. military standards, leading to cascading design and construction disruptions.

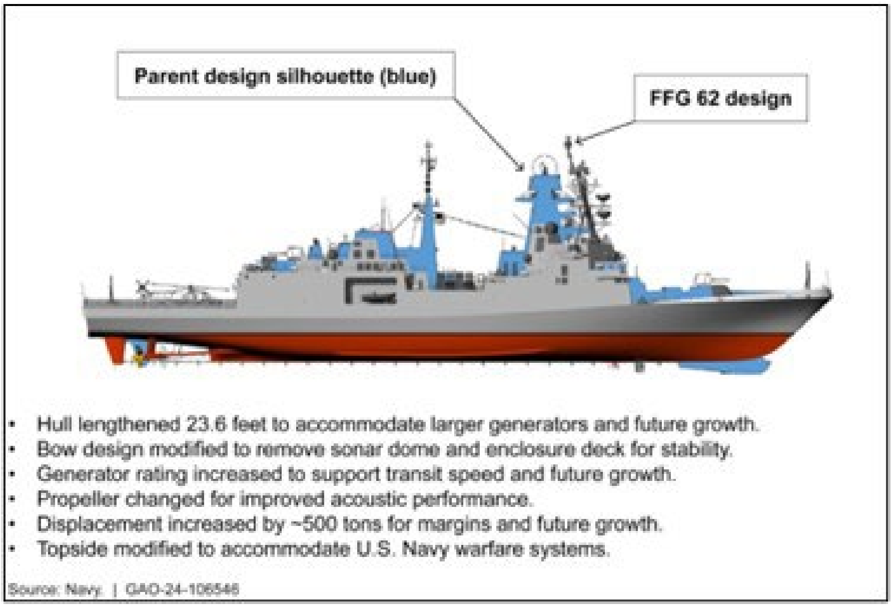


Figure 13. Illustration of FFG 62 Design Changes from Parent Design. Source: Oakley (2024).

This overestimation of design maturity reflects Flyvbjerg's (2021) assertion that project managers frequently assume best-case scenarios, leading to premature decision-making that overlooks potential technical and integration risks. The already created and proven design of the Italian French FREMM may have contributed to the U.S. Navy's optimism in modifying the frigate's design. The U.S. Navy's modifications of the FREMM design were intended to reduce risk, but the extent of the modifications required, especially for propulsion, combat systems, and survivability enhancements, was significantly underestimated. By 2024, the commonality with the original FREMM design had dropped below 15%, suggesting the ship was a new design rather than a minor modification.

The initial contract awarded in April 2020 projected the lead ship's delivery by April 2026 (O'Rourke, 2024a). However, by early 2024, the U.S. Navy publicly acknowledged that this target was unachievable, with an updated delivery estimate of 2029—three years behind schedule (O'Rourke, 2024a). The CRS report also highlights how initial estimates were based on flawed design stability metrics, emphasizing quantity over quality of design documents (O'Rourke, 2024a). This miscalculation reflects optimism bias in megaprojects, where unrealistic schedules are set based on insufficient observed data or an overreliance on best-case assumptions.

Optimism bias is evident in the initial cost projections that assumed minimal risk from design modifications. However, historical shipbuilding programs like the LCS have demonstrated the pitfalls of assuming fixed-cost efficiencies in complex naval construction. The Constellation-class frigate program initially sought to contain costs by leveraging an existing design and using fixed-price incentive contracts. However, cost growth in key government-furnished equipment systems for the first four ships has already reached $310 million, and further increases are anticipated as inflation and supply chain challenges persist (Oakley, 2024). Flyvbjerg (2021) identifies political and institutional incentives as key drivers of optimism bias, particularly in government procurement programs where cost and schedule underestimation, combined with downplaying risk factors, can secure initial funding. Additionally, cost overruns may escalate further as the program progresses beyond the first ten ships, necessitating increased congressional oversight.

2. Indications of Overconfidence Bias

Overconfidence bias refers to the tendency of individuals or organizations to overestimate their ability to predict outcomes, underestimate risks, and overlook potential challenges (Flyvbjerg, 2021). In the context of the U.S. Navy's Constellation-class frigate program, this bias can be linked to individual overestimations of project control and collective misjudgments about the program's technical feasibility, timeline, and cost constraints.

The LCS program's failure exerted immense institutional pressure on the U.S. Navy to expedite the Constellation-class frigate as a more capable and survivable small surface combatant. In such an environment, decision-makers are likely overcommitted to aggressive schedules and cost estimates to garner congressional support and maintain fleet readiness projections. A primary example of overconfidence bias in the Constellation-class frigate program is the U.S. Navy's decision to begin construction on the lead ship before the design was finalized. According to a GAO report, the U.S. Navy approved the construction of the first ship based on an incomplete design, a choice that defied leading ship design practices (Oakley, 2024).

This overconfidence in managing design stability highlights a fundamental misjudgment: the belief that construction could proceed successfully without the complete foundational designs. The consequences became evident when delays in completing design documents led to weight growth and construction slowdowns, severely hampering the timeline and driving up costs.

The initial timeline for delivering the first frigate was set for April 2026, but by 2024, the U.S. Navy had acknowledged that this deadline was unachievable, forecasting a delay of 36 months. This gap between initial expectations and reality indicates overconfidence bias, an overestimation of the U.S. Navy's ability to meet the initial schedule despite lacking the necessary design and testing data:

> The frigate is using many mission systems already proven on Navy ships. However, the Navy has yet to demonstrate two propulsion and machinery control systems. A planned update to the frigate test plan—combined with the opportunity afforded by schedule delays—could offer the Navy the chance to conduct land-based testing of these two unproven systems. (Oakley, 2024, p. 2)

The program's leadership showed misplaced confidence in the speed and efficiency of its processes, failing to adequately account for the time required to finalize key design aspects and resolve unforeseen challenges during construction (see Figure 14) (Oakley, 2024).

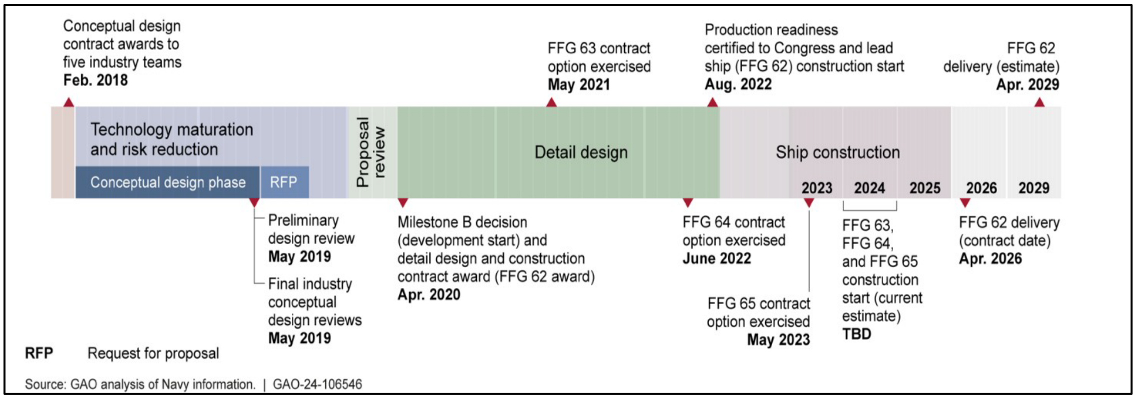


Figure 14. Frigate Acquisition Schedule. Source: Oakley (2024).

The U.S. Navy's use of a traditional, linear development approach rather than a more iterative and agile methodology also contributed to overconfidence. As commercial shipbuilders and best practices in product development advocate, iterative cycles that involve rapid prototyping and testing can expose problems early and adjust project trajectories. However, the U.S. Navy's linear approach, which did not fully incorporate this iterative feedback mechanism, reinforced the belief that issues would be resolved during the build phase. The lack of robust land-based engineering testing for the systems in question contributed to the overconfidence that any technical issues could be addressed post-construction, a classic sign of underestimating future uncertainty (Oakley, 2024).

