2021-06

CONTRACT TYPE CASE HISTORY OF THE CVN-78 AND CVN-79 PORTFOLIO ACQUISITIONS

Peachey, John T.; Stromfeld, Matthew S.

Monterey, CA; Naval Postgraduate School

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

JOINT APPLIED PROJECT REPORT

CONTRACT TYPE CASE HISTORY OF THE CVN-78 AND CVN-79 PORTFOLIO ACQUISITIONS

June 2021

By: **John T. Peachey**
Matthew S. Stromfeld

Advisor: **Robert F. Mortlock**
Co-Advisor: **Chad W. Seagren**

THIS PAGE INTENTIONALLY LEFT BLANK

REPORT DOCUMENTATION PAGE			*Form Approved OMB No. 0704-0188*

1. AGENCY USE ONLY *(Leave blank)*	**2. REPORT DATE** June 2021	**3. REPORT TYPE AND DATES COVERED** Joint Applied Project Report

4. TITLE AND SUBTITLE
CONTRACT TYPE CASE HISTORY OF THE CVN-78 AND CVN-79 PORTFOLIO ACQUISITIONS

5. FUNDING NUMBERS

6. AUTHOR(S) John T. Peachey and Matthew S. Stromfeld

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
N/A

10. SPONSORING / MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release. Distribution is unlimited.

12b. DISTRIBUTION CODE
A

13. ABSTRACT (maximum 200 words)

Analyzing whether a correlation existed between these two acquisition portfolios, we proposed and answered our four research questions. Our primary research questions and answers determined the advantages and disadvantages of contract type and whether policy initiatives shaped the acquisition strategies for the Ford-class aircraft carriers. Also, we wanted to determine how the selection of contract type can shape future acquisitions, especially when acquiring new and immature technologies. From our research, we discovered that the major difference between the acquisitions of CVN-78 and CVN-79 occurred during the detail design and construction contracts. For CVN-78, a hybrid cost type contract was awarded and was composed of multiple cost reimbursable type contracts. On the other hand, the contract selected for detail design and construction of CVN-79 was fixed price incentive fee. Additionally, policy initiatives like Better Buying Power (BBP) highly encouraged the use of incentive type contracts, especially fixed price contracts. From our research, we determined one of the reasons for the schedule and cost overruns experienced by the Ford-class aircraft carrier occurred during the acquisition of advanced yet immature technologies. MDAPs must strategically align contract type selection with technical and developmental risk in order to mitigate cost and schedule overruns. However, it must be noted that the selection of contract type alone does not indicate causation.

14. SUBJECT TERMS
contract type, overrun, case history, CVN-78, CVN-79, risk assessment, cost, schedule, performance, quality, analysis, technology, cost-effectiveness analysis, and best practices

15. NUMBER OF PAGES
75

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	**18. SECURITY CLASSIFICATION OF THIS PAGE**	**19. SECURITY CLASSIFICATION OF ABSTRACT**	**20. LIMITATION OF ABSTRACT**
Unclassified	Unclassified	Unclassified	UU

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. 239-18

THIS PAGE INTENTIONALLY LEFT BLANK

Approved for public release. Distribution is unlimited.

CONTRACT TYPE CASE HISTORY OF THE CVN-78 AND CVN-79 PORTFOLIO ACQUISITIONS

John T. Peachey, Civilian, Department of the Navy
Matthew S. Stromfeld, Civilian, Defense Contract Management Agency

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN CONTRACT MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
June 2021

Approved by: Robert F. Mortlock
Advisor

Chad W. Seagren
Co-Advisor

Rene G. Rendon
Academic Associate, Graduate School of Defense Management

THIS PAGE INTENTIONALLY LEFT BLANK

CONTRACT TYPE CASE HISTORY OF THE CVN-78 AND CVN-79 PORTFOLIO ACQUISITIONS

ABSTRACT

Analyzing whether a correlation existed between these two acquisition portfolios, we proposed and answered our four research questions. Our primary research questions and answers determined the advantages and disadvantages of contract type and whether policy initiatives shaped the acquisition strategies for the Ford-class aircraft carriers. Also, we wanted to determine how the selection of contract type can shape future acquisitions, especially when acquiring new and immature technologies. From our research, we discovered that the major difference between the acquisitions of CVN-78 and CVN-79 occurred during the detail design and construction contracts. For CVN-78, a hybrid cost type contract was awarded and was composed of multiple cost reimbursable type contracts. On the other hand, the contract selected for detail design and construction of CVN-79 was fixed price incentive fee. Additionally, policy initiatives like Better Buying Power (BBP) highly encouraged the use of incentive type contracts, especially fixed price contracts. From our research, we determined one of the reasons for the schedule and cost overruns experienced by the Ford-class aircraft carrier occurred during the acquisition of advanced yet immature technologies. MDAPs must strategically align contract type selection with technical and developmental risk in order to mitigate cost and schedule overruns. However, it must be noted that the selection of contract type alone does not indicate causation.

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

I. INTRODUCTION....1
A. RESEARCH QUESTIONS....4
1. Primary research questions....4
2. Secondary research questions....5
B. SIGNIFICANCE....6
C. SCOPE AND METHODOLOGY....7
D. CHAPTER OUTLINE....8

II. BACKGROUND....9
A. HISTORY OF CVN-78....9
B. HISTORY OF CVN-79....13
C. GERALD R. FORD CLASS MAJOR SUBCOMPONENTS....14
D. DESCRIPTION OF THE DOD ACQUISITION STRATEGY DURING ACQUISITION PLANNING, INCLUDE CONTRACT TYPE....18
E. OVERVIEW OF RELEVANT ACQUISITION REFORM INITIATIVES....21

III. LITERATURE REVIEW....25

IV. ANALYSIS OF CONTRACT TYPE USED AND POLICY INFLUENCE....29
A. OVERVIEW....29
B. CONTRACT TYPES USED AND THEIR IMPACT....30
C. POLICY INFLUENCE....36

V. CONCLUSION AND RECOMMENDATIONS....41
A. ANSWERS TO FOUR RESEARCH QUESTIONS....41
1. What were the advantages and disadvantages in terms of contract type selection used in the acquisition of CVN-78 versus CVN-79?....41
2. What policies or initiatives shaped the decision to choose the contract types during the acquisitions of CVN-78 and CVN-79? Was the intent of the initiatives ultimately successful during the acquisition?....44
3. How can contract type shape future acquisitions to deliver the expected capabilities, on time, and within the planned acquisition cost?....45

4. How can future DOD acquisition strategy be changed to better guide acquisition professionals on how to choose contract type when acquiring new/immature technologies? 46
B. SUMMARY 47
C. RECOMMENDATIONS 49

LIST OF REFERENCES 53

INITIAL DISTRIBUTION LIST 57

LIST OF FIGURES

Figure 1. USS *Gerald R. Ford* (CVN-78). Source: U.S. Navy Photo (n.d.). 10

Figure 2. An F/A-18 lands on USS *Gerald R. Ford* (CVN 78) using EMALS and AAG during the ship's post-delivery test and trails. Source: U.S. Navy Photo (n.d.).....17

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF TABLES

Table 1. CVN-78 Procurement Cost Growth for EMALS and AAG. Source: Mackin (2017b).....16

Table 2. Types of Contracts and Associated Program Risk. Source: Alder and Scherer (1998).....21

Table 3. Contract Type for the Program Name.....31

Table 4. CPIF SWOT Analysis.....32

Table 5. FPIF SWOT Analysis.....33

Table 6. 16 Critical Technologies and Capabilities. Source: Francis (2007). 37

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF ACRONYMS AND ABBREVIATIONS

AAG	advanced arresting gear
ACAT	Acquisition Category
AP	advanced procurement
ASN (RD&A)	Assistant Secretary of the Navy for Research, Development, and Acquisition
AWE	advance weapons elevators
BBP	Better Buying Power
CMBOK	Contract Management Body of Knowledge
CNO	Chief Naval Operations
CPIF	cost-plus-incentive fee
CPFF	cost plus fixed fee
DAU	Defense Acquisition University
DFARS	defense federal acquisition regulation supplement
DOD	Department of Defense
EMALS	electromagnetic aircraft launch system
FAR	federal acquisition regulation
FFP	firm-fixed price
FPIF	fixed price incentive fee
FY	fiscal year
GAO	Government Accountability Office
GDP	Gross Domestic Product
HII/NNS	Huntington Ingalls Industries/Newport News Shipbuilding (HII/ NNS)
JAP	Joint Applied Project
MDAP	Major Defense Acquisition Program
NAVSEA	Naval Sea Systems Command

NPS	Naval Postgraduate School
OPNAV	Office of the Chief of Naval Operations
OSD	Office Secretary of Defense
PEO	Program Executive Officer
SAR	Selected Acquisition Report
SWOT	strengths, weaknesses, opportunities, and threats
US	United States
USD AT&L	Under Secretary of Defense for Acquisition, Technology, and Logistics

ACKNOWLEDGMENTS

This thesis benefitted tremendously from the expert attention of our advisors, Dr. Robert Mortlock and Dr. Chad Seagren. Without their thorough reviews, recommendations, comments, consultations, and support, this case study would not have been as successful. Next, we would like to thank Matthew Norton from the Naval Postgraduate School (NPS) Writing Center for providing thoughtful suggestions, which shaped our thesis and improved our writing. Additionally, we would like to thank Susan Hawthorne from the Thesis Processing Office for her time reviewing our thesis and ensuring our work abides with the academic standards of NPS.

THIS PAGE INTENTIONALLY LEFT BLANK

I. INTRODUCTION

According to a research report by RAND Corporation, the "growth of U.S. Navy ship costs has exceeded the rate of inflation over the past four decades" (Arena et al., 2008, p. xiii). Due to the escalating cost for acquiring ships, the U.S. Navy is greatly concerned because of the increasing difficulty for affording ships needed to serve the fleet. For the U.S. Navy to meet its mission of maintaining security and deterrence through a sustained forward presence, the naval acquisition workforce is chartered to acquire the most sophisticated and technologically advanced combat systems in the world. The recent acquisitions of these advanced combat systems have come at a high cost to taxpayers and, due to technological delays, sometimes provide only a moderate advancement in warfighting capabilities. The Navy has paid a premium for its advanced warships, which are sometimes immediately returned to the shipyard for retrofitting and repair after product acceptance. As a result, the Navy has consistently experienced cost overruns and failed to meet the expected schedule for the acquisition of ships. According to a 2018 Government Accountability Office Report (GAO), "the Navy has received $24 billion more in funding than originally planned but has 50 fewer ships in its inventory" (Oakley, 2018, p. 1). Additionally, the Navy's "shipbuilding programs have experienced years of construction delays and, even when the ships eventually reached the fleet, they fell short of quality and performance expectations" (Oakley, 2018, p. 1).

Now, the Navy is "planning for the most significant fleet since increase in over 30 years of shipbuilding, which includes some costly and complex acquisitions" (Oakley, 2018, p. 1). Although the Navy is embarking upon its "ultimate goal of achieving a 355-ship fleet, challenges in meeting shipbuilding cost, schedule, and performance baselines persist" (Oakley, 2018). This Joint Applied Project (JAP) analyzes the case history regarding the acquisition strategies, specifically contract types, used for both the Gerald R. Ford class of nuclear-powered aircraft carriers CVN-78 and CVN-79 and their major defense acquisition programs. By studying the case history of both the CVN-78 and CVN-79 acquisitions, the differences in contracting strategies between these two Major Defense Acquisition Programs (MDAPs) is identified and correlated to the performance of the

programs. While acquiring the USS Gerald R. Ford class of Aircraft Carriers, this JAP identifies the contract type utilized during each acquisition. Depending on the risk level and current DOD acquisition strategy, the research being conducted assesses if the appropriate contract type was selected. In addition, this JAP analyzed the selected contract type by determining if the contract type impacted either ship's schedule, capability, and price. In essence, this JAP encompasses the contracting analysis of the CVN-78 and CVN-79 programs. To meet its shipbuilding goals, the Navy must improve its acquisition process to mitigate issues that have contributed to its history of cost overruns. By accepting the delivery of these schedule delayed ships, the Navy not only continues to receive poorer quality while paying more, but contemporaneously depreciates its buying power.

