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FAILURE IS NOT AN OPTION: A ROOT CAUSE ANALYSIS OF FAILED ACQUISITION PROGRAMS

by

Matthew R. Bogan
Anthony S. Percy
Thomas W. Kellermann

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Thesis Advisor: Robert F. Mortlock
Co-Advisor: John T. Dillard

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The current budgetary climate in the federal government is one of increasing uncertainty, making the long-term acquisition of critical weapon systems within the Department of Defense a challenging prospect. Rapid budget growth and a preoccupation with global military operations over the last fifteen years created a difficult environment to prioritize and track failed acquisition programs, resulting in a poor understanding of the actual root causes of program failures. By studying a subset of cancelled major defense acquisition programs, it is possible to achieve a better understanding of root causes for failure and analyze whether there are commonalities among the root causes for failure to apply to future programs. This research informs military leadership and program executive officers of potential risk components in future acquisition programs that are critical to the achievement of national security objectives. Areas of particular concern include poor technology progression, negative congressional involvement, waiving milestone A, and a significant change in requirements.

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FAILURE IS NOT AN OPTION: A ROOT CAUSE ANALYSIS OF FAILED ACQUISITION PROGRAMS

Matthew R. Bogan
Captain, United States Air Force
MBA, Oklahoma State University, 2014

Anthony S. Percy
Captain, United States Air Force
BSBA, University of West Florida, 2011

Thomas W. Kellermann
Captain, United States Air Force
B.S., United States Air Force Academy, 2009

Submitted in partial fulfillment of the
requirements for the degree of

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December 2017

Approved by: Dr. Robert F. Mortlock
Thesis Advisor

John T. Dillard
Co-Advisor

Dr. Rene G. Rendon
Academic Associate

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ABSTRACT

The current budgetary climate in the federal government is one of increasing uncertainty, making the long-term acquisition of critical weapon systems within the Department of Defense a challenging prospect. Rapid budget growth and a preoccupation with global military operations over the last fifteen years created a difficult environment to prioritize and track failed acquisition programs, resulting in a poor understanding of the actual root causes of program failures. By studying a subset of cancelled major defense acquisition programs, it is possible to achieve a better understanding of root causes for failure and analyze whether there are commonalities among the root causes for failure to apply to future programs. This research informs military leadership and program executive officers of potential risk components in future acquisition programs that are critical to the achievement of national security objectives. Areas of particular concern include poor technology progression, negative congressional involvement, waiving milestone A, and a significant change in requirements.

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LIST OF ACRONYMS AND ABBREVIATIONS

ACAT	acquisition category
ADM	acquisition decision memorandum
AIS	automated information system
AoA	analysis of alternatives
APB	acquisition program baseline
BBP	Better Buying Power
BCA	Budget Control Act
BES	budget estimate submission
CAE	Component Acquisition Executive
CBA	capability-based assessment
CDD	capability development document
CDR	critical design review
CJCS	Chairman of the Joint Chiefs of Staff
CPD	capability production document
CPI	consumer price index
CRS	Congressional Research Service
D/CAPE	Director, Cost Assessment and Program Evaluation
DAE	Defense Acquisition Executive
DAMIR	Defense Acquisition Management Information Retrieval
DARPA	Defense Advanced Research Projects Agency
DAS	Defense Acquisition System
DAVE	defense acquisition visibility environment
DCMA	Defense Contract Management Agency
DOD	Department of Defense
DPG	defense planning guidance
EFV	Expeditionary Fighting Vehicle
EMD	engineering and manufacturing development
FCS	Future Combat System
FFRDC	federally funded research and development center
FRP	full-rate production

FY	fiscal year
FYDP	future years defense plan
GAO	Government Accountability Office
ICD	initial capabilities document
IG	Inspector General
IOC	initial operational capability
IPT	integrated product team
JCIDS	Joint Capabilities Integration and Development System
JROC	Joint Requirements Oversight Council
KPP	key performance parameter
KSA	key system attribute
LRIP	low-rate initial production
MAIS	major automated information system
MDA	milestone decision authority
MDAP	major defense acquisition program
MDD	materiel development decision
MIT	Massachusetts Institute of Technology
NASA	National Aeronautics and Space Administration
NDAA	National Defense Authorization Act
NDS	National Defense Strategy
NMS	National Military Strategy
NPOESS	National Polar-Orbiting Operational Environment Satellite System
NSS	National Security Strategy
O&S	operations and support
OSD	Office of the Secretary of Defense
OT&E	operational test and evaluation
OTA	other transactions authority
PARCA	performance assessments and root cause analyses
PBD	program budget decisions
PDR	preliminary design review
POM	program objectives memorandum
PPBE	planning, programming, budgeting, and execution

PRR	production readiness review
RDT&E	research, development, test, and evaluation
RFP	request for proposal
SAR	Selected Acquisition Report
SATCOM	satellite communications
SECDEF	Secretary of Defense
TMRR	technology maturation and risk reduction
TRA	technology readiness assessment
TRL	technology readiness level
TSAT	Transformational SATCOM
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics

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—Anthony Percy

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—Tom Kellermann

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I. INTRODUCTION

A. OVERVIEW

The current budgetary climate in the federal government is one of increasing uncertainty, making the long-term acquisition of critical weapon systems within the Department of Defense (DOD) a challenging prospect. The approved DOD budget experienced a meteoric rise with a post–Cold War buildup beginning in 1998 and ending with the approval of the Budget Control Act (BCA) of 2011. In 1998, the budget was $255 billion, and by 2010, the year before the enactment of the BCA, had increased to an all-time high of $696 billion (Office of the President of the United States, 2017). As Figure 1 illustrates, a consumer price index (CPI) inflation adjustment reflects a budget figure of $361 billion for 2010 with the actual budget being $696 billion, a 93% increase over the inflation-only figure.

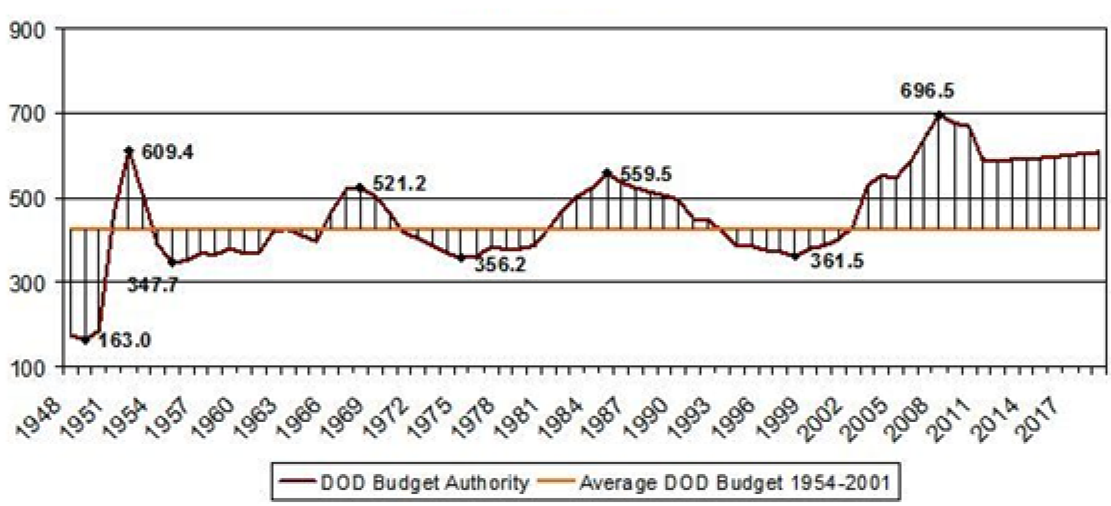

Figure 1. DOD Budget Authority (billions of 2010 US$). Source: Conetta (2010).

Rapid budget growth and a preoccupation with global military operations created a difficult environment to prioritize and track failed acquisition programs, resulting in a poor understanding of the actual root causes of program failures.

To counteract budget growth, Congress passed the Budget Control Act of 2011 to "reduce the budget deficit by $2.1 trillion over the period FY2012–FY2021" (Williams, 2017, Summary section, para. 1). According to Lynn Williams (2017) of the Congressional Research Service, "the BCA limits apply separately to defense and nondefense discretionary budget authority and are enforced by a mechanism called sequestration. Sequestration automatically cancels previously enacted spending to reduce discretionary spending to the limits specified in the BCA" (p. 2). Table 1 depicts the effects of the BCA and sequestration with the DOD budget authority for Fiscal Year (FY) 2010–FY2016.

Table 1. Department of Defense (051) Discretionary Budget Authority, in Billions of Then-Year Dollars. Source: Office of the President of the United States (2017).

Fiscal Year	2010	2011	2012	2013	2014	2015	2016
Department of Defense (051)	696	691	655	585	595	571	596

As Figure 1 and Table 1 illustrate, the DOD budget experienced a significant decrease from FY2010–FY2013, followed by budget stagnation from FY2014–FY2016, a stark contrast to the extreme budget growth of the 1990s and 2000s. Although the BCA of 2011 is not the first time Congress utilized budget enforcement mechanisms to obtain fiscal objectives, it did signify a fundamental change in the overall DOD budgeting process (Williams, 2017). Although it is always a possibility that Congress could repeal the BCA, the concept of enacting and executing sustainable budget practices is crucial to accomplishing programs that align with the National Security Strategy (NSS).

The implications of the BCA of 2011 are noteworthy. With fiscal constraint comes an emphasis on efficiency and eliminating wasteful practices. Front and center are failed acquisition programs that jeopardize the strategic direction of the United States military by not providing crucial capabilities to the warfighter, but also by creating unrecoverable sunk costs. The sequestration environment limits the available budget resources necessary to accomplish these programs, which in turn elevates the impact of program failures. Ultimately, the Government Accountability Office (GAO) lists DOD weapon systems acquisition as a high-risk area, underscoring the importance of executing programs in an effective and efficient manner. The GAO (2017) stated, "With the prospect of slowly-growing or flat defense budgets for years to come, DOD must get better returns on its weapon systems investments and find ways to deliver capability to the warfighter on time and within budget" (p. 269). By researching and determining the root causes of previous failed acquisition programs, the DOD can better plan and manage its acquisitions to meet both budget and warfighter demands.