3. Indications of Uniqueness Bias

As stated earlier in this report, uniqueness bias leads program managers to potentially overemphasize the differences between their programs and failures in the past, focusing on their program's potential for success and disregarding evidence to the contrary within reports such as the CRS report regarding the Constellation-class frigate program (O'Rourke, 2024a). The report highlights five key areas that link to a uniqueness bias within and outside the program: being overly confident in a modified parent design, ignoring established best practices, repeating known pitfalls from past programs, having an overly optimistic view on schedule and risk to the program, and having technical overconfidence in system integration. Due to the limited information available regarding specific decisions, this analysis focuses on more significant programmatic decisions that have a positive indicator of uniqueness bias.

Overconfidence in a modified parent design is linked to the creation of the Constellation class and how the U.S. Navy perceived that by adopting a derivative design from the French and Italians, the ship would only need to be modified by 15% to meet U.S. Navy requirements and standards. An example of this overconfidence is:

> At one point, the Constellation design shared about 85 percent commonality with the original FREMM design, but the alterations have brought that commonality down to under 15 percent, a person familiar with the changes told USNI News. If the FFG-62 design shares less than 15% commonality with the FREMM design, then some observers might characterize the FFG-62 program as having moved over time toward what might be termed a parent design in name only (PDINO) design approach. (O'Rourke, 2024a, p. 9)

This illustrates the fluid dynamics that the four program managers at the helm of the Constellation-class frigate program have had to contend with as they have matured the design. These changes have a snowball effect upon implementation, as one change within a subsystem can have substantial changes that ripple throughout the rest of the more extensive system. The commonality changes from 85% to 15% may have imposed significant challenges to the program's cost, schedule, and performance.

The second key area highlighting uniqueness bias is ignoring best practices. Shipbuilding has struggled recently within the United States from personnel turnover and retirements during COVID-19, and some of the art of shipbuilding has atrophied with the more significant issue of industrial capacity shrinking over the last half-century. As fewer personnel within the U.S. Navy have shipbuilding experience and contracted shipbuilders have had to rebuild their workforces, there have been gaps in knowledge. This is illustrated as follows:

> To reduce the technical risk [in the FFG 62 program], the Navy and its shipbuilder [in designing the FFG 62] modified an existing [Italian–French frigate] design to incorporate [U.S.] Navy specifications and weapon systems. However, the Navy's decision to begin construction [of the first FFG 62] before the design was complete is inconsistent with leading ship

design practices and jeopardized this approach. Further, design instability has caused weight growth. (O'Rourke, 2024a, p. 2)

This demonstrates that program managers may not have had much industrial knowledge to draw from when utilizing a parent design and the second- and third-order effects of leveraging a parent design with modifications.

Third, the Constellation class fell into the trap of repeating known pitfalls from past programs. Some portions of the first ship's keel were laid before the modular construction design and build phases of the design process were started. However, fluid designs can also lead to issues retaining a workforce that can balance multiple programs in one shipyard footprint:

> Vice Admiral James Downey, head of Naval Sea Systems Command, told reporters last week that in addition to workforce hiring and retention issues, the frigate delay stemmed in part from the ship's incomplete design and from Fincantieri working on three programs simultaneously at its Wisconsin yard, including a vessel for Saudi Arabia. (Capaccio, 2024, p. 1)

The Constellation class is being built keel-up from within the shipyard. There is no modular design approach from a construction perspective, such as with construction of the new Columbia-class submarines. These problems of balancing multiple projects at one shipyard may also indicate a uniqueness bias that is not fully understood, as its impacts are not a Constellation-centric issue.

Fourth, both the program and the U.S. Navy had an overly optimistic view of schedule and risk to the program. The Navy initially believed that the ship would have a faster design-to-delivery schedule since it would have essentially the same form factor as the FREMM, but as the contract was awarded for the Constellation class's first ship, COVID-19 impacted global supply chains. This, combined with personnel turnover both on the DoD and the contractor sides, impacted on the initial delivery indications. Although COVID-19 and personnel issues contributed to the Constellation class's schedule delays, they were not the only factors. In fact, the U.S. Navy has struggled in the past to successfully use a parent design for a new ship class:

> The U.S. Navy has experimented with many approaches to design and build its ships. Using an existing design as the "parent" design, also referred to as

> a "modified-repeat" design, is, on its face, an attractive option. Many acquisition executives, Program Managers, and some ship design engineers believe that a design based on a parent has fewer technical risks than a new "clean sheet of paper" design, and, therefore, the time and cost to design and build it will be reduced. They assume early in the ship acquisition program that "the design is mature," and because of that, fewer problems will be encountered in completing the design, and savings will thus be accrued. However, several naval ships based on a parent design have experienced unanticipated cost and schedule growth during construction and technical problems during their in-service life. (Keane & Tibbitts, 2015, p. 92)

The U.S. Navy has highlighted the need to get more ships in the water and underway to meet an ever-growing demand, especially within the Western Pacific. This has potentially pushed program managers within the Constellation class to set demanding timelines that are not feasible due to multiple variables that are not within their control. These variables may impact the program, and using a parent design may have created more issues with additional programmatic risk than initially thought.

For instance, the U.S. Navy may have believed it had technical confidence in system integration, but no new technologies would be developed for this platform:

> As an additional measure for reducing cost, schedule, and technical risk in the FFG-62 program, the Navy envisages developing no new technologies or systems for FFG-62s—the ships are to use systems and technologies that already exist or are already being developed for use in other programs. (O'Rourke, 2024a, p. 9)

No new technology development during the program indicated that the U.S. Navy and the program office did not want to overcomplicate the Constellation development, design, and manufacturing process. However, with no new technologies, there may have been a reduced prioritization of the risk analysis of implementing U.S. requirements for the propulsion and mechanical plants onboard the ship, leading to schedule delays. A parent design may have led program managers and the U.S. Navy to view the Constellation class as unique, as its design approach was much different from that of other ships currently under construction within the U.S. Navy.

4. Indications of Planning Fallacy

Analysis indicates that the Constellation-class frigate program appears to exhibit characteristics of planning fallacy. The program's estimates and milestones have been based on best-case and overly optimistic assumptions rather than realistic appraisals of complexity and risk. The Constellation-class frigate program made its schedule, cost, and performance estimates without regard to the complexity of designing and building a new class of warships. Specifically, reliance on a parent design led to overly optimistic estimations concerning the completion of design and construction. This is evidenced by the schedule of the program, the commitment to construction prior to design completion, and overreliance on quantity metrics for design progress.

The Constellation-class frigate program has consistently shifted the delivery of the first ship. Shifts in this delivery date are evidence that the program exhibits planning fallacy. For example, one CRS report states:

> The Navy acknowledges that the April 2026 delivery date, set in the contract at award, is unachievable. The lead frigate is forecasted to be delivered 36 months later than planned. (O'Rourke, 2024a, p. 14)

The U.S. Navy's April 2024 announcement states that the delays are based on workforce and supply chain issues (O'Rourke, 2024a). The original delivery date of the frigate was planned for 72 months from the beginning of construction, making a 36-month delay a 50% increase to the original delivery date. This deviation suggests that early planning relied on a best-case scenario that did not incorporate realistic risk factors. Additionally, historical data from previous shipbuilding programs were disregarded. Past shipbuilding programs used for analogous estimation would have highlighted that a 72-month delivery was highly unlikely. Reliance on a parent design would have triggered planning fallacy, making estimates concerning schedule overly optimistic.

More evidence suggesting the presence of planning fallacy in the Constellation-class frigate program is the premature commitment to construction before design completion. According to a GAO report,

> The Navy's decision to begin construction [of the first FFG 62] before the design was complete is inconsistent with leading ship design practices and jeopardized this approach. (Oakley, 2024, p. 2)

The report highlights the U.S. Navy's decision to approve construction with significant gaps in the knowledge of structural, piping, ventilation, and other systems (Oakley, 2024). This decision implies that the U.S. Navy assumed an ideal progression of design work—a manifestation of planning fallacy in which the potential for delays and design instability is underestimated. This has hindered the program's execution because construction must be periodically halted as the design evolves and matures. The U.S. Navy's reliance on the parent design led to a best-case scenario estimation of schedule. Additionally, it has impacted performance, as there is a discussion of limiting the speed requirements of the frigate (Oakley, 2024). The planning fallacy encouraged construction to begin before design maturity, introducing additional risk and unpredictability to the program.