According to the Implementation Directive for Better Buying Power (BBP) 2.0, BBP is defined as "achieving efficiency and productivity in defense spending by delivering warfighting capabilities needed with the money available" (Kendall, 2012). According to an Acquisition Research Sponsored Report Series by Naval Postgraduate School (NPS), the BBP initiative emphasizes "(1) targeting affordability and controlling cost growth; (2) incentivizing productivity and innovating its industry; (3) reducing non-productive processes and bureaucracy; (4) promoting real competition; and (5) improving tradecraft in the acquisition of services" (Woodruff, 2012, p. 33). A critical factor in achieving BBP initiatives involves employing appropriate contract types while controlling costs through the acquisition life cycle. Department of Defense (DOD) aircraft programs classify as Acquisition Category I (ACAT I). All ACAT I programs are Major Defense Acquisition Programs (MDAPs). An MDAP is a "DOD acquisition program that is not a highly sensitive classified program and does not involve the acquisition of an automated information system" (Kozlak et al., 2017, p. 391). All MDAPs are required to annually submit Selected Acquisition Reports (SARs) to Congress. "SARs outline a weapons system's status and report current funding estimates as well as actual expenditures incurred" (Kozlak et al., 2017, p. 389). After MDAPs submits their SARs, Congress then analyzes them to evaluate program cost estimates and actual costs incurred. MDAPs have a high interest from Congress due to the severity of its cost and time overruns (Ben-Ari et al., 2010, p. 12). To diagnose why the Ford-aircraft carriers are experiencing cost and time

overruns, identifying different contracting strategies in relevant MDAP acquisition portfolios and evaluating their performance can contribute to a better understanding into the root causes of these issues.

Understanding how Navy shipbuilding MDAPs have experienced cost overruns, schedule growth, and performance deficiencies, this research focuses on two Ford-class aircraft carriers: USS *Gerald R. Ford* (CVN-78) and the USS *John F. Kennedy* (CVN-79). Through the life of the Ford-class acquisitions, the situation of cost and schedule overrun led Senator John McCain to call this carrier series an "egregious example of acquisition gone awry" (*Columbia Daily Tribune*, 2016). Being met with oversight challenges, acquisition of CVN-78 has been called into question about its milestone authority decisions. During the 2015 U.S. Senate Committee on Armed Services meeting for Procurement, Acquisition, Testing, and Oversight of the Navy's Ford-class aircraft carrier program, Chairman John McCain addressed the fact that the estimated procurement cost for CVN-78 had grown 27 percent since Fiscal Year (FY) 2008 budget submission (O'Rourke, 2021, p. 21). According to a GAO report in 2018 by Shelby Oakley, CVN-78 costs were over $2 billion more than estimated. Chairman McCain opined his concerns about CVN-79 experiencing the same issues as the first iteration of the new ship, due to the unstable and immature technologies that were still being developed alongside the production of CVN-78. McCain, and other critics of the Ford-class acquisition, focused on the incorporation of these new, untested, and unfinished technologies such as the advance weapons elevators (AWE), electromagnetic aircraft launch system (EMALS), and advanced arresting gear (AAG) as a major contributor to the cost growth and schedule delays of CVN-78. Incorporating "lessons learned from the construction of CVN-78, CVN-79 is being built with an improved shipyard fabrication and assembly process" (O'Rourke, 2021). Additionally, the Navy states that "lessons learned in building, testing, and certifying CVN-78's AWEs will be applied to the AWEs of subsequent CVN-78 class carriers" (O'Rourke, 2021, p. 15). By implementing lessons learned from CVN-78, the goal for constructing CVN-79 entails eliminating pivotal contributors to cost performances challenges. Nevertheless, the estimated procurement costs of the CVN-79 have grown 24.0% when compared to the FY2008 budget (O'Rourke, 2021).

Despite the cost challenges, the United States Navy continues to contract for the production of more Ford-class aircraft carriers, running concurrent development and production without the ability to provide acquisition officials, CNO, and ASN(RDA), and SECNAV adequate data to make informed business decisions on program progression. Therefore, the purpose of this research is to study the contract types selected in response to the risk profiles caused by an unstable design and immature technologies during the acquisition of both CVN-78 and CVN-79. The Navy is at risk to continue to experience cost and schedule growth as long as there is a mismatch between the contract type most appropriate to develop and acquire advanced warfighting systems for aircraft carriers and the contract types employed during the acquisition programs.

A. RESEARCH QUESTIONS

The primary research questions this thesis answers includes what the U.S. Navy can learn from the selection of contract type for the acquisition portfolios of CVN-78 and CVN-79. Besides determining the contract types utilized for these MDAPs, this research determines the advantages and disadvantages of contract type selection. Additionally, this research analyzes policies or initiatives that affected the contract type selection for CVN-78 and CVN-79. Therefore, this thesis poses four research questions:

1. Primary research questions

- What were the advantages and disadvantages in terms of contract type selection used in the acquisition of CVN-78 versus CVN-79?
- What policies or initiatives shaped the decision to choose the contract types during the acquisitions of CVN-78 and CVN-79? Was the intent of the initiatives ultimately successful during the acquisition?

Besides studying the contract portfolios and the initiatives that helped influence the contract type selection for these acquisition portfolios, this research further analyzed how contract type selection can shape future acquisitions and determine lessons learned going forward.

2. Secondary research questions

- How can contract type shape future acquisitions to deliver the expected capabilities, on time, and within the planned acquisition cost?
- How can future DOD acquisition strategy be changed to better guide acquisition professionals on how to choose contract type when acquiring new/immature technologies?

Our findings reveal that the Navy acquired CVN-78 and CVN-79 under different contract types. A hybrid cost type contract was used for the lead ship, CVN78, and a FPIF contract for CVN79. The lead ship had considerable manufacturing risk which warrants the hybrid cost type contract, despite the increased risk of the Navy to incur additional costs. The second ship, CVN-79, shared overrun risk with the contractor through a FPIF contract. The risk, however, did not decrease as a result of the immature design. The contractor may have been incentivized to control cost, but ultimately was unable to meet the original cost and schedule estimates as a result of the redesign issues; the FPIF contract did not impact the contractor's behavior in any significant way. The cost of CVN-79 did not increase significantly, but as a result of the redesign issues on CVN-78, the schedule of CVN-79 was significantly delayed. The advantage for the Navy to using a cost type contract while the design is immature is that it enables timely delivery of the ship without sacrificing the technological capability.

The decision to use the FPIF contract for CVN-79 was likely heavily impacted by the cultural bias of the Navy, which has been historically documented to favor FPIF contracts for shipbuilding, as well as recency bias resulting from the BBP initiatives which reinforced the Navy's practice of using FPIF by championing the contract type as a cost savings measure. The BBP initiatives highlight the benefits of the FPIF contract but could have expanded on the decision-making process when choosing a contract type for the unique acquisition's needs. In the case of CVN-79, the FPIF contract was likely unsuccessful in achieving the intended results. However, future acquisitions can benefit from learning from the CVN-79 acquisition and choose the correct type for their specific risk profile. The Navy could have sought other means to control cost growth, schedule

creep and receive the intended technological capability then the FPIF contract for CVN-79. When contracting for the next MDAP, contracting professionals should consider keeping the risk with the government until the design is mature and stable. As new contracting professionals analyze previous acquisitions, they will develop additional guidance which can focus on how an acquisition professional should determine which contract type to choose. By providing clearer guidance on how to perform and make educated decisions based on the unique circumstances of the acquisitions, the government's future acquisitions will be more likely to succeed in managing cost, schedule, and technical performance.

B. SIGNIFICANCE

According to research regarding cost and schedule overruns experienced by the navy, "most Navy major defense acquisition programs assessed have had cost growth, schedule delays or both since first full estimate" (Werner, 2020). Ideally, acquisition business cases should balance resources by aligning concepts of technology, manufacturing and integrating maturity, design knowledge, and contract type. Selecting the correct contract type remains imperative for MDAP acquisition portfolios because this decision determines the responsibility for unresolved risks. By failing to align contract type with risk, the Navy will continue to derive results of less capable, smaller fleets while failing to meet its fiduciary duty of properly managing taxpayer dollars. Therefore, analyzing contract type for the portfolio acquisition of the Ford-class aircraft carriers and its impact on cost, schedule, and performance provides clarity about the advantages and disadvantages of contract type selection for the acquisition of both ships, CVN-78 and CVN-79. Likewise, analyzing the authors' secondary research questions entails determining the various policies which shaped the acquisition plan and the incentives on selecting contract type. By analyzing the influence of policy initiatives on Navy Shipbuilding MDAPs, we address the impact these resources had on contract type selection during the acquisitions of CVN-78 and CVN-79. Finally, researching the acquisition portfolios of CVN-78 and CVN-79 has enabled us to determine a standard for prudent decision-making regarding contract type selection when conducting future acquisitions of MDAPs. Discovering and documenting these best practices could improve output of

performance, and reduce obsolescence issues resulting from immature designs, ultimately reducing shipbuilding costs.

C. SCOPE AND METHODOLOGY

This research studies the case history of both the CVN-78 and CVN-79 acquisitions and identifies the differences in contracting strategies between these two MDAPs. The results of identifying the differences in contracting strategies were then correlated to the performance of the programs. In studying the contracting analysis of CVN-78 and CVN-79, the authors determine the variables relevant to the DOD's acquisition strategy, other acquisition reform strategies, and incentives influencing contract type. Data in this study is derived from existing contracts, solicitations, and requirements documents pertaining to CVN-78 and CVN-79. The data for this research derives advantages and disadvantages of the selected contract type. The advantages and disadvantages are analyzed by measuring the cost, schedule, performance/quality, and assessment of risk. Analyzing the advantages and disadvantages of contract types used in the acquisition of CVN-78 and CVN-79 helped discover lessons learned from the case study. In addition, another benefit from studying the case of contract type includes an analysis of the strengths, weakness, opportunities, and threats (SWOT) of selecting the contract type. Understanding the advantages and disadvantages of contract type selection in the CVN-78 and CVN-79 results in an analysis on the impact contract type has on schedule, delivered capabilities, cost, and risk-assessment.

After determining the risk profile and contract type for both acquisitions, this research analyzes DOD's policy initiatives that influenced contract type selection. The analysis of DOD policy initiatives is used to determine whether their influence on contract type selection had instigated poor performance capabilities, cost overruns, and schedule slippage during the acquisitions of CVN-78 and CVN-79. By comprehending the evolution of initiatives, understanding the intent of those initiatives, and analyzing whether or not these initiatives influenced the program's overall performance, the authors analyzed whether policy influenced the desired outcome. Finally, we opine lessons learned from the research and analysis, state conclusions, and provide our recommendations.

D. CHAPTER OUTLINE

The remainder of this document is organized as follows:

- To establish the historical context of this topic, Chapter II of this research provides a complete overview of the Ford-class of aircraft carriers.
- To understand the current research and establish familiarity with the acquisition of the Ford-aircraft carriers, Chapter III of this research includes a Literature Review.
- To describe the process we used to collect data and perform an examination on the acquisition portfolios of CVN-78 and CVN-79, Chapter IV of this research is our analysis on the topic.
- To explain the findings of our research and discuss the future implications of findings, Chapter V is our summary, conclusions, and recommendations.

II. BACKGROUND

In recent years, Navy shipbuilding has struggled to deliver products at the estimated cost, on schedule, and with the planned capabilities. To better understand how the DOD can overcome the issues of cost growth, schedule delays, and capability shortfalls, we analyzed the recent acquisitions of the Ford-class carriers CVN-78 and CVN-79. The Ford-class portfolio included multiple contract types for the ships and the major subcomponents, which makes it particularly useful in understanding how future acquisition business cases should address contract type to properly balance the risk in acquiring essential systems that are not yet fully understood. This chapter establishes a historical understanding of the CVN-78 and CVN-79 acquisitions, their major subcomponent acquisitions, the DOD acquisition strategies and policies of the time, and the stakeholders involved in the acquisition process.

A. HISTORY OF CVN-78

The USS *Gerald R. Ford*, also known as CVN-78, is the "first aircraft carrier redesign in over 40 years, replacing the Nimitz-class carrier design" (O'Rourke, 2021, p. 4). The last significant change to the design of an aircraft carrier was in 1975 when the *USS Nimitz* CVN-68 was commissioned. The lead ship for the new Ford-class aircraft carrier, CVN-78, illustrated in Figure 1 below, provides increased capability to the fleet, leveraging cutting-edge technology that had not yet been tested and evaluated in the early acquisition phases but would be viable at the time of delivery. According to GAO, the size and complexity of acquiring the USS *Gerald R. Ford* requires "funding for design, long-lead materials, and construction over many years" (Mackin, 2014, p. 6). Therefore, the Navy has awarded contracts for "two phases of construction- construction preparation and detail design and construction" (Mackin, 2014, p. 6). Since 2008, "Newport News Shipbuilding has been constructing CVN-78 under a cost-reimbursement contract for detail design and construction" (Mackin, 2014, p. 6). According to O'Rourke, "all U.S. aircraft carriers procured since FY1958 have been built by Huntington Ingalls Industries/Newport News Shipbuilding (HII/NNS) of Newport News, Virginia" (O'Rourke, 2021, p. 4). This is

because “HII/NNS is the only U.S. shipyard that can build large-deck, nuclear powered aircraft carriers” (O’Rourke, 2021, p. 4). Although the CVN-78 was commissioned in 2017, “technical issues regarding the weapon elevators and other ship systems have delayed the ship’s first deployment to 2022 at the earliest” (O’Rourke, 2021, p. 15).