B. AFFORDABILITY

DOD Directive 5000.01, E1.1.4. *Cost and Affordability*, states, "All participants in the acquisition system shall recognize the reality of fiscal constraints" (Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics [OUSD(AT&L)], 2007, p. 5). While this statement lacks specific details to apply the directive across the range of defense acquisition efforts, it does capture the spirit of the DOD viewpoint that executing programs within the current budget limitations is critical. Better Buying Power (BBP) 3.0, which encompasses a set of fundamental acquisition principles to achieve acquisition efficiency, lists achieving affordable programs as the top priority (DOD, n.d.). BBP states that achieving an affordable program means "conducting a program at a cost constrained by the maximum resources the department can allocate for a capability" (DOD, n.d., Achieve Affordable Programs section). Since the inception of the BCA, numerous DOD directives, including 5000.01 and BBP, reiterate the importance of efficiently utilizing the DOD budget. The common thread between all three variations of BBP is the top priority in each version, either targeting or achieving affordability. The strongest language comes from BBP 1.0, which mandates affordability as a requirement by setting an affordability objective and cap that acts as a key performance parameter (KPP) for the program (Carter, 2010). BBP 2.0 reinforces this initiative and focuses attention on enforcing affordability caps to halt programs not within the predetermined range unless the program implements tradeoffs to reduce costs (Kendall, 2012). Finally, BBP 3.0 supports the affordability requirements from BBP 1.0 and 2.0, while emphasizing the need for an affordability analysis, oversight of affordability caps, and assessment of program performance against the caps (Kendall, 2015). Table 2 summarizes the BBP initiatives for BBP 1.0 issued in 2010, BBP issued in 2012, and BBP 3.0 issued in 2015.

Table 2. Summary of BBP Initiatives. Adapted from Carter (2010) and Kendall (2012, 2015).

BBP 1.0	BBP 2.0	BBP 3.0
Target affordability and control cost growth	Achieve affordable programs	Achieve affordable programs
Incentivize productivity and innovation in industry	Control costs through the product life cycle	Achieve dominant capabilities while controlling life-cycle costs
Promote real competition	Incentivize productivity and innovation in industry and government	Incentivize productivity in industry and government
Improve tradecraft in services acquisition	Eliminate unproductive processes and bureaucracy	Incentivize innovation in industry and government
Reduce non-productive processes and bureaucracy	Promote effective competition	Eliminate unproductive processes and bureaucracy
	Improve tradecraft in acquisition of services	Promote effective competition
	Improve the professionalism of the total acquisition workforce	Improve the professionalism of the total acquisition workforce

In their article *Affordability of Defense Acquisition Programs*, Porter et al. (2015) concluded,

> Assuring the future affordability of acquisition programs in the Department of Defense (DOD) has been an enduring goal, which too frequently has not been achieved. The consequences are cancelling or curtailing programs that turn out to be unaffordable, with attendant waste. That has been true when total defense spending has been rising; it is a greater danger when total budgets are flat or declining. (p. iii)

Affordability is not a new initiative; however, it assumed a greater importance with declining and stagnant defense budgets. By understanding that affordability is actually a strategic objective and requirement for defense acquisitions, the importance of executing fiscally responsible programs is clear. As BBP stated, it is the DOD's mandate "to do more without more" (DOD, n.d., para. 1).

C. IMPACTS OF FAILURE

While the impacts of different program failures are never exactly alike, it is important to understand that the effects encompass a large scope of categories. Often the only impact considered is budgetary, and while the failure of a program often leads to the DOD losing billions of investment dollars, it can affect many areas of the acquisition enterprise (Clowney, Dever, & Stuban, 2016). In the wake of increasing budgetary pressures, it is imperative to manage acquisition programs more efficiently. A valuable portfolio management tool for running efficient programs is to understand the root causes and subsequent impacts of failed programs (GAO, 2014). At a minimum, the DOD must distribute the lessons learned from program failure to build and share knowledge to improve future program performance (GAO, 2014). Although it is important to note that cancellation is not synonymous with failure, Figure 2 illustrates the broad range of negative impacts from the cancellation of major defense acquisition programs (MDAPs).

Figure 2. Program Cancellation Effects. Source: GAO (2014).

The six program cancellation effects identify a range of potential impacts. A failing program may not experience all the typical cancellation impacts; however, the more critical and costly the program, the more likely it is to experience a broader set of cancellation effects. In the context of defense acquisition, MDAPs are often identified as both the most critical and costly programs; thus, they are the most susceptible to program cancellation effects.

Program costs refer to costs incurred after cancellation. Known as "shutdown activities," these costs include terminating or restructuring contracts and determining how to use program assets that offer value to the DOD (GAO, 2014). Agency budget impacts include all actions needed to reallocate funds from the canceled program to other projects or weapon programs. Capabilities delivery is the delay associated with providing requirements to satisfy NSS objectives and warfighter needs. During the delay, funds are often reallocated to legacy systems to provide warfighter support, but do not satisfy the long-term needs of the force. Industrial base effects refer to the diminished capacity of industrial sectors after program cancellation. In the long term, industry is less likely to provide key capabilities needed to sustain warfighter efforts. Staff and personnel impacts involve the loss of key acquisition personnel due to program cancellation and the logistics of reassigning the workforce to other programs (GAO, 2014). Lastly, additional program partner impacts refer to the stakeholders other than the program office and warfighter who experience a negative effect from the cancellation. Common stakeholders are other military services, other countries involved in the acquisition, and other federal agencies such as the Defense Contract Management Agency (DCMA) Termination Center who experience an increased workload with the cancellation. Ultimately, understanding the impacts of program failure drives the need to discover the root causes associated with the failure to better plan and mitigate the possibility of future negative impacts.

D. RESEARCH QUESTIONS

Development of the primary and secondary research questions relate to the restrictive budget environment and negative impacts of failure for critical acquisition programs. By studying these research questions, future programs may incorporate lessons learned and mitigate the potential for failure. This is critical in a fiscally constrained environment where the DOD needs to efficiently execute its budget and avoid the negative effects of program failure. The following are the primary and secondary questions addressed in this research.

Primary Questions

- What are the root causes of failure for a selected subset of MDAPs?
- Do the identified root causes fit into broad categories?

Secondary Questions

- Is it possible to normalize the root causes to apply more broadly to other MDAPs?
- After normalizing for variables, are there commonalities between the root causes of failure in MDAPs?

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II. LITERATURE REVIEW

To understand the context of root causes of failure in acquisition programs, it is important to review the different types of acquisition categories (ACATs), along with the DOD acquisition process, which is comprised of three main procurement processes. Furthermore, we discuss how Congress shapes many acquisition programs through budget enactment, legislation, and reporting requirements. Finally, we introduce a history of MDAP research studies to provide a foundation for the research methodology and analysis. Overall, this chapter establishes the framework necessary to understand the scope and analysis of the primary and secondary research questions.

A. DEFENSE ACQUISITION PROCESS

DOD Directive 5000.01 states, “The primary objective of Defense acquisition is to acquire quality products that satisfy user needs with measurable improvements to mission capability and operational support, in a timely manner, and at a fair and reasonable price” (OUSD[AT&L], 2007, p. 3). In this section, we provide a summary of the defense acquisition process by first providing an overview of acquisition categories, including ACAT I, ACAT II, and ACAT III. Next, we detail the DOD Decision Support Systems, commonly referred to as the “Big A” concept and map, which accomplishes the defense acquisition objective with the use of three main procurement processes. These processes comprise the Joint Capabilities Integration and Development System (JCIDS); Planning, Programming, Budget, and Execution (PPBE); and the Defense Acquisition System (DAS). The *Defense Acquisition Guidebook* describes the key differences between the three: “The requirements process is a capability gap process, the PPBE is a fiscal and time-based process, and the acquisition system is an event-based process” (DOD, 2017b). We detail each decision support system process to identify key characteristics, and the role of each in defense acquisition. Figure 3 shows the overlap for the three processes, each of which has a critical role in the acquisition process as an independent process and interdependent system.

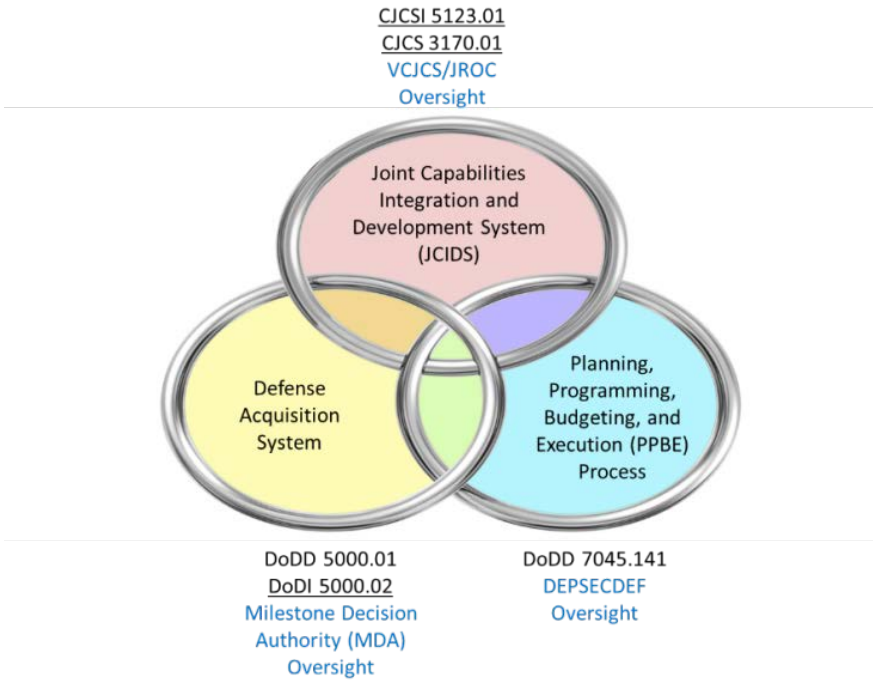

Figure 3. The DOD Decision Support Systems. Source: DOD (2017b).

1. Acquisition Categories and Roles

Defense acquisition programs receive an ACAT number designation (ACAT I through ACAT III) and type designation (MDAP, major automated information system [MAIS], or major system) based on cost thresholds or if the milestone decision authority (MDA) designates a program as special interest (DOD, 2017a). According to DOD Instruction 5000.01,

> The MDA is the designated individual with overall responsibility for a program. The MDA shall have the authority to approve entry of an acquisition program into the next phase of the acquisition process and shall be accountable for cost, schedule, and performance reporting to higher authority, including Congressional reporting. (OUSD[AT&L], 2003, p. 2)

Assigning a program to a particular category substantially affects program procedures and policies, which impact team composition and projected timelines for the program (DOD, 2017b). Table 3 depicts the different ACAT designations and decision authorities.