Lastly, the reliance on quantitative rather than qualitative design progress metrics implies additional evidence for planning fallacy in the program. A CRS report states:

> The program office tracks and reports design progress, but its design stability metric hinges largely on the quantity—rather than quality—of completed design documents. This limits insight into whether the program's schedule is achievable. (O'Rourke, 2024a, p. 2)

Moreover, the CRS warns that if the U.S. Navy continues to use such superficial measures, beginning construction on subsequent frigates might replicate the same errors that led to delays with the lead ship (Oakley, 2024). Specifically, Oakley (2024) explains that the U.S. Navy tracks design maturity through the number of Contract Data Requirement List items the shipbuilder submits. Counting the number of these items as a proxy for readiness creates a false sense of security, relies on optimistic planning, and obscures underlying technical and design challenges.

Reports suggest that by setting an unachievable delivery date, beginning construction before fully resolving design uncertainties, and relying on quantitative design metrics, the program reflected a planning fallacy—basing critical project milestones on overly favorable assumptions rather than realistic, risk-adjusted expectations.

5. Indications of Availability Bias

As stated previously, the core of availability bias is that individuals will disregard or fail to seek information contrary to their recalled and available memories. This bias can lead to program managers failing to account for risk, misestimating cost and schedule, and minimizing planning, leading to errors throughout the program's life cycle. Two key areas indicate availability bias within the Constellation class: overreliance on the parent FREMM design without accounting for U.S. adaptation risk and underestimation of the complexity of integrating existing systems that did not account for the dynamic nature of the reality of U.S. shipbuilding.

The program indicates a potential overreliance on the parent FREMM design without analyzing the risks associated with adapting the underlying design to U.S. specifications that are required of U.S. Naval warships. Significant requirements for the survival of U.S. Naval warships must be incorporated into any combatant ship. While not outlined here, these requirements are significant enough to impact any baseline design, even for allied classes of ships. This comment from 2021 stated that changes to the propulsion plant were not going to be implemented:

> While some changes are expected to meet the Navy's needs, enlarging the hull form itself can change where components in the ship must be placed, as well as the overall cost. Asked about how possible changes in the ship's hull could affect the internal design, Smith said Fincantieri Marinette Marine, the Constellation's prime contractor, worked with Naval Surface Warfare Center Carderock to develop a scale model of the ship and that most elements will stay true to the parent design. He cited the bridge and propulsion plant as areas where the Navy has not made any significant changes to the layout. (Katz, 2021)

However, as of 2025, design changes to the power plant have impacted the program's schedule. This indicates that availability bias may have occurred within the program office, creating misestimates of cost and schedule to continue the fluid design phase. Additionally, the U.S. Navy underestimated the complexity of integrating existing systems into the new hull form of the modified FREMM design:

> The Navy began frigate construction in August 2022 with an incomplete functional design, counter to leading ship design practices. The Navy and shipbuilder continue to finalize key functional design documents over a year after construction began. For example, as of December 2023, the program's functional design and 3D model remained incomplete. We found that delays in completing the functional design have had a cascading effect on other design activities, including 3D modeling, detail design, and development of work instructions needed to build the ship. (Oakley, 2024, p. 13)

These design details required substantially more time to complete than initially expected. The GAO has iteratively detailed in numerous reports that the cascading effect of not solidifying design early enough in the program has created secondary issues that have precluded the program office from remaining on schedule. Further evidence is that the U.S. Navy and the program management show indications of availability bias from an overly optimistic viewpoint. The program additionally had design stability metrics that did not account for the dynamic nature of the reality of U.S. shipbuilding. Instability and inadequacy of the design metrics due to an overreliance on quantity over quality of design are shown in the following example:

> The Navy and its shipbuilder leveraged an existing ship design to reduce technical risk and deliver frigates sooner. However, the Navy's decision to approve the shipbuilder to begin construction with an incomplete design is inconsistent with leading ship design practices, jeopardizing this strategy. Persistent shipbuilder delays in completing the design have also created mounting construction delays, rendering the lead frigate's April 2026 contract delivery date unachievable. While the Navy tracks design progress, its process to calculate design stability hinges largely on the quantity—rather than the quality—of completed design documents. The focus on quantity obscures functional design progress and how much design work remains. Program challenges and delays have increased estimated contract costs; however, the Navy's fixed-price incentive contract helps limit cost risks. (Oakley, 2024, p. 13)

This indicates that the U.S. Navy and the program office have an availability bias and will not fully implement the iteratively recommended GAO suggestions for stabilizing the program with a more practical design progress system.

6. Indications of Anchoring

Within the Constellation-class frigate program, anchoring has shaped decision-making by causing program managers to overvalue specific pieces of information, including an initial estimate, the parent design, and the program design, at the expense of a more holistic programmatic view.

Early in the program, the U.S. Navy set an optimistic baseline that anchored subsequent decisions. For example, one CRS report shows that the original 72-month schedule estimate is a fixed reference point (O'Rourke, 2024, p. 12). This reference point was used as an anchor for subsequent decisions regarding schedule. Similarly, funding decisions were influenced by early cost estimates. The GAO noted "that the Navy requested funding for the lead frigate before it had validated its cost expectations" (Oakley, 2024, p. 1). This budgetary request likely stems from initial schedule estimates and a desire to stay within schedule constraints. This reliance on initial optimistic figures, even when new information emerged, suggests that early data anchored further decisions.

Anchoring in the parent design was a critical factor that shaped the Constellation-class frigate program. Decision-makers anchored their expectations and planning around a pre-existing Italian–French frigate design, believing that modifying this design would mitigate risk and streamline development. However, this focus on parent design led to several issues. According to the GAO,

> To reduce the technical risk [in the FFG 62 program], the Navy and its shipbuilder [in designing the FFG 62] modified an existing [Italian–French frigate] design to incorporate [U.S.] Navy specifications and weapon systems. (Oakley, 2024, p. 2)

Anchoring on this established design created an expectation that the parent design's inherent capabilities and construction methodologies would carry over with minimal disruption. This assumption downplayed the complexity of adapting a foreign design to meet unique U.S. requirements. By relying heavily on the parent design, program managers were less inclined to critically evaluate the new technical demands imposed by U.S. Navy specifications. This led to underestimating the modifications required. The optimistic reliance on the parent design contributed to the decision to start construction before the design was fully completed—a decision that contradicts leading ship design practices (Oakley, 2024). Anchoring on the parent design also meant that the program inadvertently inherited limitations from the original design. The decision to modify rather than re-engineer a design from scratch implied that the Italian–French design's underlying assumptions and legacy constraints were appropriate for U.S. needs. This narrow focus hindered a comprehensive reassessment of whether the baseline design was optimal for the modern operational environment of the U.S. Navy.

The program also has been anchored to historical program methods. This is especially concerning given that the frigate program was established partly to remedy pitfalls of the LCS program. The decision to employ a traditional, linear development approach is noted in several documents, with one CRS report stating, "The frigate is using a traditional, linear development approach for design and construction" (O'Rourke, 2024a, p. 2). This choice seems anchored in past experiences with shipbuilding programs, even though those historical practices have often led to delays and cost overruns. In relying on these well-trodden methods, decision-makers may have discounted new or more adaptive strategies that could better address the unique challenges of the Constellation-class frigate program.

These examples illustrate that the parent design, specific early benchmarks, and familiar acquisition methodologies have anchored the program's decision-makers. This cognitive bias likely narrowed their focus, whether it was anchoring on an initial delivery date and cost estimate, relying too heavily on the parent design, or defaulting to established development methods. As a result, the decision-makers may have failed to fully integrate a broader range of information that could have prompted a more realistic and adaptive approach to managing the program's inherent risks.

B. TRIPLE CONSTRAINT

The triple constraint theory for the Constellation program was analyzed through the vertices of cost (budget), performance (scope), and schedule (time). The program office and program managers of the Constellation class have battled to balance the triple constraint model to ensure that the U.S. Navy receives a capable class of ships on time, within budget and meeting performance requirements. Outside factors, such as COVID-19 and a shrinking shipbuilding industrial base, combined with internal factors, including a fluid ship design of the Constellation and inversion of the parent FREMM design from 85% original and 15% redesign to 15% original and 85% redesign, have precluded the leading ship of the Constellation class from arriving in 2026 as anticipated to a new estimate of FY2029 (O'Rourke, 2024b, p. 8).