Figure 1. USS *Gerald R. Ford* (CVN-78).
Source: U.S. Navy Photo (n.d.).

The purpose behind acquiring the Ford Class was to replace the Nimitz class by creating a preeminent asset to maintain security and deterrence through sustained forward presence. Succeeding the Nimitz class, the USS *Gerald R. Ford* class provides the U.S. Navy with greater lethality, survivability, joint-operability, while harnessing unmatched versatility (O’Rourke, 2021). In an attempt to design the Navy’s most advanced aircraft carrier for the future, the design margins of CVN-78 include allowing the integration of future manned and unmanned aircraft. The newly integrated designs of CVN-78 include the A1B nuclear reactor, replacing steam catapults with EMALS, enlarged flight deck and aft positioned island, implementing faster elevators, increasing electrical power generation capacity, allowing for future technologies, reducing manpower, and implementing an AAG (Francis, 2015). By establishing acquisition requirements with cutting-edge technology, the Navy ensured that CVN-78 is capable of carrying out missions across a full spectrum

of operations (Francis, 2015). For instance, CVN-78 capabilities range from large-scale combat operations to deterrence and human assistance. Maintaining flexibility and adaptability, CVN-78 ensures the United States Navy maintains dominance in naval operations across the globe with the most advanced ship at sea.

Even with the copious capability upgrades on CVN-78, the Navy projected a future cost savings in operation and maintenance costs. However, technological challenges during production have persisted, causing severe cost, schedule, and performance overruns, which have placed the Ford-class carrier's future in jeopardy. Ever since construction began on CVN-78, technical issues have delayed deployment. These delays have forced the deployment schedule to slip, costing the Navy both the tangible money spent to prepare CVN-78 for its mission and the intangible cost of focusing on the next ship's build.

In particular, upon initial delivery of CVN-78, the Navy has experienced reliability issues with several of the critical subcomponents, driving the need for additional spares to support the ship's testing. Preparing for sufficient sparing of parts and equipment continues to be a challenge for the newest carrier group. CVN-78 has not yet worked through the reliability issues with three critical future weapon systems integral to the ship's flight operations: AWE, EMALS, and AAG (O'Rourke, 2021). As a result of the immature design of these critical systems driving reliability issues, the cost of CVN-78 is projected to overrun by more than 24 percent, when compared to the 2008 baseline (O'Rourke, 2021).

Some of these future systems were so controversial that in 2019, Navy Secretary Richard Spencer informed the president that if the weapons elevators were not functioning when CVN-78 was ready to pull out, the president could fire him (Eckstein, 2019). As of March 2021, the weapon elevators were 94% complete and are expected to be fully functional by the end of 2021 (Fabey, 2021). The mission faces significant risk if the AWEs fail, so to increase the reliability of this critical subsystems, CVN-78 is slated to undergo significant retrofitting and upgrades before it can be deployed as intended. In addition to the risk these new technologies place on the reliability of the critical systems, alongside the procurement of CVN-78, the Navy continues to contract for the engineering and manufacturing development and well as testing and evaluation. As a result, procurement

costs for CVN-78 have grown 24.7% as of FY2021, and the total estimate ship procurement cost for CVN-78 is $13.3 billion (O'Rourke, 2021).

Due to the delay in deploying CVN-78 and constant cost growth, the Navy has exercised efforts to stem cost growth and efficiently manage costs in accordance with the oversight requirements. Currently, the United States Congress is making a decision on CVN-78 that could impact the Navy's capabilities, funding requirements, and shipbuilding industrial base. In an attempt to control cost growth, the United States Congress mandated that MDAPs must be restructured. Additionally, the Congressional Research Service states "MDAPs have their most recent milestone approval revoked if it crosses the Nunn-McCurdy critical breach threshold of 25% over the current baseline estimate or 50% over the original baseline estimate" (Schwartz & O'Connor, 2016, p. 2). Nunn-McCurdy thresholds have not yet been breached, despite the cost overruns of CVN-78, however this is largely due to the structure of the program's multi-ship acquisition plan (Schwartz & O'Connor, 2016).

Even with implementing cost caps and incrementally funding the completion of the ship, the Navy has not been able to mitigate cost growth during CVN-78 production. The Congressional Budget Office addressed the costs issues, citing the Navy's estimate of the cost for the first carrier was too optimistic. Instead of trending the actual costs and schedule delays experienced over the previous decade, the Navy has utilized their initial low-cost estimate and asserted that the construction and cost of CVN-78 would be less than the acquisition costs of predecessor ships, despite the untested future weapon systems. However, the Navy's confidence level in the estimate for CVN-78 was below 50 percent, meaning the cost of construction had more than a 50 percent chance of exceeding the estimate of costs (Congressional Budget Office, 2008).

Despite the increasing costs, ensuring the readiness of CVN-78 has remained a top priority for the DOD. The U.S. Navy continues to address technical issues by allocating available resources to support the post shakedowns which validate the ship's critical capabilities. Underestimating the initial budget, the Navy intended to find cost savings through the installation of CVN-78's new systems. However, the new systems have not provided the projected cost savings due to their technology and manufacturing immaturity

and integration challenges, and instead have driven costs higher than estimates (O'Rourke, 2017). These counteracting forces have multiplied the impact to the acquisition's estimate at completion and have presented new challenges to the acquisition team. To correct deficiencies, ensure safety on the ship, and deliver operational capabilities, the Navy's acquisition team will continue to need additional funding.

B. HISTORY OF CVN-79

The second ship in the Ford-class, the USS *John F. Kennedy* (CVN-79), started procurement in FY2013, and has the same design requirements as the lead ship. The Navy's current proposed budget estimates the ship's procurement cost at about $11.4 billion, or $1.9 billion less than CVN-78 (O'Rourke, 2021). CVN-79 acquired the same new technologies incorporated into CVN-78, "comprising dramatic advances in propulsion, power generation, ordnance handling, and aircraft launch system" (Shulgin, 2019). For the acquisition of CVN-79, "HII received an undefinitized contract award from the U.S. Navy to shift the delivery strategy for the aircraft carrier *John F. Kennedy* from a two-phase delivery to a single phase" (Bourne, 2020). In addition to new technology and warfighting capabilities, CVN-79 was constructed under a fixed-price incentive fee (FPIF) contract (Mackin, 2014). Overall, "CVN-79's design involves an improved shipyard fabrication and assembly process that incorporates lessons learned from the construction of CVN-78" (O'Rourke, 2021, p. 7). Possessing fewer overall components and extended internal dry-docking, CVN-79 is scheduled for completion by 2024. Considering the cost overrun, schedule slippage, and performance underruns experienced by CVN-78, CVN-79 has implemented efforts to frontload work to lower costs while meeting technical capabilities. Implementing lessons learned from CVN-78 in terms of incremental funding, the Navy's plan involves eliminating key contributors to the cost overruns that CVN-78 experienced.

The cost of the CVN-79 acquisition continues to creep up, and despite the detailed plan to control cost has a projected overrun in excess of 27 percent more than the 2008 baseline (O'Rourke, 2021). To deliver the ship at or under the congressional mandated cost cap of $11.5B, the Navy revised their acquisition strategy, by postponing an estimated "$200 million - $250 million in previously planned capability upgrades of the ship's

combat systems to be completed well after the ship is operational" (Mackin, 2014, p. 2). Despite the Navy's efforts to control cost growth by implementing lessons learned from CVN-78, the acquisition of CVN-79 continues to present a high risk of future cost growth. Consequently, the "Navy may request additional funding through post-delivery budget accounts not included in calculating the ship's end cost" (Mackin, 2014, p. 1). Expecting completion in 2024 and deploying the CVN-79 in 2026, it appears FY21 will appropriate up to $71 million toward CVN-79 (O'Rourke, 2021). With this appropriation, the Navy possesses a plan to reduce cost and schedule overruns. For instance, the Navy desires a single-phase delivery of the ship in order to leverage opportunity costs and create an efficient schedule. Additionally, by implementing the lessons learned from CVN-78, the production of the USS *John F. Kennedy* is progressing at a much-improved rate. However, based on the estimate at completion, the cost for CVN-79 continues to creep up as a result of schedule delays relating to electrical, sheet metal, painting, and platform engineering work (Capaccio, 2020). At the current spending rate, the budget for CVN-79 will be exhausted prior to completion.

C. GERALD R. FORD CLASS MAJOR SUBCOMPONENTS

The Gerald R. Ford class of aircraft carriers incorporated new systems that increase the Navy's capability. Most of these new systems were contracted with a focus on reducing future sustainment and maintenance costs while providing the Navy the ability to deter aggressors. In doing so, the Ford class aircraft carrier advances the fleet into the future of combat. With the fleet's improved capabilities and future cost reduction of a stronger, leaner Navy, these cutting-edge technologies are critical to the Navy's success. These new critical subsystems have been contracted for a variety of different contract types, with various degrees of success. The AWE, EMALS, and AAG, three of the major subcomponents, have contributed to the delivery of the schedule delays and cost overruns of the Ford class program acquisition.

With an anticipated final completion date in 2021 on CVN-78, the AWE system has been a significant driver to the schedule delays and increase costs associate with the increased production cost of CVN-78 and CVN-79. Acquired under the same production

contract as the carriers, the Ford-class aircraft carrier design includes 11 AWEs, which move “missiles and bombs from the ship’s weapon magazines up to the ship’s flight deck, so that they can be loaded onto aircraft that are getting ready to take off from the ship” (O’Rourke, 2021, p. 13). Without functioning AWEs, the aircraft carrier’s ability to arm aircraft is limited, which could be catastrophic to the mission. A failure of the AWEs during combat operations would directly impact the lethality of the Navy’s greatest weapon platform and jeopardize lives. By the end of 2019, only four of the 11 AWEs were completed, tested, and certified (O’Rourke, 2021).

The CVN-78 and CVN-79 acquisitions included a new type of aircraft catapult called, EMALS, and aircraft arresting gear (AAG). The production of EMALS and AAG took place separately from the Ford-class carriers. The Navy utilized a firm-fixed price (FFP) contract with a delivery incentive for the production contracts of CVN-78 and CVN-79. The reliability of EMALS and AAG continues to be in question, the impact of this subcomponent jeopardizes the Ford-class carrier’s ability to rapidly deploy aircraft, which is the main purpose of an aircraft carrier. During recent testing between the post-shakedown availability and the independent streaming event 11, the reliability of the two critical subcomponents were noted as “well below the requirement of mean cycles between operational mission failure” (O’Rourke, 2021). The reliability issues of EMALS and AAG have driven procurement cost overruns for EMALS and AAG which is detailed in Table 1 below for the lead ship acquisition.

Table 1. CVN-78 Procurement Cost Growth for EMALS and AAG.
Source: Mackin (2017b).

System	FY 2008 Budget	FY 2017 Budget	Difference in Cost	Cost Growth as a Percent of FY 2008 Budget
EMALS	317.7 M	669.7 M	352 M	111%
AAG	75 M	147.6 M	72.6 M	97%

Ford-Class Aircraft Carrier: Follow-On Ships Need More Frequent and Accurate Cost Estimates to Avoid Pitfalls of Lead Ship.

EMALS and AAG have been a significant driver of cost overruns, contributing to approximately 40 percent of CVN-78's procurement cost growth (Mackin, 2017b). During the development phase, the Navy recognized the excessive cost growth and acquired EMALS and AAG on separate contracts from the CVN-78 and CVN-79 in order to limit future production cost growth. When contracting for the EMALS and AAG systems, the Navy used a FFP contract as recommended in a program assessment review initiated by USD AT&L John Young (O'Rourke, 2021). The FFP contract limited the government's risk of absorbing cost growth during the acquisition of EMALS and AAG.

The FFP contract's success in limiting the government's absorption of cost overrun, is in large part a result of the active EMALS and AAG development contracts, which are a mix of cost type contracts and have borne the cost of development change during production. As the reliability issues were identified during CVN-78 production, the cost to address the deficiencies through rework, repair, or modification to design, was predominantly absorbed by the development contracts and has resulted in significant procurement cost growth documented in Table 1 above (Macklin, 2017).

FFP contracts, like the ones used for EMALS and AAG, "provides maximum incentive for the contractor to control costs and perform effectively." (FAR 16.202-1, 2019). The production contracts were awarded concurrently with ongoing technology development and ship detail design, which resulted in uncertain final costs and performance (Mackin, 2017b). With the price fixed for the EMALS and AAG subcomponents, the Navy incentivized the delivery to have the subcomponents meet the schedule of the ship. The other new technologies were developed and produced on the main CVN-78 and CVN-79 contracts listed below. Even with the EMALS and AAG procurement being awarded on a FFP contract, they account for significant cost growth to-date for the Ford-class program (O'Rourke, 2017). Despite the challenges with EMALS and AAG, the program has experienced recent success and is photographed in Figure 1 below during the exercise which marked their 8,000 aircraft launches and recoveries aboard CVN-78.