Table 3. Description and Decision Authority for ACAT I-III Programs. Source: OUSD[AT&L] (2017).

ACAT	Reason for ACAT Designation	Decision Authority
ACAT I	• MDAP (10 U.S.C. 2430 (Reference (h))) ○ Dollar value for all increments of the program: estimated by the DAE to require an eventual total expenditure for research, development, and test and evaluation (RDT&E) of more than $480 million in Fiscal Year (FY) 2014 constant dollars or, for procurement, of more than $2.79 billion in FY 2014 constant dollars ○ MDA designation • MDA designation as special interest[1]	ACAT ID: DAE or as delegated ACAT IC: Head of the DoD Component or, if delegated, the CAE ~~(not further delegable)~~
ACAT IA[2,3]	• MAIS (10 U.S.C. 2445a (Reference (h))): A DoD acquisition program for an Automated Information System[4] (AIS) (either as a product or a service[5]) that is either: ○ Designated by the MDA as a MAIS program; or ○ Estimated to exceed: ▪ $40 million in FY 2014 constant dollars for all expenditures, for all increments, regardless of the appropriation or fund source, directly related to the AIS definition, design, development, deployment, and sustainment, and incurred in any single fiscal year; or ▪ $165 million in FY 2014 constant dollars for all expenditures, for all increments, regardless of the appropriation or fund source, directly related to the AIS definition, design, development, and deployment, and incurred from the beginning of the Materiel Solution Analysis Phase through deployment at all sites; or ▪ $520 million in FY 2014 constant dollars for all expenditures, for all increments, regardless of the appropriation or fund source, directly related to the AIS definition, design, development, deployment, operations and maintenance, and incurred from the beginning of the Materiel Solution Analysis Phase through sustainment for the estimated useful life of the system. • MDA designation as special interest[1]	ACAT IAM: DAE or as delegated ACAT IAC: Head of the DoD Component or, if delegated, the CAE (not further delegable)
ACAT II	• Does not meet criteria for ACAT I or IA • Major system (10 U.S.C. 2302d (Reference (h))) ○ Dollar value: estimated by the DoD Component head to require an eventual total expenditure for RDT&E of more than $185 million in FY 2014 constant dollars, or for procurement of more than $835 million in FY 2014 constant dollars ○ MDA designation5 (10 U.S.C. 2302 (Reference (h)))	CAE or the individual designated by the CAE[6]
ACAT III	• Does not meet criteria for ACAT II or above • An AIS program that is not a MAIS program	Designated by the CAE[6]

a. ACAT I

ACAT I programs are synonymous with MDAPs and include programs designated by the MDA as special interest (OUSD[AT&L], 2017). To designate a program as ACAT I, either the total expenditure estimates for research, development, test, and evaluation (RDT&E) must exceed $300 million (based on FY1990 constant dollars), or an eventual total expenditure for procurement, including all planned increments or spirals must exceed $1.8 billion (based on FY1990 constant dollars; Major Defense Acquisition Program Defined, 2016). The adjusted dollar amounts for FY2014 are $480 million for RDT&E and $2.79 billion for procurement (OUSD[AT&L], 2017). The decision authority for ACAT I programs depends on a further ACAT ID or ACAT IC designation. ACAT ID programs are the most critical and of the highest interest. As such, the MDA is the defense acquisition executive (DAE) who is the under secretary of defense for acquisition, technology, and logistics (USD[AT&L]). The MDA for ACAT IC programs is the head of the DOD component, or if delegated, the component acquisition executive (CAE; OUSD[AT&L], 2017).

b. ACAT IA

ACAT IA is synonymous with MAIS programs and also includes programs designated by the MDA as special interest (OUSD[AT&L], 2017). To designate a program as ACAT IA, the total expenditure estimates must meet at least one of the following criteria: if any single fiscal year costs exceed $32 million, if total expenditure estimates through deployment exceed $126 million, or if the total life-cycle costs exceed $378 million (all estimates are in FY2000 constant dollars; Definitions, 2013). The adjusted dollar amounts for FY2014 are $40 million for a single fiscal year, $165 million for costs through deployment, and $520 million for total life-cycle costs (OUSD[AT&L], 2017). The decision authority for ACAT IA programs depends on a further ACAT IAM or ACAT IAC designation. The MDA for ACAT IAM programs is the DAE, and the MDA for ACAT IAC programs is the head of the DOD component, or if delegated, the CAE (OUSD[AT&L], 2017).

c. ACAT II

ACAT II programs do not meet the criteria for ACAT I or ACAT IA programs but are a major system. A major system is a system for which the DOD is responsible and for which the total expenditure estimates for RDT&E must exceed $115 million (based on FY1990 constant dollars), or an eventual total expenditure for procurement must exceed $540 million (based on FY1990 constant dollars; Major Systems: Definitional Threshold Amounts, 1999). The adjusted dollar amounts for FY2014 are $185 million for RDT&E and $835 million for procurement (DOD, 2017b). The MDA for ACAT II programs is the CAE (OUSD[AT&L], 2017).

d. ACAT III

ACAT III programs do not meet the criteria for ACAT II programs. ACAT III programs are any automated information system (AIS) programs that are not MAIS programs. The MDA for ACAT III programs is the CAE (OUSD[AT&L], 2017).

2. Joint Capabilities Integration and Development System

The JCIDS Manual, which implements the Chairman of the Joint Chiefs of Staff (CJCS) Instruction 3170.01, governs the JCIDS process. The purpose of JCIDS is to identify and fill warfighter capabilities not met in the National Security Strategy (NSS), the National Defense Strategy (NDS), and the National Military Strategy (NMS; DOD, 2017b). According to the CJCSI 3170.01,

> The most critical aspect of the JCIDS process is to allow the JROC [Joint Requirements Oversight Council] and its subordinate boards, as informed by other stakeholders in the requirements process, to manage and prioritize capability requirements within and across capability requirement portfolios of the Joint Force, to inform other assessments within the Joint Staff, and to allow the JROC and CJCS to meet statutory responsibilities. (DOD, 2015, p. A-1)

The JROC uses a capability-based assessment (CBA) to identify needed capabilities, capability gaps, and potential non-materiel and materiel solution options (DOD, 2017b). Significant gaps documented in the CBA eventually lead to the creation of an Initial Capabilities Document (ICD). The ICD is "a critical entry criterion for the Materiel Development Decision (MDD), and guides the Materiel Solution Analysis (MSA) phase activities and assessment of potential materiel solutions through an AoA or other studies" (DOD, 2015, p. A-15). In addition, it also documents potential non-materiel solution changes to fill capability gaps (DOD, 2015). The formal acquisition process begins when a MDA "considers, along with other pertinent information, a validated ICD identifying one or more capability requirements that may be best addressed with a new materiel capability solution, and documents a positive MDD in an Acquisition Decision Memorandum (ADM)" (OUSD[AT&L], 2015, p. B-20).

3. Planning, Programming, Budget, and Execution

The PPBE process provides funding appropriations for DOD acquisition programs generated by the JCIDS process. The PPBE process consists of four phases: planning, programming, budgeting, and execution.

a. Planning

The planning phase coordinates development of the Defense Planning Guidance (DPG) between the Office of the Secretary of Defense (OSD), joint staff, and services and combatant commanders. The DPG sets the framework for the Future Years Defense Plan (FYDP) and informs the services on what to include in Program Objectives Memorandums (POM) and Budget Estimate Submissions (BES; DOD, 2017b). Ultimately, the planning phase evaluates alternative strategies and develops guidance for programs initiated by the JCIDS process.

b. Programming

The programming phase requires that the services develop a POM that specifies proposed programs and details the required forces, manpower, and funding for the next five years. Proposed programs must be consistent with the DPG and other planning, programming, and fiscal guidance. The OSD director, Cost Assessment and Program Evaluation (D/CAPE), is responsible for the overall coordination of the programming phase (DOD, 2017b). Ultimately, the programming phase turns the DPG into detailed program submissions for JCIDS capability gaps.

c. Budgeting

The budgeting and programming phases occur simultaneously. During the budgeting phase, the services provide a detailed budget estimate in a budget estimate submission (BES) for the first two years of a program. After review, the program budget decisions (PBD) incorporate the final budget estimates, which, once signed by the secretary of defense (SECDEF), become part of the president’s budget request to Congress (OUSD[C], 2008). Ultimately, the budgeting phase ensures the efficient use of budgetary resources for programs initiated by the JCIDS process.

d. Execution

The execution phase occurs simultaneously with both the budgeting, and programming phases. The execution phase assesses how current programs support the warfighter needs. Each service conducts annual execution reviews that assess compliance with SECDEF guidance, planning and programming guidance, and other metrics critical to program execution (DOD, 2013). The OSD reviews the services' findings and recommends adjustments to the program or budget. Ultimately, the execution phase measures performance and adjusts resources to achieve goals for programs initiated during the JCIDS process.

4. Defense Acquisition System

The Defense Acquisition System relies on events such as milestones, phases, and decision points to guide the life cycle of acquisition programs. The purpose of the DAS is to

> Manage the nation's investments in technologies, programs, and product support necessary to achieve the National Security Strategy and support the United States Armed Forces. The investment strategy of the Department of Defense shall be postured to support not only today's force, but also the next force, and future forces beyond that. (OUSD[AT&L], 2007, p. 3)

Overall, the DAS consists of five phases: materiel solution analysis (MSA), technology maturation and risk reduction (TMRR), engineering and manufacturing development (EMD), production and deployment, and operations and support (DOD, 2017b). Figure 4 depicts the Defense Acquisition System and the relationship between different milestones, phases, and decision points.