1. Cost

Costs are attributed to many variables within acquisitions, and due to the impact of COVID-19, there have been higher rates of inflation during the initial stages of the Constellation class planning and design phases. However, cost growth outside of those factors has been identified, including in ships five through 10:

> The Navy has identified nearly $310 million in cost growth on key government-furnished equipment systems for the first four frigates. The U.S. Navy also identified cost growth for future frigates. Program officials stated that the cost growth is largely due to inflation and economic factors affecting material and labor prices. The U.S. Navy received nearly $310 million through a reprogramming action to address this cost growth. It plans to request funds for identified cost growth in fiscal years 2025–2029 in budget requests for those years. (Oakley, 2024, p. 7)

The U.S. Navy has shown in other classes of ships that the triple constraints, particularly cost, are addressed by one of two methods: congressionally approved additional funds and operating within firm-fixed-price contracts (Oakley, 2017). It is difficult for Congress to approve additional funds for an already over-budget program while the DoD faces greater scrutiny of its spending. Secondly, operating under a firm-fixed-price contract may maintain cost growth. However, this is mainly due to an easing of prioritization among the other two sides of the triple constraint pyramid. Typically, schedules suffer the most, as it is the easiest to assume risk on and does not require additional congressional funds. This is evident in the Constellation-class frigate program that, with initial delivery of the leading ship having been delayed 3 years. Firm-fixed-price contracts are also not as conducive to programmatic success when there are high design, integration, and construction risks associated with the development of the platform and in this case a new class of ships for the U.S. Navy (Oakley, 2017).

2. Performance

Programs are tasked with finding materiel solutions to address the scope of performance and capabilities outlined within approved operational requirements. Shipbuilding within the U.S. Navy indicates that lessons learned from previous programs are being applied, such as limiting or prohibiting any new technology development within the Constellation class. However, evidence of scope creep has been identified throughout the life of the Constellation program:

> According to program officials, the increase in priority CDRL items reflects the Navy's and shipbuilder's focus on completing critical, open design documents needed to support construction. In other words, this increase does not reflect the added design scope to the existing contract. However, it reflects the program's increased focus on finalizing key design details, including design details for interdependent and distributive systems. However, until these design documents are closed (approved), the shipbuilder cannot complete the ship's 3D model, from which the shipbuilder develops the detailed design for individual grand modules. Further, according to leading ship design practices, construction on a block (or grand module) of a ship should not commence until that block's detailed design is complete. Leading commercial shipbuilders rely on this completion to ensure that the construction of blocks progresses in a timely and efficient manner. However, the frigate shipbuilder began constructing grand modules with an incomplete detail design, inconsistent with this leading practice. (Oakley, 2024, p. 15)

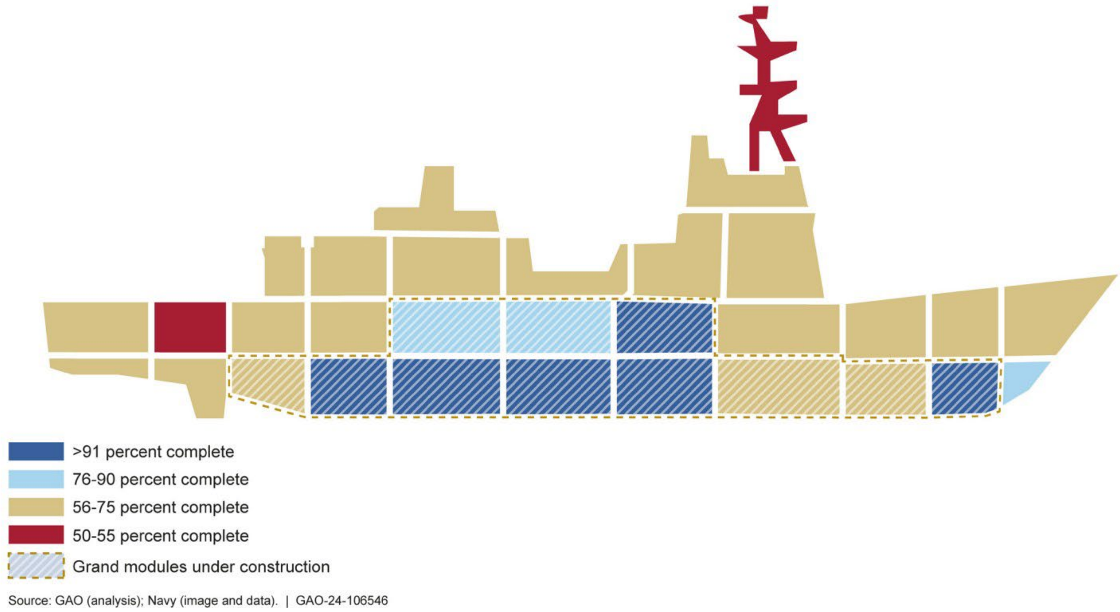
The requirements for the design modifications within the Constellation class shifted over the program's life, as integrating U.S.-based systems and survivability subsystems within the design created significant delays. The Constellation class has signs of scope creep occurring programmatically that negatively impact the ship's delivery schedule. Each schedule delay moves the Constellation class further away from its goal of reducing the global mission workload on the Arleigh Burke-class destroyers.

3. Schedule

Schedule within the Constellation class has proven to be the simplest method of maintaining flexibility within the triple constraint model. Flexibility within the schedule have led to significant delays throughout the ship's design process. One of the core issues creating schedule delays is the fluid design that created a backlog at the shipbuilder engineering development team and at the U.S. Navy office to approve the engineering design changes. The issue of approving design changes on a parent design program is underestimated from the program's initial phases. To illustrate that issue, the GAO identified problems within the government and contracted design teams to get accurate documentation completed in a timely manner to maintain the original schedule:

> We (GAO) found that CDRL (Contract Data Requirements List) items have often required multiple rounds of review between the Navy and shipbuilder to address comments and close the items as completed. For example, in July 2022, the shipbuilder responded to over 170 critical comments it received from the Navy on one of the 26 supporting documents that comprise the structural design CDRL item. The structural design was the first part of the frigate design developed by the shipbuilder and accounts for 20 percent of the overall frigate design, according to program officials. As of July 2023, program officials stated the structural design was highly mature—even though most of the 26 supporting documents remained incomplete. (Oakley, 2024, p. 20)

The Constellation was originally designed to maintain 85% of its parent FREMM design, but there are indications that the U.S. Navy underestimated the scale of design changes that would need to be addressed (see Figure 15). This created a further bottleneck for the program office to address to shore up the schedule delays.



Note: The percentage reflects a collective average generated by the GAO of 3D modeling completion based on individual percentages for six elements—structural; outfitting; machinery; electrical; heating, ventilation, and air conditioning; and auxiliary.

Figure 15. Shipbuilder Assessment Frigate 3D Modeling Progress by Grand Module (October 23). Source: Oakley (2024).

4. Triple Constraint Conclusion

The Constellation class has proven that retaining a balance within the triple constraint model for a new class of ships is very difficult. The triple constraint is a means to illustrate the balance required to achieve an on-time, on- or under-budget project that delivers what it sets out to achieve. However, in the case of the Constellation class, there have been overages in all three legs of the triple constraint triad, resulting in delayed capability for the warfighter, more strain on the destroyer fleet, increased costs, and significant amounts of design rework needed to achieve a stable design for further construction of the class.

VI. CONCLUSIONS AND RECOMMEDATIONS FOR FURTHER RESEARCH

The purpose of the present study was to determine if the triple constraint model is a valuable tool to help program managers and decision-makers understand trade-offs between schedule, cost, and performance during DoD acquisitions while balancing cognitive biases. Specifically, given the design immaturity of the Constellation-class frigate, did the program office effectively implement the triple constraint model and proactively address potential cognitive biases to deliver the frigate's capabilities on time and at a fair and reasonable cost?