Figure 2. An F/A-18 lands on USS *Gerald R. Ford* (CVN 78) using EMALS and AAG during the ship's post-delivery test and trails.
Source: U.S. Navy Photo (n.d.).

D. DESCRIPTION OF THE DOD ACQUISITION STRATEGY DURING ACQUISITION PLANNING, INCLUDE CONTRACT TYPE

According to GAO, "the Ford class program received advanced procurement (AP) funding to initiate design activities, procure long-lead materials, and prepare for construction" (Francis, 2015, p. 13). Defense Acquisition Regulation Supplement (DFARS) 217.103 states that AP is used in "MDAPs to obtain components whose long lead time requires early purchase in order to reduce the overall procurement lead time of the major end item" (AcqNotes, 2021). "By the time the Navy requested funding for construction, CVN-78 had already received $3.7 billion in advance procurement funding" (Francis, 2015, p. 14). Although the Ford-class received AP funding, the technologies were immature, cost estimates were unreliable, and had considerable unknowns (Francis, 2015, p.14). Even today the advanced technology continues to experience developmental delays, construction costs are surging, and planned procurement costs have been exceeded.

The construction on CVN-78 began with an unrealistic business case due to an underestimation of cost and the planned acquisition of immature technologies. Considering the impact of critical immature technologies, the acquisition plan of CVN-78 was subject to extremely high risk in order to deliver the ship on-time while meeting cost objectives. Even with a severe risk factor of cost overruns, schedule delays, and reduced capabilities, the business case for CVN-78 was approved (Francis, 2015). Similar to CVN-78, the CVN-79 was approved with an unrealistic business case. Although the cost of *the* USS *John F. Kennedy* sits well below the acquisition cost of CVN-78, the cost of CVN-79 exceeds the original estimation. Even with incorporating lessons learned from construction sequencing and other efficiencies from CVN-78, the CVN-79 is experiencing similar overruns.

Comparing CVN-79 to CVN-78, the cost estimate for CVN-79 "assumed that the shipbuilder would lower construction costs by realizing efficiency gains" (Mackin, 2014, p. 30). Therefore, the Navy established cost and labor hour reduction goals in order to gain efficiencies in the acquisition plan. In 2013, the anticipated CVN-79 program reported to Congress that about 7 million to 12 million fewer labor hours will be needed to construct CVN-79 compared to CVN-78 (Mackin, 2014). As further reported by Mackin in 2014, the Navy cited lessons learned during the construction of CVN-78 and revising CVN-79's

build plan to perform pre-outfitting work earlier in the build process as support for the reduction of labor hours for the CVN-79 acquisition (Mackin, 2014). Although the acquisition plan involved integrating these lessons learned from CVN-78 and gaining efficiencies by reducing labor hours, CVN-79 is estimated to cost more than originally anticipated.

"Competition with other programs for funding creates pressure to overpromise, which contributed to the acquisition plan of CVN-78 to include unrealistic costs and schedules in the initial proposal" (Francis, 2015, p.1). Instead of proposing a realistic estimation by taking into consideration historical shipbuilding experiences with cost overruns the overall acquisition plan for CVN-78 constituted severe risk. With such high risk, the USS *Gerald R. Ford* class succumbed to the pressures of obtaining competition even while acquiring cutting edge technology, ultimately creating overly ambitious goals. Overall, the acquisition of the USS *Gerald R. Ford* class of ships incorporated "a single buyer, low volume, and a limited number of major sources" (Francis, 2015, p. 1). Despite the significant challenges and unsound acquisition justification, the business case for CVN-78 and CVN-79 received approval, creating an incredible burden for the final acquisition phase.

With the final acquisition phase concurrently running key test events and construction, "the burden of completing advanced technology development now falls during the most expensive phase of ship construction" (Francis, 2015, p. 5). Due to these concurrent events, the Navy decided to manage the remaining program risks by "deferring construction and installation of mission related systems" (Francis, 2015, p. 7). The deferred construction and installation resulted in the Navy's labor hour estimation to be 2 million less than the shipbuilder's (Francis, 2015). Consequently, the discrepancies in labor hours created additional risk, the immature systems required more manpower, and the acquisition has not yet benefitted from economies of scale. With its reliability shortfalls, the ship life cycle cost increased dramatically. In view of the high level of risk, the Navy selected a cost-plus-incentive fee (CPIF) contract type for the acquisition of CVN-78 and a fixed price incentive fee (FPIF) for the acquisition of CVN-79.

A CPIF contract is a "cost reimbursement type contract with a provision for a fee that is adjusted by a formula in accordance with relationships between total allowable and target costs" (National Contract Management Association, 2019, p.131). The purpose of selecting a CPIF type contract includes creating incentives for both the buyer and seller when development risks are high or requirements are ill-defined. While determining and negotiating fee amounts, performance measurements must be clear and objectively measurable. The purpose of determining and awarding fee involves incentivizing the seller over various ranges of cost performance. However, determining minimum and maximum fee amounts can be trouble due to the difficulty of objectively measuring performance, the cost to administer performance, and the appropriate surveillance needed to ensure the seller is implementing effective and efficient cost methods. CPIF contracts are considered cost reimbursement type contracts and contractors are only expected to execute their best efforts (Grady, 2016). Therefore, the reason for selecting a CPIF contract type is to mitigate an increase of performance risk because the requirements are not well-defined.

On the other hand, NPS Report *Analyzing Cost, Schedule, and Engineering Variances on Acquisition Programs* states that FPIF contracts "are used when the government wants to incentivize technical performance and cost controls" (Griffin & Schilling, year, p. 20). For FPIF contracts, "cost uncertainties exist, but there is potential for cost reduction or performance improvement by giving seller a degree of cost responsibility and a positive profit incentive" (National Contract Management Association, 2019, p. 131). Additionally, FPIF contracts must contain "target cost, target profit, ceiling price, and profit-sharing formula" (National Contract Management Association, 2019, p. 131). According to Defense Acquisition University (DAU), the intention of a FPIF contract is to "provide the contractor a fair and reasonable incentive to assume an appropriate share of the cost risk" (DAU, n.d.). FPIF provides some shared risk with respect to cost overruns, but FPIF contracts are still considered fixed price. FPIF contracts should be implemented when contract requirements are better defined and understood. Figure 3 shows the contract type that should be selected based on program risk.

Table 2. Types of Contracts and Associated Program Risk.
Source: Alder and Scherer (1998).

Contract Type	Risk	Characteristics	Description
Fixed Price	Low Performance and Program Risk	Market-ready items. Well-defined requirements	Low levels of involvement resolving disconnects.
Cost Type	High Performance and Program Risk	Developmental Items. Ill-defined requirements	High levels of involvement in resolving project management issues
Incentive Type	Moderate Performance and Program Risk	Combination of development and low-rate production items.	High levels of involvement in reacting to and fixing project and contract disconnects and issues

Table 2. Project contracts: a decision matrix approach.

Fixed Price contracts are not appropriate when development risk exists. In the end, the contract type selected should match the development risk and ensure there is less overall program risk.

E. OVERVIEW OF RELEVANT ACQUISITION REFORM INITIATIVES

In 2010, the Department of Defense introduced "reforms in its acquisition policies that would improve program outcomes and further strengthen practices when implemented" (Francis, 2013, p. 1). Titled *Better Buying Power* (BBP) by Frank Kendall, the intention of reforming acquisition policies involved "enforcing affordability constraints, instituting long term invest plan for portfolios, implementing should cost management, and eliminating redundancies" (Kendall, 2012). Ultimately, the goal of BBP incorporated doing more with less.

While establishing a more capable and appropriately sized acquisition workforce, the BBP first incentivized target involved managing affordability and cost growth. To achieve this goal, an acquisition program must be conducted within a specified cost constraint while determining the maximum amount of resources that can be allocated. These acquisition controls would confirm the program could achieve affordability before granting milestone approval. Continuing with the notion of controlling cost growth, another mission for BBP included "driving productivity growth through will cost/should

cost management" (Kendall, 2012*)*. To adequately display a program's areas of improvement and justify each element of cost, a should cost analysis is conducted to scrutinize each element of program and eliminate unnecessary costs. In addition to controlling cost, BBP also incentivized the acquisition workforce to shorten schedule timelines.

In an effort to incentivize programs to meet shorter timeline schedules, the BBP identified schedules which experienced simple programs delays and documented the impact on the delivery of needed capabilities and cost growth. Since programs need to compete for funding, level of effort patterns were settled into, which greatly increased schedule timelines (Kendall, 2012). Consequently, the BBP's establishment of shorter program timelines resulted in expediting the process to modify requirements before obtaining the granting authority to proceed and ensuring requirements, to include schedules, achieved consistency. To achieve the objective of reducing cost and decreasing schedule overrun, the BBP recommended acquisition reform by encouraging programs to use fixed price incentive fee (FPIF) contracts with a 50/50 share line.

Implementing FPIF with a 50/50 cost share line strictly aligns the government and sellers' incentives. Being heavily incentivized, FPIF contracts require the government to know exactly what it needs and is most productive at managing risk when the requirement's baseline does not change. FPIF awards also assume the seller possesses sufficient internal controls of their processes and their costs. Therefore, FPIF contracts share cost overruns between government and seller, while rewarding cost underruns and giving both sides an incentive for good performance (Mackin, 2017a). Prior to awarding FPIF contracts, the BBP also detailed the importance of promoting real competition. To promote real competition, the program must "present a competitive strategy at each program milestone" (Carter, 2010, p. 9). Obtaining competition for complex acquisition can be difficult, in order to promote competition, the acquisition team must research the market, breakout subcontracts, and adopt commercial strategies. If barriers of competition cannot be eliminated, then the acquisition team should conduct negotiations with single bid offerors during the performance price analysis.

Besides improving the overall foundation of acquisition, the BBP also sought to improving tradecraft in services acquisitions. By improving tradecraft in service acquisitions, the DOD adopted a uniform taxonomy of contract types when acquiring services. The taxonomy of contract type for service acquisitions remained predisposed toward cost reimbursement contracts. Issuing CPIF and cost-plus-fixed-fee (CPFF) contracts for service acquisitions, "each program department must incentivize, achieve, and share in cost improvements over the period of performance" (National Contract Management Association, 2019). Ideally, selecting either CPFF or CPIF contract type for service acquisitions would improve productivity, cost efficiency, and reduce number of reviews to reduce non-productive processes. From the introduction by Ashton Carter in 2010, CVN-78 was greatly influenced by BBP's continuous process improvement imperative by following its incentives of affordability, should cost, and requirements assessment.

To address its high risk with spending and acquisition, the DOD released BBP as an initiative for internal improvement. BBP "encompassed dozens of separate initiatives around controlling costs in major weapons systems, creating incentives for industry to cut costs and deliver more innovation, and increasing competition" (Serbu, 2017). By implementing BBP, the DOD promoted an acquisition environment that obligated dollars tactically, efficiently, and intelligently. Due to the ongoing risk with government acquisition, BBP and other implemented initiatives possessed fundamental purchasing guidance. As a result of BBP, these buying initiatives heavily influenced MDAPs.

THIS PAGE INTENTIONALLY LEFT BLANK

III. LITERATURE REVIEW

The United States DOD's mission is to "provide a lethal Joint Force to defend the security of our country and sustain American influence abroad" (Department of Defense, 2018). To meet the goals of the DOD, the Office of the Secretary of Defense (OSD) must establish a National Defense Strategy which acknowledges the increasingly complex global challenges which threaten the U.S. ability to maintain peace through strength. Over the last several decades, a keystone in the National Defense Strategy has been acquisition affordability, which is detailed in the FY 2020 revisions of the U.S. Defense Acquisition System (DAS) DOD Directive 5000.01 and DOD Instruction 5000.02. Despite a focus on cost savings in modern acquisitions, the DOD has been unable to deliver MDAPs while adequately managing the triple constraint of program management: cost, schedule, and technical performance.

Even with the shortfalls of the DOD's management of the triple threat, "the acquisition system for decades has given the United States the most capable military in the world and has been improving both in the past and more recently" (Kendall, 2016, p. xvi). However, in recent years the United States has struggled to maintain our competitive edge and in order to meet our goals, must evaluate past acquisition hardships to understand why a program experienced cost overruns, schedule delays, and underdelivered technological capabilities. The results of the DAS failure to manage the triple threat has resulted in fewer MDAPs being procured at an increased acquisition cost (Dodaro, 2019). Dodaro identifies the importance of controlling costs, and the impact that knowledge-based acquisition practices can have on cost overruns for MDAPs. Dorado's Weapon Systems annual assessment highlights the negative effects insufficient knowledge has on a program entering the acquisition cycle, but does not analyze the impact different contract type selection could have made on the cost overruns experienced by the identified MDAPs.