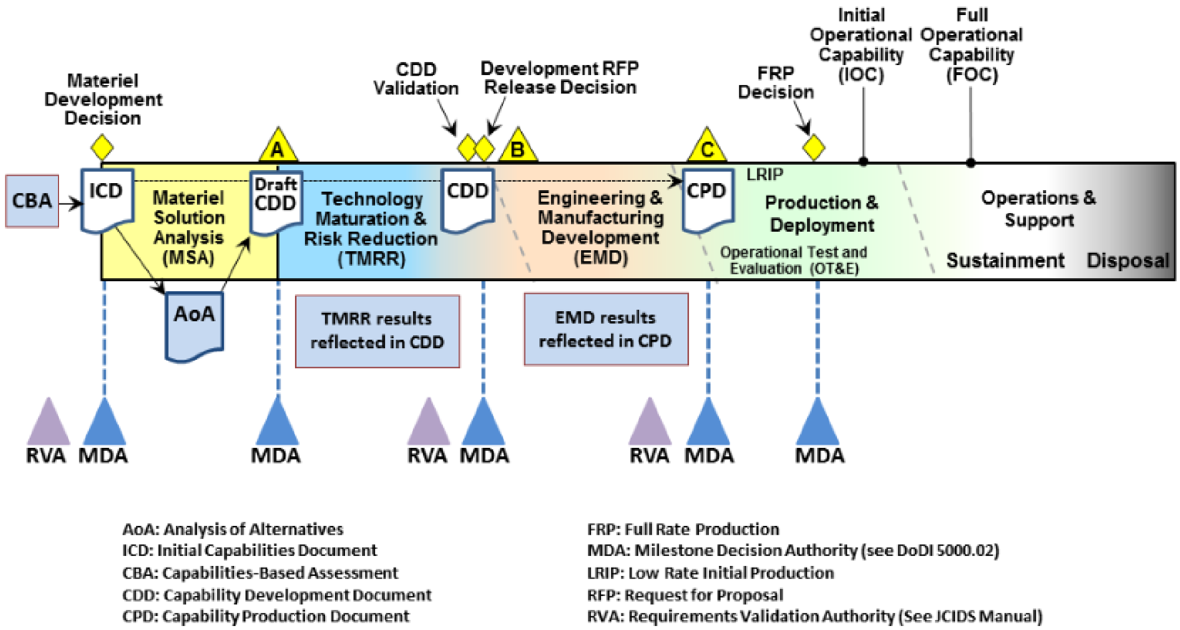

Figure 4. The Defense Acquisition System. Source: DOD (2017b).

a Materiel Solution Analysis and Milestone A

The formal acquisition process begins with the MSA phase when the MDA validates the initial capabilities document and records a positive milestone development decision. Overall, the purpose of the MSA phase is to

> Conduct the analysis and other activities needed to choose the concept for the product that will be acquired, to begin translating validated capability gaps into system-specific requirements including the Key Performance Parameters (KPPs) and Key System Attributes (KSAs), and to conduct planning to support a decision on the acquisition strategy for the product. (DOD, 2017b, Chapter 1)

An Analysis of Alternatives (AoA) assesses the trade space between all potential materiel solutions in terms of cost, schedule, risk, and performance. The findings of an AoA allow the "DAE and Service Sponsor to select a preferred materiel solution that addresses the capability gaps documented in the approved ICD" (DOD, 2017b, Chapter 2), as well as guide the MSA phase.

In addition, the MSA phase includes initial planning for the acquisition strategy by assigning a program office and program manager, and drafting a capability development document (CDD) that includes key performance parameters (KPPs) and key systems attributes (KSAs) from validated capability gaps.

The acquisition strategy also includes a decision to pursue an evolutionary or single step acquisition. An evolutionary approach delivers capability in increments to supply an initial product to the warfighter more quickly and with improvements in future version releases ("Evolutionary Acquisition," 2015). Programs that field separate, "incremental" capabilities with different milestones for each version release meet the criteria for an evolutionary acquisition approach. Starting in 2000, the DOD specified "evolutionary acquisition strategies as the preferred approach to satisfy operational needs" (OUSD[AT&L], 2007, p. 3). As a preferred and not mandatory approach, the programs best suited to use an evolutionary strategy include attributes such as products that are liable to change, continuous requirements, low maintenance items, or projects with condensed schedules (Dillard & Ford, 2009). Single step acquisitions, which produce a total system capability instead of increments, are appropriate if supported by precedent, or if funding, schedule, or size considerations dictate its use (OUSD[AT&L], 2007). Furthermore, programs best suited to use a single step strategy include attributes such as, products that are unlikely to change, binary requirements for key capabilities, or maintenance intensive products (Dillard & Ford, 2009).

The phase ends when the MDA certifies the results of the AoA along with other performance criteria to Congress, signifying the completion of Milestone A (DOD, 2017b).

b. Technology Maturation and Risk Reduction, and Milestone B

The acquisition process continues into the TMRR phase with a review of the draft CDD to create a strategy to ensure the requirements are affordable and technically achievable. Overall, the purpose of the TMRR phase is to "reduce technology, engineering, integration, and life-cycle cost risk to the point that a decision to contract for Engineering & Manufacturing Development (EMD) can be made with confidence in successful program execution for development, production, and sustainment" (DOD, 2017b, Chapter 1). To accomplish TMRR, the program office utilizes methods such as active research and competitive prototyping in conjunction with technology readiness levels (TRL) to assess the maturity of the technology. The *Technology Readiness Assessment (TRA) Deskbook* defines TRLs 1–9, with a 1 indicating the lowest level of technology maturity and a 9 indicating an operational system. Before Milestone B approval, the MDA must indicate the achievement of TRL 6, which is the demonstration of a prototype in a relevant environment (Office of the Director, Defense Research and Engineering [DDR&E], 2009).

In addition, the TMRR phase includes developing a draft request for proposal (RFP) for development and a preliminary design review (PDR). The development RFP and subsequent RFP release decision ensure that the program office has solid capability requirements, an executable acquisition strategy, and an affordable program prior to releasing the solicitation. The development RFP release decision is critical to the success or failure of fielding the proposed system (OUSD[AT&L], 2017). The PDR establishes the allocated baseline and ensures that the proposed design has a reasonable expectation of meeting the system requirements within budget and schedule. The PDR ultimately allows the system to proceed to the critical design review (CDR) with an acceptable risk, and in accordance with 10 U.S.C. § 2366, which requires approval before the completion of the TMRR phase (Major Systems and Munitions Programs: Survivability Testing and Lethality Testing Required Before Full-Scale Production, 2008). The phase ends when the MDA certifies the approval of the PDR, a positive RFP release decision, and a validated CDD, signifying the completion of Milestone B (OUSD[AT&L], 2017).

c. Engineering and Manufacturing Development, and Milestone C

The acquisition process continues into the EMD phase, which typically indicates the initiation of an actual acquisition program. The purpose of the EMD phase is to "develop, build, and test a product to verify that all operational and derived requirements have been met and to support production or deployment decisions" (DOD, 2017b, Chapter 1). Overall, the EMD phase results in the development of a proven systems capability and verification of an achievable and affordable manufacturing process.

The two major reviews during the EMD phase are the CDR and the production readiness review (PRR). First, the CDR assesses the maturity of the design by demonstrating that the design satisfies the components of the CDD, such as the KPPs and KSAs. Developmental prototyping for the system begins upon the approval of the CDR by the MDA. The second review for production readiness determines whether the system design and the manufacturer are ready to enter the production phase within an acceptable risk threshold (DOD, 2017b). The program team often uses an incremental strategy for the PRR to reduce the risk associated with a particular technology. The phase ends when the MDA validates the capability production document (CPD), which reflects all of the results gathered during EMD (OUSD[AT&L], 2017).

d. Production and Deployment

The production and deployment phase manufactures and fields the proposed system. This phase involves the following activities: Low-Rate Initial Production (LRIP), Limited Deployment, Initial Operational Test and Evaluation (OT&E), Full-Rate Production (FRP), and full deployment (OUSD[AT&L], 2017). The key aspect of this phase is the initial operational capability (IOC), which indicates when a system can meet minimal operational capabilities outlined in the CPD ("Initial Operational Capability," 2015).

e. Operations and Support

The operation and support (O&S) phase maintains the system during the life cycle. The O&S phase consists of two major efforts, sustainment and disposal. During sustainment, the system receives maintenance in the most cost-effective manner stipulated in the life-cycle sustainment plan. Disposition and demilitarization of the system, which minimize environmental and personnel impacts, occurs at the end of the life cycle (OUSD[AT&L], 2017).

5. Decision Support System Summary

The DOD Decision Support System consists of the JCIDS, PPBE, and DAS (DOD, 2017b). The three interconnected and dependent systems consist of five dimensions: rules, players, reviews, decisions, and focus (DOD, 2017b). Figure 5 illustrates the key components of each support system.

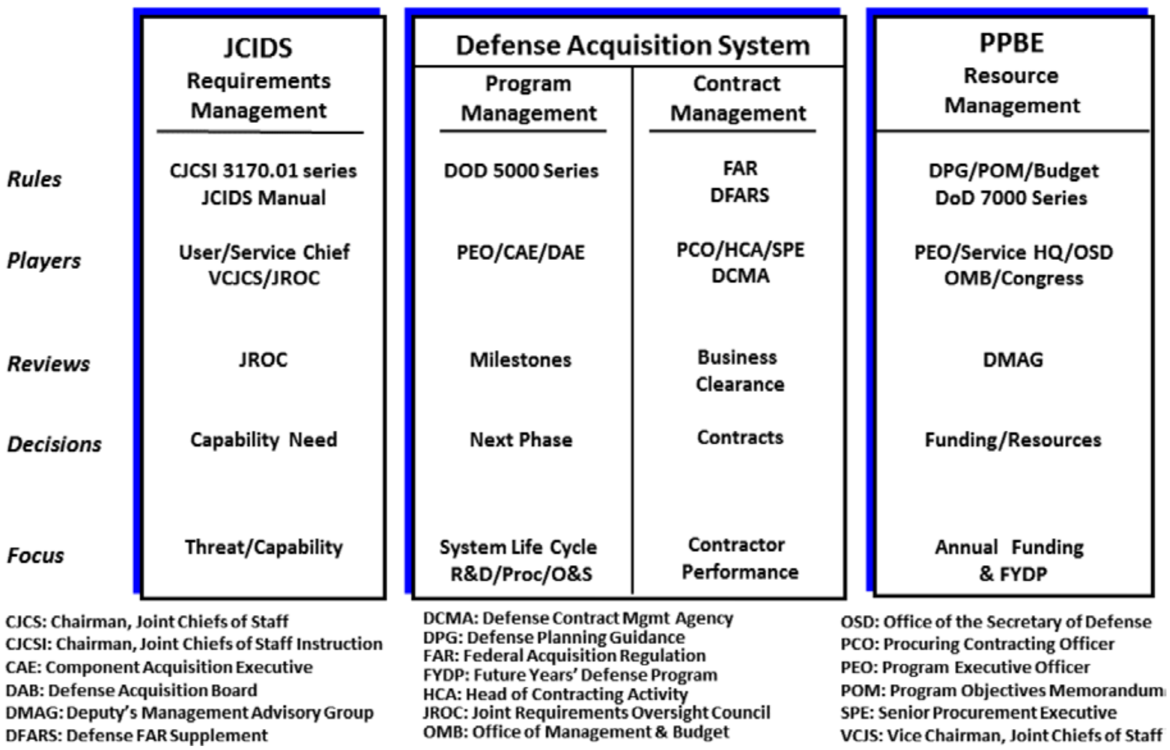

Figure 5. Five Dimensions of DOD Decision Support Systems. Source: DOD (2017b).