The present study shows that U.S. Navy ship acquisition programs, including the Constellation-class frigate program, may be at increased risk of breaking the triple constraint model due to the complexity of shipbuilding and the implications of the human factor of biases—both acknowledged and unacknowledged—when making decisions. The complexity of U.S. Naval warship building creates dilemmas for program managers as they navigate the endless variables and constraints. These variables and constraints, such as a hollowed-out civilian shipbuilding industrial base, scope creep with requirements, and the use of a parent design in the case of the baseline Constellation class, all contribute to highlighting the ineffectiveness of the triple constraint model to accurately portray the larger picture of the issues shipbuilding program managers face daily.

A. RECOMMENDATIONS

Given the prevalence of cognitive biases within the Constellation-class frigate program, it is important that the DoD systematically addresses cognitive biases within its acquisition programs. The authors recommend that the DoD address these biases in three ways:

1. education programs targeting cognitive biases
2. efforts to formally expand program managers' networks

3. introduction of methodologies and artifacts that address cognitive biases in projects and programs

Through a formal and systematic approach, the DoD can limit cognitive biases' influence on DoD acquisition programs. Cognitive biases can likely never be eradicated from DoD acquisition programs due to the nature of the cognitive biases inherent in human cognition. However, implementing these recommendations can limit the impact of these cognitive biases on DoD programs.

Education programs targeting cognitive biases have been shown to limit these biases in organizational decision-making and project management (Fasolo et al., 2024; Nili & Barros, 2024). Education programs highlight cognitive biases' impact on programs and encourage program managers to address their and their teams' biases within acquisition programs. The DoD is well-positioned to implement an education program for its program managers. Many Army program managers learn about cognitive biases and sound decision-making principles through the defense program management curriculum at the Naval Postgraduate School (NPS). The U.S. Navy could have its program managers complete the same courses. U.S. Navy program managers primarily consist of engineering duty officers who receive graduate-level training in engineering. Although this provides these officers with much technical information, little effort is given at the graduate level to train these future program managers in Program Management Institute standards and acquisition science. Having future program managers attend the defense program management program at NPS will provide them with the tools and resources to manage these programs more effectively. The Defense Acquisition University (DAU) also provides program managers and other acquisition professionals with acquisition training required to work on defense acquisition programs. The DAU could streamline cognitive bias education by adding it to its curriculum. Adding this to the curriculum, which is already required among acquisition professionals, will help inform DoD program managers and limit cognitive biases' impact on DoD acquisition programs. During the selection of program managers within DoD programs, the requirement to include civilian professional certifications that may consist of industry best practiced certifications such as Project Management Professional (PMP), Program Management Professional (PgMP), and/or Portfolio

Management Certification (PfPM) may be of great benefit to advance the program manager talent pool.

Past research also shows that expanding project managers' networks, formally and informally, can limit the impact of cognitive biases in large-scale projects (Fasolo et al., 2024; Nilli & Barros, 2024). Expanding program managers' networks can help hone their critical thinking skills, broaden their experience, and introduce new perspectives and ideas. Some programs use specific tools, like software, that encourage collaboration with those outside the specific program. Other programs use informal techniques, like workshops and conferences. Whether informal or formal, collaboration and communication with acquisition professionals outside the silo of the program can provide insight that can limit the impact of cognitive biases on defense acquisition programs. As with cognitive bias education, the DoD is already well suited to implementing these changes in its acquisition programs. For example, the Constellation-class frigate is housed in the Program Executive Office of Unmanned and Small Combatants. Among other things, this PEO is responsible for the U.S. Navy's LCS, mine warfare, and unmanned ship programs. This PEO is housed within Naval Sea Systems Command (NAVSEA) and is responsible for aircraft carriers, submarines, and other surface ships. Given the nature of the acquisition organization, NAVSEA and Program Executive Office of Unmanned and Small Combatants could foster collaboration and communication among the various programs within their purview through systematic, formal, and informal means. Doing so would develop their program managers and address cognitive biases within their programs.

The project management literature suggests many tools and artifacts for combating biases. These include reference-class forecasting, independent health checks and audits, and other Project Management Institute tools (Flyvbjerg & Gardner, 2023; Kerzner, 2025). Reference-class forecasting involves predicting the future outcomes of a program using historical data from past programs (Flyvbjerg & Gardner, 2023). Doing this allows project managers to limit the perspective that their program is unique. Additionally, it helps anchor program managers in a more realistic perspective of the program outcomes. The DoD has a plethora of information on shipbuilding. Utilizing reference-class forecasting in these programs will help individual program managers predict more realistic outcomes given the constraints of their program. Independent health checks and audits provide outside information concerning the metrics and progress of a program (Kerzner, 2025). Allowing outside entities to investigate the program will help introduce a greater depth of cognition and new perspectives regarding the program's progress. DoD acquisition programs already have much oversight, including independent cost estimates and congressional investigations (e.g., GAO reports). However, many of the findings of these independent entities are either dismissed or overlooked, often because of cognitive biases. DoD acquisition programs must create a culture in which outside perspectives are welcomed and thoughtfully implemented. Lastly, the Project Management Institute provides many artifacts that have been historically implemented to limit cognitive biases in projects. These include agile methodologies, requirement prioritization, and cost and schedule estimating techniques. DoD acquisition teams must become more familiar with these tools and introduce Project Management Institute artifacts into DoD acquisitions. These additional methodologies and artifacts will give program managers a greater breadth of tools to combat cognitive biases and encourage the successful execution of DoD acquisition programs.

B. SUPERFICIALITY OF TRIPLE CONSTRAINT

The triple constraint theory of cost, schedule, and performance is a commonly used framework in project management and has become a dogma in the defense acquisition system. While this model is helpful for essential project planning, it oversimplifies the complexities of defense projects. Many factors, such as external changes, risk uncertainties, and stakeholder needs, affect a project's success, yet the triple constraint model focuses only on three primary constraints. Projects are much more dynamic in practice, involving numerous factors that cannot be reduced to cost, schedule, and performance.

Since the triple constraint theory overlooks important qualitative aspects like quality and stakeholder satisfaction, a significant recommendation is to view the theory as a rudimentary tool while still incorporating features tailored to specific projects. For example, performance may be a primary constraint in the triple constraint theory, but performance quality may be understated in key performance parameters or indicators. A project might meet its cost, schedule, and performance targets, but it can still be considered a failure if it does not meet quality standards or stakeholder expectations. The technically focused theory also does not address the role of team dynamics, leadership, and organizational culture, all crucial elements for a project's success that are not captured in the triple constraint model. A project team's ability to adapt to changes, work cohesively under pressure, and leverage diverse skills is essential for achieving the desired outcomes.

The relationship between cost, schedule, and performance is not always straightforward. These elements are interdependent, and decisions in one area often affect the others. For example, reducing costs might delay the schedule or impact performance. Modern projects, especially those involving innovation or research and development, are subject to frequent changes, making the triple constraint theory framework too rigid to capture the evolving nature of these projects; resource constraints, whether human, technical, or material, further complicate this dynamic.

While the triple constraint model can help guide some project priorities, it should not be the sole framework used to manage projects. It is better viewed as one of many tools in project managers' toolkits, best used alongside other models like risk management or agile methods. A more comprehensive approach is needed to manage the full range of factors influencing project success. The triple constraint theory should be a starting point, not a definitive guide to project management decisions.

C. AREAS FOR FURTHER RESEARCH

Throughout the present study, GAO and CRS reports were used to investigate past U.S. shipbuilding programs and the current Constellation-class frigate program. As an intentional scope limitation on the project, research documents were restricted to include sources from outside the program. Future Constellation-class frigate program researchers should investigate classified programmatic documentation to better delineate the program managers' decision-making processes with greater contextual clues of cognitive biases to better understand their choices. Further study of the holistic decision-making process incorporating both classified and unclassified information would provide an improved understanding of cognitive biases and how program managers rely on the triple constraint model. Future work should also explore cognitive biases that were left out of the present study. Specifically, strategic misrepresentation and escalation of commitment should be examined within the broader context to determine the systemic and cultural biases inherent in program managers' decisions.