As part of the continuous improvement effort, the DOD has been implementing the best practices outlined in Frank Kendall's BBP initiatives, which among many things has a focus on employing appropriate contract types. The selection of the correct contract type to mitigate the acquisition's risk profile is critical to the mission's success; however, there

have been conflicting results in recent MDAP acquisitions. For example, the Navy's shipbuilding practices when acquiring ships are notoriously complicated to manage and consistently experience delays from design to delivery. The Navy prefers a FPIF contract type and over the last ten years, the Navy has used FPIF contract types on over 80 percent of their shipbuilding contracts (Mackin, 2017a). Mackin discusses the Navy's use of FPIF contracts, asserting the Navy's selection of contract type is not a result of the BBP initiatives, but rather can be traced to the Navy's acquisition culture as the practice has been in favor with shipbuilding programs for the last 40 years. Despite the Navy's heavy use of FPIF contracts for shipbuilding, the acquisition team is not receiving the benefit described in the BBP initiative. The BBP establishes that FPIF contracts are effective tools in mitigating the perceived risk of a program's successful delivery, promoting shipbuilder efficiency, and controlling costs, but Mackin does not relate the Navy's acquisition practice to the BBP and analyzes why has the Navy fails to incentivize productivity in industry, to mitigate cost growth and schedule creep. Mackin asserts the Navy should maximize the effectiveness of FPIF contracts by better documenting their rational for the use of incentives and track the efficacy of the incentive throughout the long and complicated shipbuilding process.

The BBP initiative's recommendation involves leveraging FPIF contracts to encourage better cost and schedule performance outcomes, but BBP 2.0 specifically emphasizes the use of the "appropriate contract vehicle for the product or services being acquired" (Kendall, 2012). Mackin states that FPIF contracts are successful when a "program's early production phase has begun or near the end of engineering and manufacturing development" (Mackin, 2017a, p. 10). In the case of many shipbuilding contracts, the Navy awarded the design and construct contract before retiring technical risk which ultimately resulted in the program's cost growth (Mackin, 2017a). Mackin addresses the shortfalls experienced by shipbuilding programs and the different contract types used for CVN-78 and CVN-79; however, the research does not analyze forces that shaped the Navy's choices for contract type and does not make a recommendation to shape future shipbuilding acquisition plans. Mackin primarily addresses the inconsistent documentation that should be in the acquisition file which provides the justification for the contract type

selected. There is a trend of the Navy using FPIF contracts, but there are no consistent standards to measure the effectiveness of the incentives to control the contractor's behavior. With more detailed justification for each incentive element, the Navy would be able to better analyze their choices in order to make sound decisions during negotiations.

The Navy's shipbuilding contracts are using the BBP's preferred FPIF contract type, but they are not fully evaluating the maturing of the technology and are awarding FPIF contract with immature and unstable designs. The Navy may not ultimately receive a deficiency-free ship at delivery, but rather one that matches the inadequate specifications. Frank Kendall established criteria for the use of FPIF contracts in his 2016 Annual Report, Performance of Defense Acquisition System, which state a fixed-price contract be selected for development when "1) Requirements are stable 2) Technologies are mature 3) The contractor is experienced 4) The contractor can absorb overruns 5) The contractor has a business case for absorbing any overruns that occur" (Kendall, 2016, p. 3). The authors analyzed the Navy's preference of FPIF production contracts and their use with concurrent technology development to understand if a different contract would have resulted in the same cost growth. The Navy's shipbuilding practice of having using active development contracts and production contracts provides a unique opportunity to evaluate the impact a selected contract type has on controlling risk and whether current policy initiatives are having their intended effect.

THIS PAGE INTENTIONALLY LEFT BLANK

IV. ANALYSIS OF CONTRACT TYPE USED AND POLICY INFLUENCE

A. OVERVIEW

In this chapter, we provide an overview of the contract types used in the acquisition of the USS *Gerald R. Ford*, CVN-78, and the USS *John F. Kennedy*, CVN-79, and the policies that influenced the Navy's selection of contract type. We provide an analysis of the impact the selected contract type had on the acquisition, identifying correlations between contract type and the control of cost overruns, schedule creep, and technological performance as it relates to these specific acquisitions. In this analysis, we seek to address the impact contract type has on the Navy's acquisition of MDAPs and whether modern policy initiative recommendations correctly influenced the Navy's acquisition plan.

We first identify the stakeholders involved the acquisition plan. Once the stakeholders are determined, we discuss the acquisition plan's use of multiple contracts in support of the acquisition and whether or not the contract's risk was managed as intended. The data used in this analysis was collected from both Naval Sea Systems Command and Naval Air Systems Command as well as available resources as cited. We synthesize the data to analyze and understand the intended effect the Navy desired when issuing the contract by reviewing the different contract types used throughout the acquisition of both aircraft carriers. The authors then address the effectiveness that contract type had on controlling risk, specifically when the acquisition plan uses concurrent development, and production contracts as is the Navy's common practice in shipbuilding.

We then provide an overview of the policies that address the selection of contract type based on risk and discuss if policy recommendations were correctly interpreted given the specific acquisition plan used by the Navy in the procurement of ships with CVN-78 and CVN-79 as examples. Through the collection of policy initiatives active during the acquisition, the authors review the contract type selected and analyze if the Navy shaped their acquisition strategy as a result of current policies. Lastly, the authors analyze if current policies related to contract type selection had their intended impact on controlling costs, maintaining schedule, and supporting the delivery of the intended technology. Following

the analysis, the authors present our conclusion of correlations observed between contract type selection and the program maintaining their acquisition baselines in Chapter VI.

B. CONTRACT TYPES USED AND THEIR IMPACT

The development effort for the Ford-class aircraft carrier group, from concept through production, was not acquired on a single contract. The effort was awarded on multiple cost type contracts through the award of the lead ship and then moved to a FPIF contract for full rate production. The main contract was awarded to Newport News Shipbuilding (NNS) in 2000 for the development and production of the ship; however, two major subcomponents, EMALS and AAG, would ultimately be developed and acquired on separate contracts starting 2004 with General Atomics (GA). Early cost type contracts for the Ford-class carrier focused on the ship's concept. In 2004, the beginning of construction preparation for the Ford-class carrier took place on a NNS CPAF contract, while the decision was made to acquire EMALS and AAG directly from GA, instead of as a subcontractor to NNS. The system development and demonstration of EMALS was awarded on a CPAF and AAG on a separate CPFF contract directly to GA in 2003 and 2004 respectively. The remaining technologies were planned to be acquired under the single CVN-78 construction preparation contract awarded to NNS, a cost type contract.

With successful progress on the development and construction preparation contracts, the Navy awarded a 2008 CVN-78 Detail Design & Construction contract to NNS as well as a separate contract in 2009 to GA for EMALS and AAG production. CVN-78 Detail Design & Construction was awarded as a hybrid contract with the following mix of contract types; CPIF, CPAF, and CPFF. This hybrid contract would be responsible for the majority of the USS *Gerald R. Ford's* development and delivery. The contract awarded to GA for EMALS and AAG production was negotiated as a FFP contract, where the EMALS and AAG subcomponents would be delivered and installed on the CVN-78 as government furnished property. The CPAF and CPFF development contracts awarded in 2003 and 2004 for EMALS and AAG would remain active through the delivery of CVN-78.

By integrating lessons learned from the acquisition and testing of CVN-78, the Navy updated their acquisition strategy for CVN-79. The Navy and NNS learned

efficiencies by producing a line of similar ship builds between CVN-78 and CVN-79. Similar ship modules will benefit an assembly line by improving production learning curves and producing sustainable supply chains which will reduce costs. CVN-79 received its own set of contracts awarded to NNS, a 2009 CVN-79 Construction Preparation contract which utilized the CPFF and CPIF contract type, as well as a 2015 Detail Design & Construction which was awarded with a FPIF contract. The EMALS and AAG subcomponents were again awarded on a FFP contract with GA, for the delivery of a functioning system aboard CVN-79. The contract type awarded to CVN-79 is the first major difference between the CVN-78 and CVN-79 acquisitions. At the time of CVN-79's award, CVN-78 had not yet been delivered and the development contracts for CVN-78, EMALS, and AAG were actively modifying their respective designs. The main contracts discussed are provided in Table 3 for further analysis.

Table 3. Contract Type for the Program Name

Contractor	Contract	Program Name	Contract Type	Award Date
Newport News Shipbuilding	N00024-04-C-2118	CVN-21 (also called CVN-78) Construction Preparation	CPIF/CPAF/ CPFF	5/11/2004
General Atomics	N68335-04-C-0167	EMALS SDD	CPAF	4/2/2004
General Atomics	N68335-03-C-0205	AAG SDD	CPFF	7/28/2003
Newport News Shipbuilding	N00024-08-C-2110	CVN 78 Detail Design & Construction	CPIF/CPAF/ CPFF	8/1/2008
General Atomics	N68335-09-C-0573	EMALS and AAG production contract for CVN 78	FFP	6/30/2009
Newport News Shipbuilding	N00024-09-C-2116	CVN 79 Construction Preparation	CPFF/CPIF	1/15/2009
Newport News Shipbuilding	N00024-15-C-2114	CVN 79 Detail Design & Construction	FPIF	6/5/2015
General Atomics	N00019-14-C-00037	EMALS and AAG production contract for CVN 79 (and 80)	FFP	5/8/2014

The Ford-class carriers represent the first significant redesign in almost 50 years and presents significant risk as it incorporates cutting edge technology to deliver the largest warship ever conceived (Mackin, 2017b). Maintaining cost and schedule goals is a herculean task when acquiring unproven advanced technologies, considering the severe amount of technical risk with the Ford-class carriers, it is not a reasonable expectation to be able to anticipate the hurdles experienced through development. As a result of significant risk, the use of a cost type contract is recommended, which means the cost risk of the acquisition is predominantly shifted to the government. In situations such as these, performance management must be closely monitored so that changes to the acquisition program baseline can be understood, documented, and addressed.

The different contract types establish balance risk between the government and contractor. Depending on the acquisition's risk profile, each contract type has a set of strengths and weaknesses. The following SWOT analysis is provided to document the benefits and shortcomings for the two incentive type contracts utilized in the subject acquisition.

Table 4. CPIF SWOT Analysis

Strengths	Weaknesses
• Create incentives for both buyer and seller • Use when development risks are high or requirements are ill-defined • Mitigate an increase of performance risk • Incentives improve productivity, cost efficiency, and reduce number of reviews for non-productive processes • Align Government mission requirements with incentives for the Contractor	• Government inherits more risk • Structuring contract to ensure contractor stays motivated • High administration costs • Needs objective performance measures although requirements are ill-defined and/or technologies are immature
Opportunities	**Threats**
• Flexibility • High profitability opportunity for mitigating development risk • Reduction of costs • Higher performance	• Contractors are only expected to execute their best efforts • Negotiation tactics and difficulties to provide incentive range • More uncertainty

Table 5. FPIF SWOT Analysis

Strengths	Weaknesses
• Incentivize technical performance and control costs • Shifts cost risk to the Contractor • Positive profit incentives while sharing cost risk • Best used with mature technologies and stable design	• Cost uncertainties exists • Should only be implemented when contract requirements are well-defined and immature technologies do not exists • Not appropriate when development risk exists • Extensive administrative effort on both seller and buyer
Opportunities	**Threats**
• Potential for cost reduction or performance improvement • Higher profitability for the Contractor by mitigating risk • Potential for cost reduction or performance improvement	• Government needs to know exactly what it needs • Requirements baseline cannot change • Negotiation tactics can sway the structure of FPIF contracts and favor the Contractor

Despite the significant risk posed by the development, installation, and integration of advanced technologies on the Ford-class aircraft carriers, the Navy received authorization to award production contracts. In 2015, the GAO noted that both cost and labor hours for CVN-78 was underestimated and the design was immature (Mackin, 2017b). This posed the greatest risk for the government and drove cost growth in the form of additional testing delays and reduced capabilities. The risk was shifted to the government in the Navy's selection of cost type contracts; however, the immature design and unproven technologies supported the government's absorption of risk. The immature design increased the government's share of costs to account for delays resulting from redesigns to address performance issues and the cost associated with programmatic challenges of a shifting schedule. In an attempt mitigate a portion of the risk, the Navy incentivized their cost type development contracts. The incentives would ultimately not prove to be influential on the contractor's ability to control cost growth or to meet the scheduled delivery of the ship when the technology is immature and the requirements unrealistic. As the detail design & construction contract started to overrun, the government and NNS agreed to convert the contract from a 'level of effort, fixed fee' contract to a completion contract with a firm target and incentive fee. The agreement would limit cost growth if there were no modifications to the ship. However, the new terms and conditions

of the completion contract did not completely stop the cost growth as CVN-78 continued to be modified to incorporate more money for design changes. Per O'Rourke's data in his 2021 March update on the Navy Ford (CVN-78) Class Aircraft Carrier Program, CVN-78 has experienced cost growth of 27% when compared to its 2008 estimate and 8.1% when compared to the 2013 re-baseline (O'Rourke, 2021). The continued cost growth experienced, even after the acquisition baseline was updated, demonstrates the unrecognized program changes which occurred despite the incentives awarded and paid through the CPIF contracts.