B. CONGRESSIONAL OVERSIGHT

1. Budget Control

The U.S. Constitution gives Congress explicit "power of the purse" to collect taxes and spend federal money on various programs or to pay debt obligations. To exercise this power, Congress passes authorization and appropriation bills to spend the money under its control. This process begins with the president submitting a budget request to Congress during the first week of February (Stanton & Yourish, 2010). Using the president's budget as a baseline, the House and Senate propose budget resolutions and then vote on those resolutions to provide a framework to make actual budget decisions (Stanton & Yourish, 2010). Once passed, the House and Senate subcommittees determine the funding levels for discretionary programs. One of the subcommittees deals exclusively with defense to create an authorization bill, known as the National Defense Authorization Act (NDAA), followed by an appropriation bill known as the Department of Defense Appropriations Act. Figure 6 illustrates how the president's budget becomes an appropriations act.

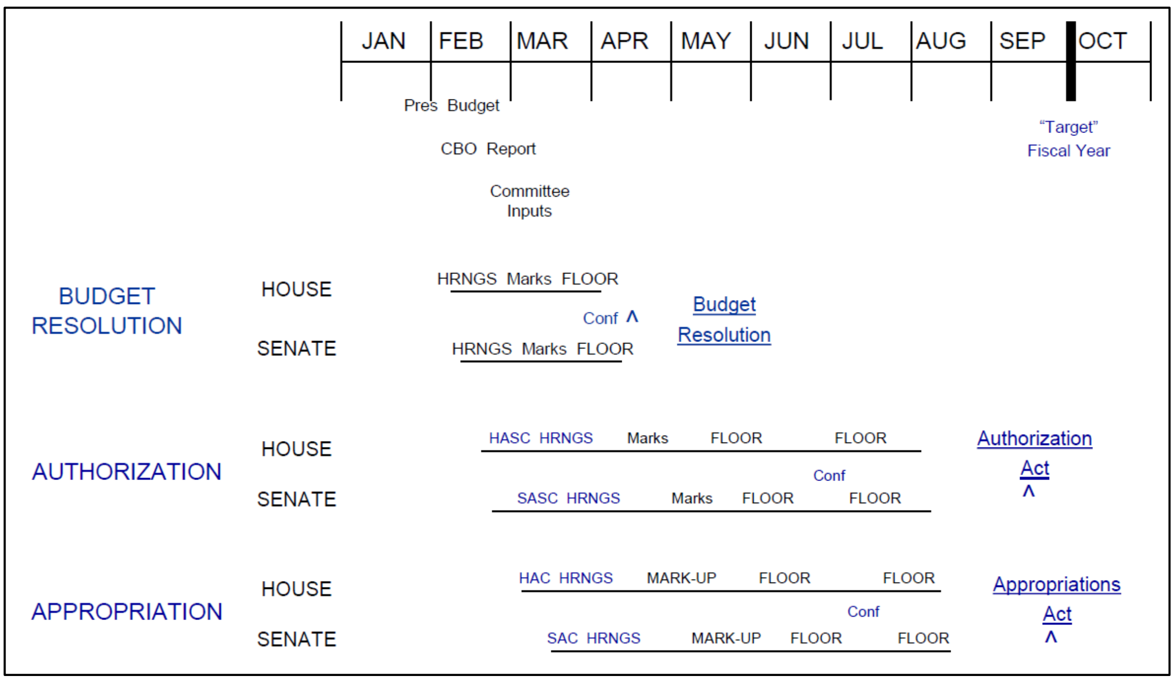

Figure 6. Congressional Enactment Timetable. Source: DOD (2017c).

Since the defense budget is discretionary, Congress retains funding control over all defense spending, including acquisition programs. Although the PPBE process plans for future defense expenditures, in any given year, Congress retains the authority to add, subtract, or completely abolish the funding planned for specific programs.

2. Mandatory Reporting Requirements

To assist Congress in making decisions related to the annual NDAA and to monitor performance of MDAPs, acquisition programs must submit Selected Acquisition Reports (SARs) to Congress by December of each year. The SARs include updated estimates of cost, schedule, and performance status, which includes a comparison to the original program baseline (DOD, 2017a). 10 U.S.C. § 2432(b)(2) requires quarterly submissions to Congress if there is greater than a 15% increase in program unit acquisition cost or a six-month delay in any program schedule milestone since the last SAR submission (Selected Acquisition Reports, 2016). In addition, the Nunn-McCurdy Act, originally introduced in the 1982 NDAA, requires that MDAPs report to Congress when cost overruns exceed a certain threshold, known as cost breaches. The two types of cost breaches are significant and critical. In *The Nunn-McCurdy Act: Background, Analysis, and Issues for Congress*, Moshe Schwartz (2015) stated,

> A "significant" breach is when the Program Acquisition Unit Cost (the total cost of development, procurement, and construction divided by the number of units procured) or the Procurement Unit Cost (the total procurement cost divided by the number of units to be procured) increases 15% or more over the current baseline estimate or 30% or more over the original baseline estimate. A "critical" breach occurs when the program acquisition or the procurement unit cost increases 25% or more over the current baseline estimate or 50% or more over the original baseline estimate. ("Summary section, para. 2)

In the event of a critical cost breach, program termination is necessary unless the SECDEF certifies to Congress that the program is essential to national security and there are no acceptable substitutes to the program (Critical Cost Growth in Major Defense Acquisition Programs, 2016). Lastly, in 2009, Congress enacted the Weapon System Acquisition Reform Act (WSARA), which requires programs to focus on managing technology risk, employing realistic program cost estimates, and competitive prototyping, before program initiation (Weapon Systems Acquisition Reform Act, 2015). The purpose is ultimately to create more stable programs that allow Congress to understand the framework for how the MDA approves program activities and milestones. Overall, Selected Acquisition Reports, the Nunn-McCurdy Act, and WSARA are all tools Congress utilizes to monitor MDAP performance and make future budget decisions.

C. GENERAL CAUSES FOR PROGRAM FAILURE

A failed program, explained further in Chapter III, involves a significant financial impact and presents a critical problem in securing warfighter capabilities. The common perception in regards to the causation of program failures is that the presence of at least one key root cause leads to failure. The key causes collectively thought to contribute to program failure in today's acquisition environment are immature technology, changing requirements, poor cost estimation, unstable budgets, schedule-driven programs, and underestimating risk. These are extremely general causes, and in fact are difficult to classify as root causes since there are underlying actions (i.e., root causes) that lead to these scenarios. Our research indicates that each general cause for failure is widely known and is an important foundation for exploring deeper root causes of failure in MDAPs.

Immature technology often refers to not meeting the appropriate TRL at a given milestone (Clowney et al., 2016). The GAO (2009) further expounded on the issue of immature technology with the following statement:

> The chief reason for these problems is the encouragement within the acquisition environment of overly ambitious and lengthy product developments that embody too many technical unknowns and not enough knowledge about the performance and production risks they entail. The knowledge gaps are largely the result of a lack of early and disciplined systems engineering analysis of a weapon system's requirements prior to beginning system development. (p. 8)

This often leads to acquisition programs with significant technology risk because of the inability to mature technology prior to systems development (GAO, 2016).

Changing requirements refers to not properly controlling client-initiated requirements changes or curtailing scope creep due to either vagueness or a poor understanding of scope and an inadequate requirements management plan (Clowney et al., 2016). The GAO (2009) explained,

> Because the government often does not perform proper up front requirements analysis to determine whether the program will meet its needs, significant contract cost increases can and do occur as the scope of requirements changes or becomes better understood by the government and contractor. (p. 8)

The significant cost increases driven by changing requirements links to other general causes for failure such as poor cost estimation and unstable budgets. This often generates multiple causes for failure in a program, as changing requirements will lead to issues with cost estimation and potentially unstable budgets because of the associated cost growth. Lastly, the GAO also identified unstable requirements as a negative influence that can cause a program to fail (Arena et al., 2015).

Budget-related activities, which include cost management plans, budget and cost estimation, and budget determination, are ranked as the number one reason why programs fail by DOD industry programs managers, and the number two reason by DOD program managers (Clowney et al., 2016). The GAO identified poor cost estimation, especially optimistic cost estimates, as a negative influence that cause programs to fail (Arena et al., 2015). This is often due to assigning cost-estimating personnel without the requisite knowledge to execute appropriate cost estimates, and proceeding with a program while there is substantial requirements uncertainty (GAO, 2009). This also links to the previous general cause for failure of changing requirements, which creates problems with the initial cost estimation process. Ultimately, poor cost estimation leads to budget variances in the billions, which affects future funding commitments, long-term planning, and the ability to accurately estimate program risk (GAO, 2009).

Unstable budgets also correlate with budget-related activities such as poor cost management plans, lack of cost control, and mismanagement of cash flow (Clowney et al., 2016). Unstable budgets are often the result of the DOD obligating to more programs than budget resources dictate, which makes execution of different investments difficult to achieve (GAO, 2009). Therefore, programs face the challenge of receiving insufficient funding to attain successful program outcomes, which creates instability in the entire DOD acquisition portfolio. Lastly, the GAO also identified unstable funding as a negative influence that can cause a program to fail (Arena et al., 2015).

Schedule-driven programs face issues such as consistent schedule pressure, unrealistic duration of milestones, and low-speed decision-making. Overall, schedule-related attributes were ranked as the number one reason why programs fail by DOD program managers (Clowney et al., 2016). In addition, the GAO also identified optimistic schedule estimates as a negative influence that can cause a program to fail (Arena et al., 2015). Schedule driven programs connect to other general causes of failure such as immature technology, which cause program managers to conduct developmental testing and production simultaneously (GAO, 2016). This schedule driven pressure often results in multiple general causes for failure present in defense acquisition programs.