LIST OF REFERENCES

Andrews, D., Criscuolo, C., & Gal, P. (2015). *Frontier firms, technology diffusion and public policy: Micro evidence from OECD countries* [Working paper]. Organisation for Economic Co-operation and Development. https://www.oecd.org/en/publications/frontier-firms-technology-diffusion-and-public-policy_5jrql2q2jj7b-en.html

Aranda, J., & Easterbrook, S. (2005, September). Anchoring and adjustment in software estimation. *Proceedings of the 10th European Software Engineering Conference Held Jointly with 13th ACM SIGSOFT International Symposium on Foundations of Software Engineering* (pp. 346–355).

Baratta, A. (2006). The triple constraint: A triple illusion. *2006 PMI Global Congress Proceedings*, 1–7. https://www.ucipfg.com/Repositorio/MAP/MAPD-05/BLOQUE-ACADEMICO/UNIDAD5/lectura1.pdf

Barbosa, S. D., Fayolle, A., & Smith, B. R. (2019). Biased and overconfident, unbiased but going for it: How framing and anchoring affect the decision to start a new venture. *Journal of Business Venturing*, *34*(3), 528–557.

Barndollar, G., & Mai, M. C. (2024, May 17). The U.S. Navy can't build ships. *Foreign Policy*. https://foreignpolicy.com/2024/05/17/us-navy-ships-shipbuilding-fleet-china-naval-race-pacific/

Buehler, R., & Griffin, D. (2015). The planning fallacy: When plans lead to optimistic forecasts. In M. D. Mumford & M. Frese (Eds.), *The psychology of planning in organizations* (pp. 31–57). Routledge.

Buehler, R., Griffin, D., & Ross, M. (1994). Exploring the "planning fallacy": Why people underestimate their task completion times. *Journal of Personality and Social Psychology*, *67*(3), 366–381.

Buehler, R., Griffin, D., & Ross, M. (2002). Inside the planning fallacy: The causes and consequences of optimistic time predictions. In T. Gilovich, D. Griffin, & D. Kahneman (Eds.), *Heuristics and biases: The psychology of intuitive judgment* (pp. 250–270).

Burkart, N., & Huber, M. F. (2021). A survey on the explainability of supervised machine learning. *Journal of Artificial Intelligence Research*, *70*, 245–317.

Commander, Naval Surface Forces. (n.d.). *Littoral combat ship class – LCS*. U.S. Navy. Retrieved October 14, 2024, from https://www.surfpac.navy.mil/Ships/By-Class/Littoral-Combat-Ship-Class-LCS/

Capaccio, A. (2024). U.S. *Navy's new warship is plagued by worker turnover*. Bloomberg. https://www.bloomberg.com/news/articles/2024-04-12/warship-maker-can-t-keep-enough-skilled-workers-to-build-navy-s-new-vessel

Chen, Y., Ahiaga-Dagbui, D. D., Thaheem, M. J., & Shrestha, A. (2023). Toward a deeper understanding of optimism bias and transport project cost overrun. *Project Management Journal*, *54*(5), 561–578.

Chadee, A., Hernandez, S. R., & Martin, H. (2021). The influence of optimism bias on time and cost on construction projects. *Emerging Science Journal*, *5*(4), 429–442.

Cornelio, J. R. J., Sainati, T., & Locatelli, G. (2023). Digging in the megaproject's graveyard: Why do megaprojects die, and how to check their health? *International Journal of Project Management*, *41*(6), 1–16.

Cunha, J. A., Viglioni, T., Thomaz, J., & Moura, H. (2014). Project management in light of cognitive biases: A public sector IT organization case. In V. Grozdanic (Ed.), *Proceedings of the 10th European Conference on Management, Leadership and Governance* (pp. 50–58).

Dent, E. (2024, April 15). *Fincantieri, U.S. Navy lay keel of first constellation frigate*. Fincantieri Marine Group. https://fincantierimarinegroup.com/fincantieri-us-navy-lay-keel-of-first-constellation-frigate/

Dessart, F. J., Barreiro-Hurlé, J., & Van Bavel, R. (2019). Behavioural factors affecting the adoption of sustainable farming practices: A policy-oriented review. *European Review of Agricultural Economics*, *46*(3), 417–471.

Dijkstra, K. A., & Hong, Y. Y. (2019). The feeling of throwing good money after bad: The role of affective reaction in the sunk-cost fallacy. *PlOS One*, *14*(1), 1–19.

Deputy Chief of Naval Operations for Warfighting Requirements and Capabilities. (2022, April). *Report to Congress on the annual long-range plan for construction of naval vessels for fiscal year 2023*. Office of the Chief of Naval Operations. https://media.defense.gov/2022/Apr/20/2002980535/-1/-1/0/PB23%20SHIPBUILDING%20PLAN%2018%20APR%202022%20FINAL.PDF

Drew, C. (2009, April 18). General Dynamics to build new destroyer. *The New York Times*. https://www.nytimes.com/2009/04/18/business/18ships.html

Executive Services Directorate. (2022, April 28). *Littoral combat ship mission modules.* https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2022_SARS/LCS_MM_SAR_DEC_2022_final.pdf

Department of the Navy. (2022, April 27). *Littoral combat ship (LCS)* (Selected Acquisition Report). https://www.esd.whs.mil/Portals/54/Documents/FOID/Reading%20Room/Selected_Acquisition_Reports/FY_2021_SARS/22-F-0762_LCS_SAR_2021.pdf

Fabricius, G., & Büttgen, M. (2013). The influence of knowledge on overconfidence: Consequences for management and project planning. *International Journal of Business and Management*, *8*(11), 1–12.

Fabricius, G., & Büttgen, M. (2015). Project managers' overconfidence: How is risk reflected in anticipated project success? *Business Research*, *8*, 239–263.

Fanning, A. L., O'Neill, D. W., Hickel, J., & Roux, N. (2022). The social shortfall and ecological overshoot of nations. *Nature Sustainability*, *5*(1), 26–36.

Fasolo, B., Heard, C., & Scopelliti, I. (2024). Mitigating cognitive bias to improve organizational decisions: An integrative review, framework, and research agenda. *Journal of Management*, Article 1287188.

Fernandes, R. G., da Silva, L. F., & Vils, L. (2023). Distributed team cognition and collaborative problem-solving in project management. *International Journal of Managing Projects in Business*, *16*(1), 713–742.

Flyvbjerg, B. (2007a). Eliminating bias in early project development through reference class forecasting and good governance. In K. J. Sunnevåg (Ed.), *Beslutninger på svakt informasjonsgrunnlag* [Decisions Based on Weak Information] (pp. 90–110). Norwegian University of Science and Technology.

Flyvbjerg, B. (2007b). How optimism bias and strategic misrepresentation in early project development undermine implementation. In K. J. Sunnevåg (Ed.), *Beslutninger på svakt informasjonsgrunnlag* [Decisions Based on Weak Information] (pp. 41–55). Norwegian University of Science and Technology.

Flyvbjerg, B., Garbuio, M., & Lovallo, D. (2009). Delusion and deception in large infrastructure projects: two models for explaining and preventing executive disaster. *California management review*, *51*(2), 170–194.

Flyvbjerg, B. (2016). The fallacy of beneficial ignorance: A test of Hirschman's hiding hand. *World Development*, *84*, 176–189.

Flyvbjerg, B. (2021). Top ten behavioral biases in project management: An overview. *Project Management Journal*, *52*(6), 531–546.

Flyvbjerg, B. (2024). Heuristics for better project leadership: Teasing out tacit knowledge. *Project Management Journal*, *55*(6), 615–625.

Flyvbjerg, B., Ansar, A., Budzier, A., Buhl, S., Cantarelli, C., Garbuio, M. ... Van Wee, B. (2018). Five things you should know about cost overrun. *Transportation Research Part A: Policy and Practice*, *118*, 174–190.

Flyvbjerg, B., Budzier, A., Christodoulou, M. D., & Zottoli, M. (2024). *Uniqueness bias: Why it matters, how to curb it*. ArXiv. https://doi.org/10.48550/arXiv.2408.07710

Flyvbjerg, B., & Gardner, D. (2023). *How big things get done: The surprising factors that determine the fate of every project, from home renovations to space exploration and everything in between.* Signal.