Contracts that are acquiring new technologies, critical to the National Defense Strategy are likely to experience challenges during development. With so much programmatic risk, the only reasonable path forward for the acquisition is for the government to absorb the cost risk through a flexibly priced contract. This was the case for CVN-78 and for the construction preparation contract for CVN-79. However, in an attempt to mitigate cost creep, the Navy utilized a FPIF contract for CVN-79's detail design & construction. According to federal acquisition regulation (FAR) Part 16, FPIF contracts should be used when "the contractor's assumption of a degree of cost responsibility will provide a positive profit incentive for effective cost control and performance" (FAR 16.403(b)(2), 2019). At the time of the author's research, the CVN-79 FPIF contract has not yet been completed, but as stated in O'Rourke's March 2021 update, the ship is projected to have a cost overrun of 24% when compared to the 2008 baseline and -0.1% when compared to the 2013 re-baseline (O'Rourke, 2021). The estimated cost growth when compared to the 2008 baseline demonstrates the large amount of unknown risks to the program, but identify that those risks were predominately known and under control by the re-baseline in 2013.

The acquisitions of the ships experienced cost overruns and schedule delays, but the majority of the cost overruns experienced by CVN-78 and CVN-79 programs are attributable to the EMALS and AAG subcomponents which were specifically acquired on separate contracts in an attempt to control the cost growth of the aircraft carrier's most iconic weapon system. The production contracts for CVN-78 and CVN-79 were awarded as FFP contracts and did not significantly increase from their estimate at contract award

through their current projected cost at delivery. The SAR for CVN-78 as of FY 2018 President's Budget stated "The Navy was successful in using Firm Fixed Price (FFP) Contracting for EMALS on the CVN-78 to control costs and has utilized the same contracting approach on the CVN-79" (Garfinkel, 2017, p. 45). However, in the case of EMALs and AAG, the development contracts remained open and active, and the cost to address design issues was incurred by the cost type development contracts, instead of the shifting cost to the production contracts, which as a result of the FFP contract type, should have been allocated to the contractor. Allocating all of the cost to the contractor on the FFP production contract may not be reasonable and could have prevented them from delivering the assets. However, by keeping the development contracts active, the Navy essentially created a multi-contract acquisition under a cost type contract. An objective view of the part that the FFP contract type played in cost savings to the Navy needs to consider the costs incurred on the development contracts.

FFP and FPIF contracts can be excellent selections to mitigate cost creep and shift the cost risk from the government to the contractor. However, they are best used with a mature acquisition with stable designs. The misuse of FFP and FPIF contracts can create larger liabilities when used improperly, and often the government is incurring the cost by modifying the contract instead of shifting the risk to the contractor. When the fixed priced contracts required a design change, the fixed priced contract would issue a stop order and the cost to address the design issue would be allocated to the cost type development contract. As a result, the government incurred administrative costs to properly manage their contract portfolio, but did not significantly benefit from the award of a fixed price contract. As is the case with the production of EMALS and AAG for both CVN-78 and CVN-79, immature designs represent an opportunity for cost growth as the amount of unknown issues poses a significant risk. As desirable as a fixed priced contract may be, its use in acquiring MDAPs that require the development of technologies and that do not yet have mature designs may have generated more administrative effort, rather than streamline the acquisition process and result in cost savings. By overlapping the technology development, design, and construction phases the Ford-class carrier's program risk significant increased, this may be the single largest driver for cost increase to this program's acquisition.

The Navy has a history of using incentives when acquiring ships, but the incentives consistently fail to impact the contractor's ability to deliver the anticipated capability. As seen in the acquisition of CVN-78 and CVN-79, as well as their major subcomponents, none of the implemented incentives resulted in reduced costs, adherence to schedule, or the delivery of the expected technological capability. When comparing the advantages and disadvantages of the contract type selection for the acquisition of CVN-78 versus CVN-79, we find the incentives used for CVN-79 were no more effective in limiting cost overruns and schedule creep or improving the capability of the production. There are many factors that contributed to the overruns, however the fixed price contract type will remain ineffective in limiting the government's absorption of cost until the development contract is completed and the design is mature. The Navy's selection of a FPIF for CVN-79 is aligned with the BBP's general recommendation and the recency bias identified in historical Navy shipbuilding practices. The intent of BBP was to encourage FPIF contract, but only when the business case fit the contract type's risk profile. As a result of the practice of choosing a FPIF contract with an unstable and immature design, the acquisition did not have the intended impact as the true cost was shifted away from the fixed price contracts to the cost type development contracts. The Navy's overuse and reliance on fixed price type contracts for development efforts may not be a good fit for the acquisition of MDAPs. Utilizing the right contract type can shape future acquisitions by appropriately allocating risk based on the maturity of design and can help reduce administrative burden, while seeking cost savings through other means. More specific guidance on choosing the right contract type, instead of a preferred contract type, can help acquisition professionals make the right decision for their current situation and should focus on documenting supportable, definable, and trackable incentive elements that should only be authorized for payment if the criteria are met.

C. POLICY INFLUENCE

Frank Kendall's BBP 2.0 envisioned contracting agencies applying appropriate contract types that controlled costs through the acquisition life cycle. To manage affordability and cost growth, Kendall's BBP recommended the application of FPIF contracts. "Over 80 percent of the Navy's shipbuilding contracts awarded over the past 10

years were fixed-price incentive (FPI)" (Mackin, 2017a, p. 1). The intention of leveraging FPIF contracts is to encourage better cost and schedule performance from the contractor. Incentive type contracts are appropriate when there is a "desire or need to provide a contractor/seller with additional motivation to attain specific acquisition objectives that would be unlikely to be obtained without the incentives" (National Contract Management Association, 2019, p. 132). However, FPIF contracts should only be implemented when requirements are stable and technologies are mature.

According to GAO, the Navy had not "invested significantly in research and development to incorporate leading edge technologies into current carriers" (Francis, 2007, p. 1). Although the Navy had not invested in leading edge technologies, the Gerald R. Ford class of aircraft carriers were designed to include several advanced technologies. The Navy identified 16 critical technologies that CVN-78 depended on to meet development and production. The 16 critical technologies listed by GAO are referenced in Table 4.

Table 6. 16 Critical Technologies and Capabilities. Source: Francis (2007).

Technology	Capability Improvement
1,100-ton air-conditioning plant	Greater cooling capability with fewer units than the legacy system.
Advanced arresting gear	Recovers current and future aircraft, lighter than the legacy system, software controls reduce manning.
Advanced weapons elevator	Elevators that use moving electromagnetic fields instead of cabling. Allows elevator shaft to use horizontal doors to close off magazines. Reduces manning and maintenance costs.
Aviation data management control system	Optimizes weapons inventory and arrangement. Interfaces new technologies such as EMALS and the advanced arresting gear for operation and management purposes.
Dual band radar—multifunction radar and volume search radar	Integrates two radars operating on different frequency bands: • volume search radar: long-range searches to detect small targets. • multifunction radar: horizon/surface search and tracking.
Evolved Sea Sparrow missile for CVN 21	Supports raid requirement with a data link between combat systems and missiles.
EMALS	Replaces steam catapult. Uses an electrically generated, moving magnetic field to propel aircraft to launch speed.
Heavy underway replenishment	Quicker shipboard replenishment through reinforced steel beams that increase ship separation (180 to 300 ft.) and load transport (5,700 lbs to 12,000 lbs).
High-strength low-alloy steel 65 and 115	Lightweight steel reduces ship weight.
Joint precision approach and landing system (JPALS)	Global positioning system technology allows for all-weather, day-night landings.
Nuclear propulsion and electric plant	Converts energy into electricity. Provides 2.8 times more electrical generating capacity than previous carrier class.
Plasma arc waste destruction system	Uses extreme temperatures to convert 6,800 lbs/day of paper, cardboard, plastic, cloth, wood, incidental food, metal, and glass into gaseous emissions.
Reverse osmosis desalination system	Desalinates water without requiring a steam distribution system and creates potable water.
Shipboard weapons loader	Self-powered, self-charging munitions loader intended to lift up to 3,000 lbs in sea states 5 or 6.

Table 4. Navy Faces Challenges Constructing the Aircraft Carrier Gerald R. Ford within Budget.

The Navy mitigated the risk of these technologies except for EMALS, AAG, and dual band radar (Francis, 2007). These pivotal technologies possessed little margin for error because "the lateness of these systems would lead to more labor costs due to the potential of inefficient work-around and schedule delays" (Francis, 2007, p. 2). To subside the small margin of error for the lateness of high risk technologies, the Navy should have continued to mature these technologies in a separate effort while the ship build was modular. Additionally, the Navy should have instituted an open architecture to incorporate these technologies once they became mature. By applying this classic incremental development framework for shipbuilding, it would have been easier to manage risk because immature technologies would have been identified and handled during its iteration process.

Successful delivery of the CVN-78 includes being on schedule, fully mature, and operational (Francis, 2007). Considering the risk of deploying immature technologies with EMALS, AAG, and the dual band radar, a CPIF contract was selected for the portfolio of CVN-78. Assessing affordability and requirements assessment, a CPIF contract was an appropriate choice regarding contract type considering the risk of the acquisition profile. With the lack of investment on research and development, the significance of releasing mature technologies, and stable requirements, the government needed to inherit more risk due to the high amount of uncertainty with the weapons systems. With a high degree of uncertainty on immature technologies, speculative labor hours, and unstable requirements, selecting a cost reimbursement type contract aligned with policy. Additionally, the contract portfolio for CVN-78 desired to implement cost incentives to motivate the seller to manage costs effectively for major systems development. On the other hand, the acquisition of CVN-79 used a different approach during contract type selection.

Possessing the same design requirements as the lead ship, CVN-79 still sought to acquire the same new technologies as CVN-78. Implementing lessons learned from the schedule slippage and cost overruns experienced by CVN-78, CVN-79 implemented efforts to lower costs while meeting technical capabilities. To capitalize on schedule flexibility and deliver the ship at a lower cost, the contract type selected for CVN-79 was a FPIF. Although the same risk profile existed with unstable designs and immature technologies, a different contract type was selected for CVN-79. The government intended

to encourage better cost control and performance on schedule delivery, but the same risk caused by immature technologies and unstable design existed. FPIF contracts places more cost risk on the contractor and should only be used with well-defined requirements. Based on the policy detailed in BBP 2.0, a FPIF contract would not align as the appropriate selection for mitigating risk.

For the acquisitions of CVN-78 and CVN-79, selecting the correct contract type was pivotal for mitigating risk. However, the selection of contract type alone does not indicate causation of the experienced schedule slippage and cost overruns. Annotating differences in contract type for CVN-78 and CVN-79, CVN-78 utilized a CPIF type contract while CVN-79 applied a FPIF type contract. In this case, the use of a cost type contract is recommended because of the significant risk of acquiring immature technologies. FPIF contracts should be implemented when requirements are stable and technologies are mature. Although FPIF contracts were heavily incentivized by BBP and other initiatives, a cost type contract is recommended to absorb cost from the significant risk. This analysis has addressed the four research questions proposed in the introduction of thesis, summarized our research, and provided recommendations for future MDAPs in the conclusion and recommendations below.

THIS PAGE INTENTIONALLY LEFT BLANK

V. CONCLUSION AND RECOMMENDATIONS

A. ANSWERS TO FOUR RESEARCH QUESTIONS

1. What were the advantages and disadvantages in terms of contract type selection used in the acquisition of CVN-78 versus CVN-79?

The acquisition strategies, in regard to contract type, for both CVN-78 and CVN-79 had many documented similarities during production. Both ships had construction preparation contracts, which were awarded as hybrid cost type contracts, CPFF/CPIF/CPAF for CVN-78 and CPFF/CPIF for CVN-79. The major subcomponents, EMALS and AAG, which were acquired outside of the main contract for the carrier, utilized a FFP contract in both acquisitions. The major difference between the acquisitions of CVN-78 and CVN-79 was during the detail design & construction contracts, which would ultimately delivery the Ford-class carrier, and was awarded as a hybrid cost type contract for CVN-78, CPIF, CPAF, and CPFF. However, the detail design and construction contract was awarded as a FPIF contract on CVN-79. The selection of contract type should depend strictly on the situation of the acquisition, depending on how stable the design is and reflect the risk of the unknown variables. Selection of contract type determines "how cost and/or performance risk is allocated between the parties" (National Contract Management Association, 2019, p. 129). Therefore, advantages and disadvantages of each contract type are dictated by the elements of risk each acquisition portfolio possesses.