Underestimating risk refers to the inability of programs personnel to anticipate problems and perform appropriate risk assessments (Clowney et al., 2016). Many programs receive approval to proceed, but do not consider the resources or technology levels needed to successfully execute the program (GAO, 2009). Both insufficient resources and technology are risks to the program and must receive appropriate consideration. Therefore, underestimating risk links to all of the previous general causes for failure as risk is inherent with technology, requirements, cost/budgets, and schedule. The GAO ultimately indicated that programs that underestimate risk often approve inadequate business cases with poor knowledge of both requirements and resources required for execution (GAO, 2009).

The six general causes commonly believed to result in program failure are immature technology, changing requirements, poor cost estimation, unstable budgets, schedule-driven programs, and underestimating risk. The GAO identified all general causes except for underestimating risk as a negative influence that can cause a program to fail. In addition, Clowney et al. (2016) identified all general causes for failure as six of the top seven leading factors that influence project failure.

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III. METHODOLOGY

A. SCOPE

To identify the root causes of failure for acquisition programs, it is paramount to develop an appropriate research scope. The initial scope objective consisted of two parameters. The failed programs must include a significant financial impact and present a critical problem in securing future warfighter capabilities. For this reason, the first decision in regards to scope consisted of selecting only ACAT programs for study. Furthermore, we narrowed the scope to only MDAPs (ACAT I), which have the highest dollar value thresholds of any ACAT designation and are the most significant programs in terms of capability. In FY2016, the DOD was expected to invest $1.4 trillion for the current 79 MDAP programs, each of which provides substantial upgrades to military capabilities (GAO, 2017). To ensure the relevance of the root causes, we further narrowed the scope to include only programs canceled between FY2001–FY2016. This helps to reduce variability caused by different statutory requirements, acquisition process changes, and learning curve improvements over time. Next, we selected only programs unable to field complete operational systems. Programs canceled during production generally provide some capability to the warfighter, just with a smaller production quantity than originally planned. Programs with no fielding provide marginal, if any, benefits to the warfighter. Marginal benefits include economic value, knowledge, skills, lessons learned, spin-off capabilities and insights but do not include any operational systems for use (Clowney et al., 2016). Lastly, we selected only programs with greater than $2 billion in sunk costs. This threshold is arbitrary, but the uncertainty involved with RDT&E activities for cutting-edge technology indicates that programs canceled while minimizing sunk costs are not necessarily failures. Overall, the scope of research consists of eight canceled programs. The selection criteria to meet the scope objectives consisted of MDAP programs canceled between FY2001–FY2016, no fielded products, and greater than $2 billion in sunk costs. Table 4 indicates the programs selected for study, the designated service, and the affiliated sunk costs.

Table 4. MDAPs Canceled before Fielding, in Billions of Then-Year Dollars. Source: Harrison (2016).

Program	Service	Sunk Costs
Future Combat Systems (FCS)	Army	18.1
Comanche Helicopter	Army	7.9
National Polar-Orbiting Operational Environment Satellite System (NPOESS)	Air Force	5.8
Airborne Laser	Air Force	5.2
VH-71 Presidential Helicopter	Navy	3.7
Expeditionary Fighting Vehicle (EFV)	Navy	3.3
Transformational SATCOM (TSAT)	Air Force	3.2
Crusader	Army	2.2

B. RESEARCH METHODS

Data for all eight programs were collected from both government and non-government sources. We accessed the online government system Defense Acquisition Management Information Retrieval (DAMIR) to collect the Selected Acquisition Reports (SARs) and Acquisition Program Baselines (APBs) for each program. To complement these government documents, we also consulted the Defense Acquisition Visibility Environment (DAVE) for any AMDs or other decision documents pertinent to program cancellation, if available. Additional government sources included GAO, Congressional Research Service (CRS), Office of Performance Assessment and Root Cause Analyses (PARCA) and Inspector General (IG) reports. However, the PARCA office only conducts studies related to critical cost growth in MDAPs, and not necessarily all terminated or "failed" programs. 10 U.S.C. § 2433a stipulates that the PARCA conduct an analysis on programs that exceed critical cost growth thresholds or when requested by the secretary of defense; the under secretary of defense for acquisition, technology, and logistics; the secretary of a military department; or the head of a DOD agency (Critical Cost Growth in Major Defense Acquisition Programs, 2016). Therefore, the PARCA research assisted in understanding cost growth issues, but did not provide an encompassing perspective on root causes for failure. Non-government sources included a full open-source search using LexisNexis and Google Scholar to filter reputable academic articles, journals, and other published works. In addition, the RAND Corporation provided reports and analysis on select programs.

Data compilation for all eight programs involved the creation of a data matrix. Due to the copious amounts of source data, we developed a data matrix to track pertinent information from each source. The rows are the eight programs selected for study, and the columns are the different data sources such as SARs, APBs, and so on. To capture the "root causes" of failure during research is not a clear process, as even the PARCA office whose mission is to conduct root cause research focuses only on cost growth. Therefore, we incorporated any information pertaining to program entry points, re-baselines, breaches, cancellations, and any miscellaneous program problems into the data matrix. By collecting and consolidating data from a consistent group of sources, coupled with the development of an appropriate scope, we normalized as many variables as possible before the data analysis.

C. FAILURE CONSIDERATIONS

Program cancellation or contract termination is not synonymous with program failure. In fact, programs that experience a termination or cancellation are often successful, especially early in RDT&E activities. In an environment dealing with the development of state-of-the-art technology and military-specific equipment, it is unreasonable to expect every program to result in a fielded system. Although not a DOD entity, the Defense Advanced Research Projects Agency (DARPA) understands that to create breakthroughs in science and technology, many projects will not produce a tangible product. Private research laboratories such as X, a department of the company Google, understand this dilemma as well. The X (n.d.) website states,

> We’re a moonshot factory. Our mission is to invent and launch “moonshot” technologies that we hope could someday make the world a radically better place. … One of our most important principles is to run as fast as we can at all the hardest parts of a problem, and try to prove that something can’t be done. We want to force ourselves to learn. We actively embrace failure: by making mistakes, we make progress. In this way, our ideas get stronger faster, or we discard them and move on to new ones.

The key component for determining a successful cancellation or termination for defense acquisition programs is controlling the resource inputs. Not every MDAP program results in a fielded system. However, if program teams control resources such as fiscal expenditures, human assets, and government equipment, a cancellation is not necessarily a failure, because the government gains knowledge and lessons learned at a reasonable cost. A program with high sunk costs and no complete fielded products is the worst-case scenario for failure. The warfighter does not receive any tangible product, and the government unnecessarily expends resources to conclude that a program is not viable for future development and production. In a letter to now-former Secretary of Defense Chuck Hagel, five former deputy secretaries of defense highlighted the issue:

> The hard choices should be made early. The federal budget outlook is not projected to improve for several years. So if a program or capability is not affordable now it is unlikely to be affordable going forward. Delaying hard choices means that resources will be spent on systems that will never be built and not be available at the right levels for the highest priority programs and capabilities. (Porter et al., 2015, p. iii)

Although the letter primarily addressed affordability, the concept of making a difficult choice and canceling unfeasible programs as early as possible is clear. Therefore, we concluded that only MDAP programs with greater than $2 billion in sunk costs and no complete fielded systems were truly failures appropriate for study.

IV. DATA ANALYSIS AND FINDINGS

A. PROGRAM SUMMARIES

1. Future Combat Systems

To initiate the Future Combat System (FCS) program, the Army utilized DARPA to perform the initial design and development work by employing an Other Transactions Authority (OTA) arrangement to award and administer the program from 2000–2005 (Feickert, 2006). With that, the program execution included an evolutionary strategy to produce increments with increasing capability (Pernin et al., 2012). Since the products and requirements were likely to change and time was a critical factor to meet warfighter needs, the program manager supported the selection of an evolutionary approach (Pernin et al., 2012). However, the FCS acquisition program did not conduct an MSA or Milestone A decision (DOD, 2005a). The MSA translates validated capability gaps into system-specific requirements, and the analysis of alternatives conducted during this period assesses the trade space between all potential materiel solutions in terms of cost, schedule, risk, and performance. According to the GAO, the FCS program commenced without a sound acquisition strategy or business approach, which led to a failure to execute a knowledge-based acquisition. Furthermore, the failure to achieve consistent technical progress during development led to affordability issues due to continued spending during development and then subsequent congressional budget reductions (GAO, 2010b). In fact, the technical issues eventually resulted in a Milestone B approval without meeting the minimum TRL requirements or completing a preliminary design review (Pernin et al., 2012). Lastly, changes in the national security strategy and operational warfare environment, due in large part to the September 11 terrorist attacks, created a large discrepancy between the FCS operational concepts and current warfare strategy (GAO, 2010a).

Research indicates that the findings stipulated in various government reports translate into four root causes for failure. First, the program waived a Milestone A approval, hindering the ability of the program to validate capability gaps; assess the estimated cost, schedule, and performance of the proposed solution; and develop a sound business approach. The second root cause for failure points to repeated congressional involvement, especially in regards to cutting budgets when the program experienced cost overruns in development. Instead of adjusting the budget to fit the needs of a developing and cutting-edge acquisition program, or at the very least maintaining a stable budget figure, Congress cut FCS budget requests on at least three separate occasions (DOD, 2007). The third root cause for failure is the lack of control for technology progression. The design and development of the FCS took longer and cost more money than originally expected; however, this is a common circumstance for a state-of-the-art acquisition program. A root cause for failure arises when the acquisition program allows the achievement of a milestone decision with inadequate technology, resulting in potential future cost overruns for the program, and expectations from Congress that a program is progressing as planned. The last root cause for failure in the FCS program is a vast change in warfighter requirements. The national security strategy and operational environments changed drastically due to the September 11 attacks and subsequent wars in Iraq and Afghanistan. This resulted in the FCS program capabilities becoming obsolete for the current warfighter needs.

2. Comanche Helicopter

The Comanche Helicopter acquisition program did conduct a Milestone A decision (formerly known as Milestone I) in 1988, with a Milestone B approval not coming until 2000 (DOD, 2002). The predominant reason for the delay involved multiple development and design issues, which required the program to invest additional program budget to achieve the appropriate technology levels. However, the GAO stated that the Comanche program is a good example of attaining key product knowledge as the acquisition program milestones progressed commensurate with the technological maturity (GAO, 2004a). The downside to acquiring key product knowledge was that high development costs drove the unaffordability of each Comanche Helicopter, as "the estimated cost of each aircraft had soared to $53 million from an original target of $8 million" (Merle, 2004, p. 1). Program initiation occurred well before the DOD stated that evolutionary was the preferred acquisition approach, but shortly after the announcement, the Comanche program did restructure the approach to incorporate an evolutionary strategy (GAO, 2004a). The acquisition office appropriately applied an evolutionary approach since new and changing requirements existed, which helped balance the program by spreading out requirements (GAO, 2004a). Lastly, changes in the national security strategy and operational warfare environment, due in large part to the September 11 terrorist attacks, led to a Comanche program “no longer consistent with the changed operational environment” (Merle, 2004, p. 2).