Grennes, T. J. (2017, May 2). *An economic analysis of the Jones Act* (Mercatus Center Research Paper Series). Mercatus Center at George Mason University. https://ssrn.com/abstract=3211671

Hester, P. T., & Calida, B. (2010). Biases and heuristics in R&D program management decisions. *Proceedings from the 31st American Society for Engineering Management Conference*, 2–6. https://www.researchgate.net/publication/274701142_Biases_and_Heuristics_in_Governance

Hsieh, H. F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative health research*, *15*(9), 1277–1288.

Ika, L. A., Love, P. E., & Pinto, J. K. (2020). Moving beyond the planning fallacy: The emergence of a new principle of project behavior. *IEEE Transactions on Engineering Management*, *69*(6), 3310–3325.

Ika, L. A., & Pinto, J. K. (2022). The "re-meaning" of project success: Updating and recalibrating for a modern project management. *International Journal of Project Management*, *40*(7), 835–848.

Ika, L., Pinto, J. K., Love, P. E., & Pache, G. (2023). Bias versus error: Why projects fall short. *Journal of Business Strategy*, *44*(2), 67–75.

International Organization for Standardization. (1994). *Quality management and quality assurance—Vocabulary* (ISO 8402). ISO.

Jani, A. (2011). Escalation of commitment in troubled IT projects: Influence of project risk factors and self-efficacy on the perception of risk and the commitment to a failing project. *International Journal of Project Management*, *29*(7), 934–945.

Jones, L. R., & Euske, K. J. (1991). Strategic misrepresentation in budgeting. *Journal of Public Administration Research and Theory*, *1*(4), 437–460.

Katz, J. (2021). *Navy says Constellation hull change won't affect internal design.* Breaking Defense. https://breakingdefense.com/2021/08/navy-says-constellation-hull-change-wont-affect-internal-design/

Katz, J. (2024). *SECNAV says 45-day shipbuilding review will be followed by another review.* Breaking Defense. https://breakingdefense.com/2024/04/secnav-says-45-day-shipbuilding-review-will-be-followed-by-another-review/

Keane, R., Jr., & Tibbitts, B. F. (2015). The fallacy of using a parent design: 'The design is mature.' *Transactions*, *123*, 91–104.

Keil, M., Tan, B. C., Wei, K.-K., Saarinen, T., Tuunainen, V., & Wassenaar, A. (2000). A cross-cultural study on escalation of commitment behavior in software projects. *MIS Quarterly*, *24*(2), 299–325.

Kerzner, H. (2025). *Project management: A systems approach to planning, scheduling, and controlling*. John Wiley & Sons.

Khan, S. S., & Stylianou, A. (2009). IT project management & managerial risk: Effects of overconfidence. *International Research Workshop on IT Project Management 2009*, 64–71. https://aisel.aisnet.org/irwitpm2009/4/

Kahneman, D. (2011). *Thinking, fast and slow*. Farrar, Straus and Giroux.

LaGrone, S. (2022, January 17). *Navy unveils next-generation DDG(X) warship concept with hypersonic missiles, lasers*. USNI News. https://news.usni.org/2022/01/12/navy-unveils-next-generation-ddgx-warship-concept-with-hypersonic-missiles-lasers

LaGrone, S. (2023, August 19). *USS Zumwalt arrives in Mississippi for hypersonic weapon installation*. USNI News. https://news.usni.org/2023/08/19/uss-zumwalt-arrives-in-mississippi-for-hypersonic-weapon-installation

LaGrone, S. (2023, December 26). *Report to Congress on Navy Force Structure and Shipbuilding*. USNI News. https://news.usni.org/2023/12/26/report-to-congress-on-navy-force-structure-and-shipbuilding-8?utm_source=chatgpt.com

Lloyd's Register of Shipping. (2024). World fleet statistics (2024 ed.). Lloyd's Register. https://www.lr.org

Lorko, M., Servátka, M., & Zhang, L. (2019). Anchoring in project duration estimation. *Journal of Economic Behavior & Organization*, *162*, 49–65.

Love, P. E. (2011). 'Plugging the gaps' between optimum bias and strategic misrepresentation and infrastructure cost overruns. *Procedia Engineering*, *14*, 1197–1204.

Love, P. E., Edwards, D. J., & Irani, Z. (2011). Moving beyond optimism bias and strategic misrepresentation: An explanation for social infrastructure project cost overruns. *IEEE Transactions on Engineering Management*, *59*(4), 560–571.

Love, P. E., Smith, J., Simpson, I., Regan, M., & Olatunji, O. (2015). Understanding the landscape of overruns in transport infrastructure projects. *Environment and planning B: planning and design*, *42*(3), 490–509.

Love, P. E., Ika, L. A., & Ahiaga-Dagbui, D. D. (2019). On de-bunking 'fake news' in a post truth era: Why does the planning fallacy explanation for cost overruns fall short? *Transportation Research Part A: Policy and Practice*, *126*, 397–408.

Love, P. E., Sing, M. C., Ika, L. A., & Newton, S. (2019). The cost performance of transportation projects: The fallacy of the planning fallacy account. *Transportation Research Part A: Policy and Practice*, *122*, 1–20.

Machiels, T., Compernolle, T., & Coppens, T. (2023). Stakeholder perceptions of uncertainty matter in megaprojects: The Flemish A102 infrastructure project. *International Journal of Project Management*, *41*(1), p. 2-10.

Maritime Administration. (1971). *MARAD 1971, year of breakthrough: The annual report of the Maritime Administration for fiscal year 1971*. Department of Commerce. https://www.maritime.dot.gov/sites/marad.dot.gov/files/2022-06/maradannualreport1971.pdf

Maritime Administration. (2011). *Comparison of U.S. and foreign-flag operating costs*. U.S. Department of Transportation. https://www.maritime.dot.gov/sites/marad.dot.gov/files/docs/resources/3651/comparisonofusandforeignflagoperatingcosts.pdf

Mackin, M. (2017, March). *Navy shipbuilding: Need to document rationale for the use of fixed-price incentive contracts and study effectivness of added incentives* (GAO-17-211). Government Accountability Office. https://www.gao.gov/assets/gao-17-211.pdf

Mackin, M. (2017, June). *Ford-class aircraft carrier: Follow-on ships need more frequent and accurate cost estimates to avoid pitfalls of lead ship* (GAO-17-575). Government Accountability Office. https://www.gao.gov/assets/gao-17-575.pdf

Mercier, S., & Smith, V. (2015, September). *Military readiness and food aid cargo preference: Many costs and few benefits.* American Enterprise Institute. https://www.aei.org/research-products/report/military-readiness-and-food-aid-cargo-preference-many-costs-and-few-benefits/

McCray, G. E., Purvis, R. L., & McCray, C. G. (2002). Project management under uncertainty: The impact of heuristics and biases. *Project Management Journal*, *33*(1), 49–57.

Moreno, A. M., & Peters, L. (2016). Software project management fallacies. In *11th International Joint Conference on Software Technologies* (pp. 109–116).

Mortlock, R. (2022). Been there, done that: Behavioral acquisition. *Army AL&T Magazine*. https://asc.army.mil/web/news-been-there-done-that-behavioral-acquisition-part-two/

Mortlock, R. (2020). Studying acquisition strategy formulation of incremental development approaches. *Defense AR Journal*, *27*(3), 264–311.

Mortlock, R., & Dew, N. (2021). Behavioral biases within defense acquisition. *Proceedings of the Eighteenth Annual Acquisition Research Symposium*, 93–114. https://dair.nps.edu/bitstream/123456789/4356/1/SYM-AM-21-049.pdf

Mortlock, R. F., & Karnes, J. L. (2021). Aligning program management competencies to industry standards. *Defense Acquisition Research Journal*, 28(4), 366–419.

Meyer, W. G. (2014). The effect of optimism bias on the decision to terminate failing projects. *Project Management Journal*, *45*(4), 7–20.

Nelson, E. (2022). *How did it happen?: The Great Inflation of the 1970s and lessons for today* (Finance and Economics Discussion Series 2022–037). Board of Governors of the Federal Reserve System. https://doi.org/10.17016/FEDS.2022.037

Nili, A., & Barros, A. (2024). Save your projects: How to minimize cognitive biases that re-engage you with underperforming vendors. *Procedia Computer Science*, *239*, 1586–1593.