Generally, cost type contracts shift significant financial risk on the government. The contractor will typically have a cost ceiling and is able to incur allocable costs to the contract while charging the government for costs incurred. Once the cost ceiling is met, the contractor will typically not have an obligation to continue the effort, unless more funding is obligated. Under a cost contract or a CPFF contract, the contractor has no incentive to control costs, other than competition. As a means for the government to mitigate the risk of absorbing the costs in excess of the contract's estimate at complete, they can utilize cost incentives through a CPIF contract where individual incentive elements are written into the contract. CPIF contracts are advantageous as they provide the contractor an opportunity to "earn more profit/fee by reducing cost, exceeding the performance objectives or achieving

the desired schedule" (Memo, 2016, p. 16). As a result of issuing these incentives, the government is then able to align these incentives with their requirements. However, the disadvantages of a CPIF contract include the demands and expertise for properly structuring the contract to ensure the contractor stays motivated. Therefore, the government must be the subject matter experts in aligning contract requirements with incentivizes to generate the contractor's best performance. Although there is a "strong correlation between the use of incentive contracts and better performance outcomes" (Grady, 2016, p. 8), poorly structured incentive contracts increase cost risk on the government.

In the case of the acquisition of CVN-78, immature technologies and ill-defined requirements exemplified the significant risk for the acquisition portfolio. As a result of these immature technologies and poorly defined requirements, the program experienced significant risk for the development, performance, and cost estimation. Thus, fixed price contracts are not appropriate when development risk exists. Due to the high levels of program risk with immature technologies and uncertainties, a cost type contract was advantageous to receiving the desired capabilities. Although cost type contracts place more cost risk on the government, the contractors need an opportunity to "reduce cycle times, maintain schedule, and maximize efficiency" (Grady, 2016, p. 19) given the immature technologies surrounding the acquisition portfolio. In order to promote these characteristics, issuing a cost type contract with the subject risk profile is advantageous to the government.

On the other hand, the acquisition profile of CVN-79 included the selection of a FPIF contract type. Generally, the benefits of issuing a FPIF type contract are consistent with a CPIF type contract. Incentive type contracts are advantageous because they allow the government to structure a contract that aligns their requirements and incentivizes the contractor to control costs in order to earn more profit. Additionally, FPIF contracts typically cost less because they are implemented with lower-risk requirements and solicitations (Grady, 2016). Conversely, FPIF contracts are not suitable in acquisition situations where "technical uncertainty exists because there is also a great likelihood of cost uncertainty" (Grady, 2016, p. 18). Thus, FPIF contracts should only be implemented when requirements are stable and technologies are mature. In the case of CVN-79, the

acquisition portfolio of encapsulated significant production risks, stemming from its immature technologies. For that reason, selecting an FPIF contract based on the performance risk profile was not advantageous to the government's goal of receiving the intended capabilities.

The utilization of FFP contracts for EMALS and AAG would have been a successful means of shifting risk of cost growth from the government to the contractor, however the benefit would have only been recognized if the cost type development contracts were inactive. FFP contracts typically shift all cost risk to the contractor, creating a situation where the price to the government and the technologies received does not fluctuate from the initial estimate. FFP contracts benefit contractors when costs are able to be controlled and reduced, but decrease the contractor's profit when the contract experiences cost growth. In the case of EMALS and AAG, the cost to address performance issues resulting from the immature technology were predominantly absorbed by the development cost type contract which the government ultimately paid for. For acquisitions with stable designs, a FFP contract is a great tool, however the contract type did not have its intended effect in this case and should not have been used while the cost type development contract was active.

When deciding upon contract type based on performance and development risk, the areas to consider include "stability and clarity in the specifications, type and complexity of item or service being procured, maturity of technology, prior experience in providing required supplies or servicers, contractor technical capability, and extent and nature of proposed subcontracts" (Grady, 2016, p. 5). The major difference between the acquisitions of CVN-78 and CVN-79 was during the detail design & construction contracts, which would ultimately delivery the Ford-class carrier. CVN-78 was awarded as a hybrid cost type contract; CPIF, CPAF, and CPFF. On the contrary, CVN-79 was awarded a FPIF type contract for detail design and construction. Since the contract specifications lacked clarity and technology was immature, the most advantageous contract type for the acquisition of CVN-78 and CVN-79 includes a cost type contract.

2. What policies or initiatives shaped the decision to choose the contract types during the acquisitions of CVN-78 and CVN-79? Was the intent of the initiatives ultimately successful during the acquisition?

According to GAO, the "DOD has taken steps to improve its use of incentive contracts-often beyond what is required by the FAR- by revising the DFARS, instituting its Better Buying Power initiative, and developing new guidance and training courses" (DiNapoli, 2017, p. 10). Through a myriad of training courses, the DOD encouraged acquisition professionals to utilize incentive type contracts. Additionally, BBP literature highly encouraged the use of incentive contracts for contracting personnel. With highly reputable acquisition leaders and memoranda encouraging the use of incentive contracts, individuals in charge of defense acquisition programs were easily influenced. The DOD revised the FAR and DFARS to mirror the BBP initiatives, encouraging the selection of incentive type contracts. Through these initiatives, the DOD specifically "emphasized the use of objective incentives through FPI and CPIF contracts" (DiNapoli, 2017, p. 10). The purpose of issuing these initiatives and policies involved incentivizing the contractor to control its costs and provide them the opportunity to earn more profit. These initiatives and policies accumulated significant influence. Due to the DOD's focus of applying incentive type contracts, "65 of 78 major defense acquisition programs used either FPI or CPIF type contracts as of January 2017" (DiNapoli, 2017, p. 13).

In the case of this study, the definition of success is subjective. In the case of encouraging the use and implementation of incentive type contracts, DOD policies and initiatives were highly successful. For instance, 83% of MDAPs used incentive type contracts for their acquisition portfolios. Thus stimulating success for MDAPs using incentive type contracts. However, the influence that incentive type contracts had in influencing contractor performance is often misconstrued. According to GAO, the "DOD acknowledged that some officials interpreted the first memorandum to mean that FPI contracts should be used to the exclusion of other contract types" (DiNapoli, 2017, p.13). Due to DOD policies and BBP initiatives prioritizing incentive type contracts, acquisition professionals neglected selecting the appropriated contract type based on the subject risk profile of their acquisition. Ideally, acquisition and contracting professionals must consider the full range of contracts when selecting the appropriate contract type. As a result of the

BBP initiatives and DOD policies, incentive type contracts were implemented without the full evaluation and documentation of the entire risk portfolio. Therefore, determining success is immensely difficult because, although these initiatives and policies influenced MDAPs to select incentive type contracts, "incentive type contracts do not always lead to better outcomes" (DiNapoli, 2017, p. 33).

3. How can contract type shape future acquisitions to deliver the expected capabilities, on time, and within the planned acquisition cost?

The selection of contract type can influence the success of future acquisitions to deliver the expected capabilities, on time and at cost. By assessing the risk profile of a given acquisition and selecting the appropriate contract type, the acquisition workforce can set up a contract for success. There are many variables beyond contract type that effect cost, schedule and performance in a complex acquisition, however selecting an effective contract type from the start can help the government receive the benefit they are contracting for.

When the acquisition is acquiring immature technologies with many unknown, the government should fully understand the risk they are taking on. It does not serve the government's end goals by moving to either a FPIF or FFP contract too early as significant cost growth will be absorbed by the government in some form. By moving to a FPIF or FFP contract too early, the government creates administrative challenges by having to maintain active cost type development contracts alongside the FPIF or FFP so that the design changes can be implemented before production. Had the government assessed the high risk of the acquisition and kept all contracts cost type, then this administrative burden would have been reduced and the program office would have more resources to focus on the design challenges.

Incentives can be a beneficial tool in controlling contractor behavior, but its ability to shape outcomes from a new technology is limited. Without an incentive on a cost type contract, contractors do not have enough stake in the acquisition to innovate during the contract's life in order to reduce costs. Properly applying incentives can encourage a contractor to provide the intended benefit for less than the estimated price. However, it is

unrealistic to believe incentives can mitigate the risk associated with an unproven technology. This is the case with many MDAPs in recent years and is certainly the experience of CVN-78 and CVN-79. The amount of unknown variables was too significant to assume the incentive would be effective in controlling cost growth.

The government must be realistic when choosing a contract type. By analyzing the specific risk of a specific acquisition, the government can prepare a contract type that aligns with the risk profile. If the risk is high, then the business case should reflect that risk and focus on the derived benefit from pursuing this new technology. When utilizing incentive payments, the incentives should only be released to the contractor if the original goals were met. Incentives should not be awarded to cover additional costs incurred by the contractor that were not in the original estimate. Once technologies are mature enough that the risk profile supports a FPIF or FFP contract, then the fixed price award should be used without an active development contract. Without an active development contract, the risk of cost overruns is the burden of the contractor and not the government. When the government decides to move to a FPIF or FFP contract, then the development contracts should be completed or near completion so that they are not utilize when the acquisition faces turbulence. By choosing the correct contracting vehicle, the government can influence the contractor by managing the costs, schedule and quality of an acquisition.

4. How can future DOD acquisition strategy be changed to better guide acquisition professionals on how to choose contract type when acquiring new/immature technologies?

Current DOD acquisition strategy has a focus on making decisions based on the specific situation in order to influence the outcome. However, there is an enormous amount of cultural and recency bias to overcome in the awarding of certain contract types for certain technologies within the DOD. The Navy has historically used FPIF contracts for shipbuilding and when recent policy initiatives, such as the BBP, aligned with the Navy's preferred practice, contracting professionals were likely empowered to continue to make the same decisions and repeat the same outcomes. The DOD must promote the ideas documented by the GAO as new policy initiatives consistently in order to combat the cultural bias of the acquisition team to award the same way as the previous MDAP. Future

DOD acquisition strategies must highlight and champion the idea of treating each acquisition as an individual action, based on its specific risk profile and not based on broad guidance.

The BBP initiatives discussed when to use incentive contracts, but the message was heavily focused on the benefits from using incentive contracts. In future DOD policy initiatives, the DOD needs to emphasize when the use specific contract types. By promoting the most valuable situations rather than the benefit received, more acquisition teams will have the knowledge to select a contract type for their specific scenario. If an acquisition team should determine that incentives are a viable option, then policy should aid the acquisition team by adequately highlighting the critical importance of the incentivized elements, in include samples and reference material for the detailed justification and documentation. By empowering the acquisition team to make critical decisions based on the facts of their acquisition and not through broad application of general policy the DOD can better support using the correct contract type for the future acquisition.

DOD acquisition policy does not currently address the use of concurrent development and production contracts. Future DOD acquisition policy needs to opine on how the acquisition team should handle such a situation. The policy would prefer for development to be fully complete before production begins, but the Navy's shipbuilding track record shows that concurrent development and production is likely a reality as rapid development becomes more heavily relied upon. DOD acquisition strategy should address the impacts of running concurrent development and production to guide the acquisition team on their selection of contract type. By providing helping the acquisition team understand how to operate a portfolio of contracts with different contract type, and how the effectiveness of contract type changes as the portfolio grows will encourage the acquisition team to make reasonable and justifiable decisions.

B. SUMMARY

We analyze the acquisitions of both CVN-78 and CVN-79 and examine the impact of each carrier's selected contract type. The Navy continues to pay a price premium for

advanced warships, which results in the ships being returned to the shipyard for retrofitting and repair. Experiencing cost overruns and schedule slippages, the Navy continues to fail at achieving "efficiency and productivity in defense spending by delivering warfighting capabilities needed with money available" (Kendall, 2012). Therefore, the purpose of this JAP was to determine whether the selection of contract type impacted cost and time overruns experienced by the Ford-aircraft carriers. Besides determining whether contract type selection impacted cost and time overruns, another pivotal piece to this research includes identifying the contracting strategies utilized for these acquisitions whether the Navy can accumulate lessons learned from the history of these acquisitions.

Replacing the Nimitz class, the design of CVN-78 consists of providing an increased capability to the fleet with cutting-edge technology. However, the cutting-edge technology designed had yet to be tested and evaluated. Due to these immature technologies, technical risk from AAG, EMALS, and AWE permeated the acquisition portfolio. Persistent immature technologies caused severe cost, schedule, and performance overruns, which ended up delaying the delivery of CVN-78. Implementing lessons learned from CVN-78, CVN-79's characteristics consisted of improved shipyard fabrications and assembly process. Although CVN-79 implemented lessons learned, the acquisition of CVN-79 consisted of high risk for future cost growth. The major difference between the acquisitions of CVN-78 and CVN-79 was during the detail design and construction contracts. CVN-78 was awarded as a hybrid cost type contract for CVN-78; CPIF, CPAF, and CPFF. While on the contrary, the detail design and construction for CVN-79 was awarded as a FPIF contract.