The Comanche Helicopter program experienced two key root causes for failure. First, the program did not control technology progression. Unlike the FCS, which allowed milestone approvals before technological maturity, the Comanche program progressed far too slowly, resulting in research and development costs that quadrupled and a schedule dictating a 21-year period before initial capability (GAO, 2004b). The accumulation of these development costs eventually resulted in the total unit cost for each helicopter being unaffordable. Even with a switch to an evolutionary acquisition approach, the program failed to meet technological maturity for the first increment. The second root cause for failure in the Comanche program is a vast change in warfighter requirements. The national security strategy and operational environments changed drastically due to the September 11 attacks and subsequent wars in Iraq and Afghanistan. This resulted in the Comanche program capabilities becoming obsolete for the current warfighter needs.

3. National Polar-Orbiting Operational Environment Satellite System

The NPOESS acquisition program did conduct a Milestone A decision as a tri-agency program between the Department of Commerce (National Oceanic and Atmospheric Administration), DOD, and the National Aeronautics and Space Administration (NASA; GAO, 2011b). A Massachusetts Institute of Technology (MIT) research study cites cost growth, schedule delays, and management issues as the primary reasons for failure of the NPOESS program (Dwyer, Szajnfarber, Cameron, Bradford, & Crawley, 2014). In 2011, a congressional investigation stated major performance problems and schedule delays led to significant cost overruns, but that all of those factors resulted from a dysfunctional management structure between the three agencies (*From NPOESS to JPSS*, 2011). The NPOESS program pursued a single step acquisition approach with only six satellites planned for launch (GAO, 2008b). A study by the RAND Corporation indicated that the maturation of the space industry, failure intolerant approach from customers, and high launch costs created expectations that all satellites must work to near perfection and include all required capabilities (Arena et al., 2015). Due to the NPOESS program possessing binary requirements for key capabilities and a maintenance intensive system with constant ground monitoring the use of a single step acquisition approach is appropriate.

Ultimately, the research findings on the NPOESS program lead back to one key root cause for failure, a poor management structure between the agencies. The lack of governance rules and management roles made the organizational complexity, differing financial responsibility, and requirements approval process almost impossible to manage. The tri-agency process made it difficult to follow both the JCIDS and PPBE structure that appropriately manage the requirements and budgeting process.

4. Airborne Laser

The Airborne Laser acquisition program did conduct a Milestone A decision in 1996 (DOD, 1999). The program followed a single step acquisition approach since it began before 2000, and no research indicates that a switch to an evolutionary approach ever occurred. The Airborne Laser program involved binary requirements for its key capabilities such as developing a high-energy laser aboard a Boeing 747 to destroy ballistic missiles during the boost phase of flight; thus, a single step approach was appropriate. According to the GAO, affordability and technical concerns ultimately led to the cancellation of the Airborne Laser program (GAO, 2011c). The failure to achieve consistent technical progress during the first few years of development led to affordability issues, with a seven-year schedule delay and increased budget estimate of $4 billion (GAO, 2011c). In turn, the lack of technical progress led to congressional budget cuts in 2001, which removed $647 million of RDT&E funding out of the FY2001–

FY2005 FYDP, led to a three-year increase in the schedule, and caused an overall program budget increase of $845 million (DOD, 1999).

The Airborne Laser program experienced two key root causes for failure. First, the program did not control technology progression. The Airborne Laser program repeatedly increased its RDT&E budget and schedule requests to continue development and design work at levels below TRL 6. Overall, the program invested more than $5 billion and 14 years of schedule, while never receiving a Milestone B approval (GAO, 2011c). This root cause arises when technology expectations are unrealistic and program decisions do not consider previously incurred costs as sunk. The second root cause for failure involves repeated congressional involvement pertaining to budget cuts in development. By steadily cutting the short-term development budget, congressional involvement makes it difficult to invest the time and resources to conclude that the technology is either not feasible, or to have the program progress in an affordable manner. Instead, the development budget stretches over an increasingly long period, making the technology assessment very slow, and long-run costs extremely high.

5. VH-71 Presidential Helicopter

The VH-71 program included an evolutionary approach with increment one meeting some operational requirements, and the second increment providing the full operational capability (O'Rourke, 2009). Due to the time criticality of the program driven by the September 11 terrorist attacks, and because certain requirements were susceptible to change, the program properly applied an evolutionary approach. The VH-71 Presidential Helicopter acquisition program did not conduct an MSA or Milestone A decision, and in fact, the program received its initial approvals of both Milestone B & C simultaneously in 2005 (O'Rourke, 2009). As a result, the program scheduled the design, test and production phases to take place concurrently (Tiron, 2007). Furthermore, the program delayed the best practice of conducting a preliminary design review by 13 months and critical design review by two years (GAO, 2011a). The PDR is a TMRR activity required before Milestone B approval, which establishes the allocated baseline, and ensures the design has a reasonable expectation of meeting the system requirements within budget and schedule. The GAO stated that the eventual termination of the program resulted from cost growth, schedule delays, and poor system performance from immature technologies (GAO, 2011a). Due to technological challenges at an advanced stage in the acquisition system, the program office initiated a substantial redesign, driving significant cost growth in the program (Baker, 2008). Lastly, the program experienced a mandate by Congress and the White House to compress the schedule, thus entering the acquisition with a Milestone B & C approval, along with various budget cuts by Congress because of slow development activities (Tiron, 2007).

Our research shows that the previous findings equate to three root causes of failure. First, the program waived a Milestone A approval and immediately entered the program with both Milestone B and C approvals. This directly conflicted with a GAO best practice, and significantly hindered the ability of the program to perform the appropriate systems engineering analysis, address preliminary design issues, and develop an appropriate business case, to include an analysis of alternatives. The second root cause for failure in the VH-71 program is the lack of control for technology progression. As seen in the FCS program, this program allowed the approval of Milestone B with an inadequate TRL for the program and without a stable design. When the VH-71 program proceeded past Milestone B without feasible technology, the program experienced cost growth from redesign work and additional development costs. The last root cause for failure is from repeated congressional involvement, especially the mandate to compress the program schedule (a key reason for bypassing Milestone A), and cutting RDT&E funding by $50 million due to slow technological development. The extreme schedule pressure emphasized the need to efficiently and effectively complete development work; however, budget cuts to a program already struggling with development only exacerbates the problem instead of motivating personnel to fix the issue.

6. Expeditionary Fighting Vehicle

The Expeditionary Fighting Vehicle acquisition program did conduct a Milestone A decision in 1995 (DOD, 2010). Program initiation occurred well before the DOD selected evolutionary as the preferred acquisition approach, but after the announcement there is no indication that the Comanche program was restructured to incorporate an evolutionary strategy. The EFV had both time sensitivity to produce a warfighter capability and requirements likely to change over time, indicating the suitability of an evolutionary approach. The GAO stated that the EFV program suffered from substantial historical cost growth and significant reliability problems in regards to the operational use of the systems technology (GAO, 2010c). After the Milestone B approval, and during the EMD phase of the defense acquisition system, the Congressional Research Service stated that the original schedule to demonstrate technological maturity of the EFV and incorporate results of tests into design changes had proved insufficient (Feickert, 2011). Thus, attempting to meet the demands of the schedule did not allow sufficient time to mature the operational technology and incorporate changes into the production design. By 2007, the national security strategy led to a change in the Marines' ground mobility strategy, which resulted in a production quantity reduction of EFVs from 1,013 to 573 ("Expeditionary Fighting Vehicle (EFV)," n.d.). Ultimately, the reduced quantities led to a unit cost Nunn-McCurdy breach, indicating an unaffordable program and significant cost growth.

The EFV experienced three key root causes for failure. First, the EFV program did not pursue an evolutionary acquisition approach. The program consistently struggled with maturing technology, especially during EMD. An evolutionary approach affords the program additional time to develop an operational end capability using increments instead of attempting to meet all technology objectives for one complete end system. Second, the program did not control technology progression. Although the program instituted a successful TMRR phase and Milestone B with a TRL 6, they did not follow the same process during EMD. Instead of allowing marginal schedule growth to fix design issues, and then re-testing to confirm the solution, the program continued to move forward without mature technology until critical failures resulted in three program re-baselines and over three years of additional schedule (Feickert, 2011). The re-baselines resulted in substantial cost growth and significantly contributed to the program becoming unaffordable and unreliable. The third root cause for failure in the EFV program is a vast change in warfighter requirements. The National Security Strategy and subsequently the

Marines' ground mobility strategy changed due to the constant counterinsurgency wars fought in Iraq and Afghanistan. This resulted in a substantial quantity reduction in EFVs, driving the unit cost per EFV to be unaffordable, and highlighting the program's significant cost growth with a Nunn-McCurdy breach.

7. Transformational SATCOM

The Transformational Satellite Communications (SATCOM) acquisition program did not conduct an MSA or Milestone A decision (DOD, 2005b). To help establish reliable cost, schedule, and performance estimates without Milestone A, the GAO recommended the program develop a sound business case by achieving pillars of knowledge such as early design studies, but the schedule did not allow for these activities (GAO, 2003). In addition, a Milestone B approval initiated the program in 2004 with only one of the seven critical technologies being mature (GAO, 2006a). Due to unreliable cost, schedule, and performance goals and initial development concerns related to immature technology, Congress twice reduced the programs funding during development (GAO, 2006a). The first budget cut in 2004 resulted in a budget reduction from $774 million to $474 million, which also triggered a Nunn-McCurdy breach in schedule due to a corresponding schedule slip (DOD, 2004). Lastly, the Transformational SATCOM program implemented a single step acquisition approach, which at the time of the decision fit the DOD preference to make fewer but more complex satellites rather than large constellations of less complex satellites (GAO, 2006b). As with the NPOESS program this preference is due to the maturation of the space industry, failure intolerant approach from customers, and high launch costs (Arena et al., 2015). Eventually, the DOD agreed to reduce initial capabilities to pursue an evolutionary approach, but the program received a termination shortly after this decision (GAO, 2006a). At the time the TSAT program correctly applied a single step acquisition approach. However, recent breakthroughs in launch vehicles, which greatly reduce costs, may dictate a switch to satellite systems following an evolutionary approach.