Oakley, S. S. (2024, May). *Navy frigate: Unstable design has stalled construction and compromised delivery schedules* (GAO-24-106546). Government Accountability Office. https://www.gao.gov/assets/gao-24-106546.pdf

Oakley, S. S. (2025, March). *Navy shipbuilding: A generational imperative for systemic change.* (GAO-25-108136). Government Accountability Office. https://www.gao.gov/assets/gao-25-108136.pdf

O'Brochta, M. (2017). Why bad projects are so hard to kill. *PM World Journal*, *6*(3), 1–14.

Office of the Under Secretary of Defense (Comptroller)/Chief Financial Officer. (2024, March). *Defense budget overview: United States Department of Defense fiscal year 2025 budget request*. Department of Defense. https://comptroller.defense.gov/Portals/45/Documents/defbudget/FY2025/FY2025_Budget_Request.pdf

O'Neill, D. W., Fanning, A. L., Lamb, W. F., & Steinberger, J. K. (2018). A good life for all within planetary boundaries. *Nature Sustainability*, *1*(2), 88–95.

O’Rourke, R. (2019, December 17). Navy Littoral Combat Ship (LCS) Program: Background and Issues for Congress (CRS Report No. RL 33741). Congressional Research Service. https://sgp.fas.org/crs/weapons/RL33741.pdf

O’Rourke, R. (2023, October 4). *Navy force structure and shipbuilding plans: Background and issues for Congress* (CRS Report No. RL32665). Congressional Research Service. https://crsreports.congress.gov/product/pdf/RL/RL32665/394

O’Rourke, R. (2024a, August 5). *Navy Constellation (FFG-62) class frigate program: Background and issues for Congress* (CRS Report No. R44972). Congressional Research Service. https://crsreports.congress.gov/product/pdf/R/R44972

O’Rourke, R. (2024b, December 13). *Navy Ford (CVN-78) class aircraft carrier program: Background and issues for Congress* (CRS Report No. RS20643). Congressional Research Service. https://sgp.fas.org/crs/weapons/RS20643.pdf

O’Rourke, R. (2025, March 21). *Navy DDG-51 and DDG-1000 Destroyer Programs: Background and Issues for Congress.* (CRS Report No. RL32109). Congressional Research Service. https://www.congress.gov/crs-product/RL32109

Parker, D. W., Parsons, N., & Isharyanto, F. (2015). Inclusion of strategic management theories to project management. *International Journal of Managing Projects in Business*, *8*(3), 552–573. https://doi.org/10.1108/IJMPB-11-2014-0079

Patrucco, A. S., Bellis, P., Trabucchi, D., & Buganza, T. (2024). Behavioral biases and cognitive pitfalls: Navigating resource orchestration in supplier-partnered innovation projects. *IEEE Transactions on Engineering Management*, *72*, 227–239. https://ieeexplore.ieee.org/document/10770288

Perignat, E., & Fleming, F. F. (2022). Sunk-cost bias and knowing when to terminate a research project. *Applied Chemistry*, *134*(36), 1–9.

Pinto, J. K. (2013). Lies, damned lies, and project plans: Recurring human errors that can ruin the project planning process. *Business Horizons*, *56*(5), 643–653.

Pinto, J. K. (2014). Project management, governance, and the normalization of deviance. *International Journal of Project Management*, *32*(3), 376–387.

Pollack, J., Helm, J., & Adler, D. (2018). What is the iron triangle, and how has it changed? *International Journal of Managing Projects in Business*, *11*(2), 527–547. https://doi.org/10.1108/IJMPB-09-2017-0107

Prater, J., Kirytopoulos, K., & Ma, T. (2017). Optimism bias within the project management context: A systematic quantitative literature review. *International Journal of Managing Projects in Business*, *10*(2), 370–385.

Prieto, B. (2006). Managing the planning fallacy in large, complex infrastructure programs. *Project Management Journal*, *2*(8), 1–16.

Ramasesh, R. V., & Browning, T. R. (2014). A conceptual framework for tackling knowable unknown unknowns in project management. *Journal of Operations Management*, *32*(4), 190–204.

Rendon, R. G., & Snider, K. F. (Eds.). (2019). *Management of defense acquisition projects* (2nd ed.). American Institute of Aeronautics and Astronautics.

Rodrigues, L., & Francis, P. (1999, July 30). *Best practices: Better management of technology development can improve weapon system outcomes* (GAO/NSIAD-99-162). General Accounting Office. https://www.govinfo.gov/app/details/GAOREPORTS-NSIAD-99-162

Rowlands, S. C. (2024). Skills of an effective United States Air Force program manager: A qualitative descriptive study of the skills required for United States Air Force program managers [Doctoral dissertation, Franklin University]. OhioLINK Electronic Theses and Dissertations Center. http://rave.ohiolink.edu/etdc/view?acc_num=frank1708629841222996

Schmidt, J. B., & Calantone, R. J. (2002). Escalation of commitment during new product development. *Journal of the Academy of Marketing Science*, *30*, 103–118.

Shalev, E., Keil, M., Lee, J. S., & Ganzach, Y. (2014). Optimism bias in managing IT project risks: A construal level theory perspective. *Proceedings of the European Conference on Information Systems*, 1–18. https://www.researchgate.net/publication/259252843_Optimism_bias_in_managing_it_project_risks_A_construal_level_theory_perspective

Shelbourne, M., & LaGrone, S. (2024, April 3). *Constellation frigate delivery delayed 3 years, says Navy*. USNI News. https://news.usni.org/2024/04/02/constellation-frigate-delivery-delayed-3-years-says-navy

Shmueli, O., Pliskin, N., & Fink, L. (2013). The planning fallacy as an explanation for over-requirement in software development. *International Research Workshop on Information Technology Project Management 2013* (pp. 100–110).

Shore, B. (2008). Systematic biases and culture in project failures. *Project Management Journal*, *39*(4), 5–16.

Son, J., & Rojas, E. M. (2011). Impact of optimism bias regarding organizational dynamics on project planning and control. *Journal of Construction Engineering and Management*, *137*(2), 147–157.

Stake, R. E. (2005). Qualitative case studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (pp. 443–466). Sage Publications.

Stingl, V., & Geraldi, J. (2017). Errors, lies and misunderstandings: Systematic review on behavioural decision making in projects. *International Journal of Project Management*, *35*(2), 121–135.

Sullivan, M. (2009, March). *Defense acquisitions: Assessment of selected weapons programs* (GAO-09-326SP). Government Accountability Office. https://www.gao.gov/assets/gao-09-326sp.pdf

Thaler, R. H. (2015). *Misbehaving: The making of behavioral economics*. W. W. Norton & Company.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131.

VanderPlas, A., & Watson, M. (2024). *Cognitive bias in defense financial management: A Marine Corps perspective* [Doctoral dissertation, Naval Postgraduate School]. NPS Archive: Calhoun. https://calhoun.nps.edu/entities/publication/c7efb38c-380d-4257-9939-11e1551fe909

Van Wyngaard, C. J., Pretorius, J. H., & Pretorius, L. (2012). Theory of the triple constraint — A conceptual review. *2012 IEEE International Conference on Industrial Engineering and Engineering Management*, 1991–1997. https://doi.org/10.1109/ieem.2012.6838095

Virine, L., Trumper, M., & Virine, E. (2018). Heuristics and biases in project management. *PM World Journal*, *7*(1), 1–11.

Weiss, J. (n.d.). *World shipbuilding deliveries (in 1000GT) by countries from 1964 to 2009*. Retrieved April 18, 2024, from https://www.researchgate.net/figure/World-Shipbuilding-Deliveries-in-1000GT-by-countries-from-1964-to-2009-Source-Lloyds_fig1_326752483

Zíka, V., & Koblovský, P. (2016). Optimism bias and overconfidence effects in managerial decision making. In *Economics and Business Management in the 21st Century*.

Acquisition Research Program
Naval Postgraduate School
555 Dyer Road, Ingersoll Hall
Monterey, CA 93943

www.acquisitionresearch.net