Being heavily incentivized by BBP, FPIF contracts require the government to know exactly what it needs and is most productive at managing risk when the requirement's baseline does not change. However, fixed price contracts are not appropriate when development risks exists. Fixed priced contracts shall only be selected for development when "1) Requirements are stable 2) Technologies are mature 3) The contractor is experienced 4) The contractor can absorb overruns 5) The contractor has a business case for absorbing any overruns that occur" (Kendall, 2016, p. 3). Maintaining cost and schedule baselines when acquiring immature technologies is unreasonable considering the severe

amount of risk associated with the Ford-class carriers. Due to the amount of risk associated with immature technologies, a cost type contract would be the recommended contract type selection. With immense programmatic risk, the only reasonable path forward for the acquisition is for the government to absorb the cost through a flexibly priced contract. With the lack of investment on research and development, the significance of releasing mature technologies, and stable requirements, the government should inherit more risk due to the high amount of uncertainty with the weapons systems. Ideally, FPIF contracts should be implemented when requirements are stable and technologies are mature. Even with the accumulated research, it should be noted that the selection of contract type alone does not indicate causation of the experienced schedule slippage and cost overruns experienced by CVN-78 and CVN-79.

C. RECOMMENDATIONS

In order for the U.S. to maintain our dominant position across the globe, we must continue to acquire cutting edge technologies that modernize our MDAPs. However, modern MDAPs come at a significant price as they will commonly incorporate new technologies, often with unproven and new designs. The DOD must identify the critical MDAPs and focus on the development before construction. The more refined the development of a program is, the less funding that will be needed for redesigns during the production and post-delivery phases. The DOD should view each acquisition as a unique opportunity to choose the correct acquisition mythologies that best suit the specific need.

The government must decide if a new technology is critical to the national defense strategy. If it is, then the technology should be developed on separate contracts until the design is mature enough to be integrated into the intended platform. This may have proven impossible for the EMALS and AAG subcomponents as they had considerable influence on the entire ship's design, but had other new technologies been developed as modular, then a proven design could be use until a development on the new technology is complete. Had the Ford-class carrier been developed as a modular system, then the Navy could have decided to delay the integration of a technology such as the AWEs from being installed on the lead ship, and wait for the technology to mature. By waiting for a technology to mature

before being used in a production contract, the Navy would likely incur most of the costs on a flexibly priced contract for development and then would be in their right to support a FPIF contract for production. If the Navy utilized a shipbuilding approach, which integrated new technologies once the design was functioning and stable, then significant savings could have been realized on the first versions of the Ford-class carriers.

If it is not possible to wait for a technology to mature and a decision on which technology to use must be made for the construction of a ship, then the acquisition team should utilize a cost type contract. Any shift from a cost type contract to a fixed price contract, either FPIF or FFP, is premature if development is ongoing. The fixed priced contract will not have their intended effect as costs for redesign will be shifted to the development contract. By running concurrent development and production the government takes on significant risk that would otherwise shift the contractor under a typical fixed price acquisition.

Incentives can provide a benefit to the government, increasing the contractor's stake in the control of cost growth. However, incentives must be selected judiciously and be well documented. The acquisition team must become subject matter experts and choose the specific incentive elements carefully to influence contractor behavior. If a contractor has not met the entire intent of an incentive, then the incentive should not be paid. Too often the government is paying the contractor the full incentive payment, but is not receiving the intended outcome. There will continue to be many unknown variables when acquiring new technologies, understanding how new information impacts the acquisition program baseline and making changes as appropriate will benefit a realistic cost estimation throughout the acquisition life cycle.

There are many factors that can contribute to overruns in cost and schedule and the acquisition environment is too complex to identify a single factor as the element that drove a cost overrun. However, while reviewing the Navy's acquisition of MDAPs over the past several years, there is consistently a trend of spending more funding to receive a late delivery that is less capable than the original design intended. The authors do not claim that the correlation between the overruns and is caused by the contract type selected, but there are observable correlations that warrant further investigate and discussion. While the

authors are unable to directly state that the wrong contract type selection has allowed for these overruns, it is possible to consider how a different contract type may have improved the acquisition process.

THIS PAGE INTENTIONALLY LEFT BLANK

LIST OF REFERENCES

AcqNotes. (2021, March 04). *Financial management. Advanced procurement funding.* Retrived May 31, 2020. https://acqnotes.com/acqnote/careerfields/advance-procurement-funding

Alder, T. R., & Scherer, R. F. (1998). Project contracts: A decision matrix approach. *PM Network, 12*(7), 37–41.

Arena, M., Blickstein, I., Grammich, C.A., & Younossi, O. (2006). *Why has the cost of Navy ships risen? A macroscopic examination of the trends in U.S. naval ship costs over the past several decades.* RAND. https://www.rand.org/content/dam/rand/pubs/monographs/2006/RAND_MG484.pdf

Capaccio, A. (2020). Next carrier's cost creeps up after first one hit $13.3 billion. *Bloomberg*. https://www.bloomberg.com/news/articles/2020-08-05/next-carrier-s-cost-creeps-up-after-first-one-hit-13-3-billion

Carter, A. (2010, September 14). *Better buying power: Guidance for obtaining greater efficiency and productivity in Defense spending*. [Memorandum]. Under Secretary of Defense for Acquisition, Technology and Logistics. https://www.acq.osd.mil/fo/docs/USD_ATL_Guidance_Memo_September_14_2010_FINAL.PDF

Columbia Daily Tribune. (2016, December 20). *McCain blasts Navy warships in report on Pentagon waste.* https://www.columbiatribune.com/07ff2fcb-781d-57d5-bbdf-dd69ad55b3c7.html

Defense Acquisition University (n.d.). *Fixed price incentive firm target (FPIF) contract type.* DAU Acquipedia. Retrieved March 31, 2021, from https://www.dau.edu/acquipedia/pages/articledetails.aspx#!102

DiNapoli, T. (2017). *Defense contracting: DOD needs better information on incentive outcomes* (GAO-17-291). Government Accountability Office.

Dodaro, G. L. (2019). *Weapons system annual assessment* (GAO-19-336SP). Government Accountability Office.

Eckstein, M. (2019, March 21). 30-year plan: Navy puts 355-ship cap on fleet size; plans to introduce large combatant, CHAMP Auxiliary Hull. *USNI News*. https://news.usni.org/2019/03/21/long-range-ship-plan-outlines-355-ship-cap-on-fleet-size-plans-to-introduce-large-combatant-champ-auxiliary-hull

Fabey, M. (2021, March 16). U.S. Navy reports progress on key carrier Ford systems. Jane's Navy International. https://www.janes.com/defence-news/news-detail/us-navy-reports-progress-on-key-carrier-ford-systems

FAR 16.401(c), General (2019).https://www.acquisition.gov/far/part-16

Francis, P. (2007). *Defense acquisitions: Realistic Business Cases Needed to Execute Navy Shipbuilding Programs* (GAO-07-943T). Government Accountability Office.

Francis, P. (2013). *Defense acquisitions: Where should reform aim next?* (GAO-14-145T). Government Accountability Office.

Francis, P. (2015). *Ford-Class aircraft carriers: Poor outcomes are the predictable consequences of the prevalent acquisition culture (*GAO-16-84T). Government Accountability Office.

Grady, C. (2016, April 01). *Guidance on using incentive and other contract types* [Memorandum]. Department of Defense. https://www.acq.osd.mil/dpap/policy/policyvault/USA001270-16-DPAP.pdf

Garfinkel, S. (2017). *CVN 78 Gerald R. Ford Class nuclear aircraft carrier (CVN 78) as of FY 2018 president's budget* (Report No. DD-A&T(Q&A)823-223). DAMIR. https://fas.org/man/eprint/sar-cvn78.pdf

Griffin, W. E., & Schilling, M. R. (2011). *Analyzing cost, schedule, and engineering variances on acquisition programs* [Master's thesis, Naval Postgraduate School]. NPS Archive: Calhoun. https://calhoun.nps.edu/bitstream/handle/10945/10615/11Dec%255FGriffin%255FMBA.pdf?sequence=1&isAllowed=y

Hale, R. (2002). Promoting efficiency in the Department of Defense: keep trying, but be realistic. *Center for Strategic and Budgetary Assessment, 1*(1). https://csbaonline.org/research/publications/promoting-efficiency-in-the-department-of-defense-keep-trying-but-be-realis/publication/1

Kendall, F. (2012, November 13). *Better buying power 2.0: Continuing the pursuit for greater efficiency and productivity in Defense spending*. [Memorandum]. Under Secretary of Defense for Acquisition, Technology and Logistics. https://business.defense.gov/Portals/57/Documents/OUSD-AT-L-Memorandum,%20Better%20Buying%20Power%202.0-Continuing%20the%20Prusite%20for%20Greater%20Efficiency%20and%20Productivity%20in%20Defense%20Spending-13%20Nov%202012.pdf

Kendall, F. (2016). *Performance of the defense acquisition system.* https://www.acq.osd.mil/fo/docs/performance-of-defense-acquisition-system-2016.pdf

Kozlak, S., Lucas B., Ritschel, J. D., Seibel, M., & White E. D. (2017). Analyzing cost growth at program stages for DOD aircraft. *Defense Acquisition University, 24*(3). 386–407. https://doi.org/10.22594/dai.16-763.24.04

Mackin, M. (2014). *Ford-class aircraft carriers: Congress should consider revising cost cap legislation to include all constuction contracts (*GAO-15-22). Government Accountability Office.

Mackin, M. (2017a). *Navy shipbuilding: Need to document rationale for the use of fixed Price incentive contracts and study effectiveness of added incentives* (GAO-17-211). Government Accountability Office.

Mackin, M. (2017b). *Ford-class aircraft carriers: Follow-on ships need more frequent and accurate cost estimates to avoid pitfalls of lead ship* (GAO-17-575). Government Accountability Office.

Malone, P. (2018). *CVN 78 Gerald R. Ford class nuclear aircraft carrier (CVN 78) as of FY 2018 president's budget* (Report No. DD-A&T(Q&A)823-223). DAMIR. https://fas.org/man/eprint/sar-cvn78.pdf

Mattis, J. (2018). *Summary of the national defense strategy of the United States of America*. https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf

National Contract Management Association (2019). *Contract Management Body of Knowledge: CMBOK* (6th ed.). National Contracting Management Association.

Oakley, S. S. (2018). *Navy shipbuilding: past performance provides valuable lessons for future investments* (GAO-18-238SP). Government Accountability Office.

Oakley, S.S. (2020). *Navy shipbuilding: increasing focus on sustainment early in the acquisition process could save billions*. (GAO-20-2). Government Accountability Office.

Orszag, P. (2008). *Resource implications of the Navy's fiscal year 2009 shipbuilding plan.* https://www.cbo.gov/sites/default/files/110th-congress-2007-2008/reports/06-09-shipbuilding_letter.pdf

O'Rourke, R. (2017). *Navy Ford (CVN-78) class aircraft carrier program: background and issues for Congress* (CBS Report No RS20643). Congressional Research Service. https://www.hsdl.org/?view&did=800182

O'Rourke, R. (2021). *Navy Ford (CVN-78) class aircraft carrier program: Background and issues for Congress* (CBS Report No RS20643). Congressional Research Service. https://fas.org/sgp/crs/weapons/RS20643.pdf

Woodruf, S. N. B. (2012). *DOD implementation of the better buying power initiatives* [Master's thesis, Naval Postgraduate School]. NPS Archive: Calhoun. https://calhoun.nps.edu/bitstream/handle/10945/27921/12Dec_Woodruff_Shamika.pdf?sequence=1&isAllowed=y

Schwartz, M. & O'Connor, C. (2016). *The Nunn-McCurdy Act: Background, analysis, and issues for Congress* (CRS Report No. R41293). Congressional Research Service. https://fas.org/sgp/crs/natsec/R41293.pdf

Serbu, J. (2017, February 28). The legacy of Better Buying Power: DOD's gambit to reform acquistiion 'from within'. *Federal News Network. https*://federalnewsnetwork.com/defense/2017/02/bbpndaa-special-report-part-1/

Shulgin, D. (2019, December 08). *Serve with courage*. Modern weapons. http://www.dmitryshulgin.com/2019/12/08/serve-with-courage/

Tax Policy Center (2020). *Briefing book: A citizen's guide to the fascinating (through often complex) elements of the U.S. tax system.* [Briefing Book]. https://www.taxpolicycenter.org/sites/default/files/briefing-book/tpc_briefing_book_2021.pdf

Werner, B. (2020, June 5). GAO: Navy needs more risk awareness to prevent cost, schedule overruns. *USNI News.* https://news.usni.org/2020/06/05/gao-navy-needs-more-risk-awareness-to-prevent-cost-schedule-overruns

INITIAL DISTRIBUTION LIST

1. Defense Technical Information Center
   Ft. Belvoir, Virginia

2. Dudley Knox Library
   Naval Postgraduate School
   Monterey, California