Our research shows that the previous findings translate into three root causes of failure. First, the program waived Milestone A and immediately entered the program with a Milestone B approval. This directly conflicted with a GAO recommendation and did not allow the program to develop a sound business case, realistic cost, schedule, or performance estimates, or the appropriate pillars of knowledge (design studies and mature technologies) to be successful. The second root cause for failure in the TSAT program is the lack of control for technology progression. This program allowed a Milestone B approval without mature technology, resulting in schedule slips and budget cuts due to the additional time and effort needed to support development activities. The last root cause for failure is from repeated congressional involvement, especially in regards to two budget cuts during development, the first of which resulted in a $300 million reduction. This directly caused a Nunn-McCurdy breach and did not provide sufficient resources to the program to work through technology development issues, and meet the necessary schedule and life-cycle budget goals.

8. Crusader

The Crusader acquisition program did conduct a Milestone A decision in 1994 (DOD, 2001). Program initiation occurred well before the DOD stated evolutionary as the preferred acquisition approach, and then a termination decision started in 2002, not allowing enough time for a switch to an evolutionary strategy (GAO, 2002). The GAO stated that the key reason to cancel the Crusader was because "the warfighter no longer needed a 60-ton armored cannon to combat Soviet forces on the battlefields of Europe" (GAO, 2008a, p. 2). In addition, Secretary of Defense Donald Rumsfeld stated that the Crusader is not relevant in 21st-century warfare (Dao, 2002). The DOD also ignored a GAO recommendation and best practice to further mature technologies before production, but the program received a termination determination before the start of production (GAO, 2002). This also indicates that the program progressed adequately under the single step acquisition approach.

Our research indicates the sole root cause for failure in the Crusader program is a vast change in warfighter requirements. The national security strategy and operational environments changed drastically due to the September 11 attacks and subsequent wars in Iraq and Afghanistan. This resulted in the Crusader program capabilities becoming obsolete for the current warfighter needs and the Army's planned transformation to a lighter and more deployable future force.

B. ROOT CAUSE CATEGORIES

The research and root cause analysis indicates that broad categories exist for root causes for failure. To eliminate outliers and create statistically significant categories that link root causes to program failure, we developed a threshold for each category. At a minimum, three out of the eight programs, or 37.5% of the programs studied, must contain a root cause that fits into the same broad category. This eliminates the possibility of creating a categories based on root causes seen as outliers in only one or two programs.

The first broad category is entering the acquisition program without an MSA or Milestone A approval. Three of eight failed programs, or 37.5% of the programs studied, did not conduct a Milestone A approval. The second broad category is an insurmountable requirements change driven by the needs of the warfighter resulting in adjusting the national security strategy. Four of eight failed programs, or 50% of the programs studied experienced a drastic change in force requirements. The third broad category is congressional involvement, especially in regards to cutting budgets during program development. Four of eight failed programs, or 50% of the programs studied, experienced a drastic change to the program structure due to congressional involvement. The last broad category is a lack of control in technology progression involving both the approval of milestones without matured technology and spending an unrealistic amount of resources on creating a technical solution. Six of eight failed programs, or 75% of the programs studied, experienced some form of poor technology progression. Table 5 indicates which studied programs experienced a root cause of failure in each of the broad categories.

Table 5. Broad Categories of Failure

Program	Milestone A Waived	Requirements Obsolescence	Congressional Involvement	Technical Progression
FCS	X	X	X	X
Comanche		X		X
NPOESS				
Airborne Laser			X	X
VH-71	X		X	X
EFV		X		X
TSAT	X		X	X
Crusader		X		

C. NORMALIZATION ACROSS MDAPS

Our research indicates that the broad categories for root causes of failure in a select set of MDAPs are applicable to other MDAPs. The categories are general in nature and involve root causes that may exist in any MDAP, not just the research subset. Most MDAPs face the same statutory and regulatory requirements, which should normalize the programs enough to apply the lessons learned from this research. In addition, many research documents cross-referenced acquisition programs not specifically studied, with frequent mentions of root causes similar to the broad categories. Although not every other failed MDAP will fit into each broad category, the likelihood of at least one root cause category is extremely high. Of the selected set of programs for study, seven out of eight programs, or 87.5% had a root cause for failure in at least one broad category. The root causes for failure that are outliers and do not fit into broad categories are extremely difficult to normalize and apply broadly. For instance, the NPOESS and EFV programs experienced a root cause outlier, but just one reference point is not possible to apply to other programs.

The selected set of programs normalized variables for program classification (MDAPs), the timeframe for cancellation (2001–2016), the inability to field operational systems, and the presence of sunk costs of more than $2 billion. After grouping the root causes for failure into broad categories, there are apparent commonalities between the root causes in this set of MDAPs. First, every program which waived the Milestone A approval eventually experienced a negative congressional involvement. Furthermore, every program that experienced a congressional involvement also faced issues with the technological progression of the program. The commonalities show that if a program waives the Milestone A requirement, in all likelihood, it will experience both a congressional action hindering the program and difficulty with appropriately developing the technology. Anytime a program waives Milestone A, the root causes of congressional involvement and technology progression are no longer mutually independent. The same rule applies to congressional involvement and technological progression. If congressional involvement is present, then there will also be issues with technology development. However, these events are not always in chronological order. This research did not determine the relative strength of each root cause for failure, but the presence of more than one root cause of failure indicates a higher probability of eventual program failure. Six of eight failed programs, or 75% of the programs studied experienced more than one root cause for failure.

D. RECOMMENDATIONS

Based on the four broad categories of root causes of failure in acquisition programs, our team compiled recommendations to mitigate root causes of failure for future programs. These recommendations consider the current acquisition environment and statutory requirements for stakeholders. However, the recommendations are not all encompassing since it is critical to understand the root causes of failure in prior programs to apply lessons learned to future programs.

All future MDAPs, regardless of schedule demands or perceived technological maturity, should conduct a materiel solution analysis and only proceed into TMRR with a Milestone A approval from the MDA. The MSA phase allows the program manager and leadership to select a preferred materiel solution through an analysis of alternatives that addresses the capability gaps identified in the JCIDS process. If time is a critical factor, it is possible to focus additional resources on achieving Milestone A in a shortened timeframe, which is a preferred tradeoff to entering the acquisition program without a legitimate business case. Lastly, Milestone A helps build a cohesive government program team that jointly develops realistic cost, schedule, and performance expectations for the program. These realistic expectations are critical to avoid future issues with congressional involvement and poor technology progression.

It is possible to address requirements obsolescence due to a changing national security strategy or warfare environment in a few ways. First, acquisition programs must constantly review changes in service-specific strategy and national security strategy to ensure proper alignment with capability gaps. To assist in this process, an annual or biannual JCIDS assessment throughput the program life cycle may help to validate the capability gaps met by the acquisition program. This allows for either incremental changes to the acquisition program or a much earlier decision to terminate the program, greatly reducing sunk costs. The second recommendation involves designing systems with an open architecture concept with adaptability to meet many of the changes necessary throughout a long product development cycle. It is almost impossible to predict a catastrophic event such as the September 11 terrorist attacks, which revolutionized warfighting strategy, but designing systems with an adaptable structure allows for a potential solution to meet new capability gaps.

Congressional involvement often takes place after an annual SAR submission that contains negative program issues or after a Nunn-McCurdy breach takes place. To mitigate congressional involvement, it is important to set realistic program expectations, including creating a development budget that considers the challenges of meeting TRL objectives. Furthermore, implementing a pre-notification process to notify Congress of any predicted Nunn-McCurdy breaches or poor annual SAR assessments will afford Congress adequate time to consider the appropriate course of action.

Lastly, the most common root cause of failure in acquisition programs is poor technology progression. To address this issue, acquisition programs should no longer move forward with the defense acquisition system process until reaching the appropriate technical maturity. Especially important is ensuring all critical technologies reach a TRL 6, which is demonstration in a relevant environment before a Milestone B approval. On the flipside, programs must understand their resource limitations and cannot stagnate in the TMRR phase and utilize resources for too long; otherwise the unit cost for systems becomes unaffordable. The programs must define critical limitations for resource allocations and schedule upfront with only marginal changes during development, as opposed to the re-baselining method currently used. For innovative technology with little to no current design or development work, specifically TRLs 1–3, the programs should not be responsible for maturation. Instead, outside organizations such as DARPA, military research laboratories, or federally funded research and development centers (FFRDC) are much better suited to handle initial development work. It is not necessarily a failure to prove that technology is unfeasible early in development, since it saves all of the future investment costs. Programs do not embrace this concept; however, independent research organizations are more comfortable with making this assessment.

V. CONCLUSION AND AREAS OF FURTHER RESEARCH

A. DISCUSSION OF RESULTS

Execution of MDAPs occurs in a harsh budgetary, political, and resource-constrained environment. Our research shows that all studied MDAP programs lead back to at least one root cause for failure. Often, failed programs experience more than one root cause, strengthening the probability of failure. Many of the root causes discovered fit into the four broad categories of entering the acquisition program without an MSA or Milestone A approval, vast requirement changes driven by the national security strategy adjusting to the needs of the warfighter, negative congressional involvement, and lack of control in technology progression. These categories are broad enough to apply lessons learned to all current and future MDAPs, since all programs fall under similar statutory and regulatory requirements. Ultimately, the findings generated a series of recommendations to counteract future root causes of failure in MDAPs.

B. STUDY LIMITATIONS

The data used in this study is almost exclusively from government sources, or from an entity contracted by the government to perform research. The key sources are SARs, APBs, and GAO, PARCA, IG, and CRS reports, all of which the government produces, while the RAND Corporation created reports backed by government funding. Most academic and open source articles also heavily rely on the aforementioned government source data. To conduct a thorough root cause analysis, a 360-degree perspective of all stakeholders is necessary, with an equal emphasis on the perspective of prime contractors and subcontractors involved with the program. Although government reports document factual circumstances surrounding acquisition programs, often times it is difficult to remove all bias concerning the responsibility of why an acquisition program failed. In addition, we did not conduct research surveys or interviews to ask directed questions about program specifics and conditions relating to program failure from either government or contractor sources.

The infrequent number of cancelled MDAPs with sunk costs greater than $2 billion and no fielded systems is another limiting factor. Due to such a small sample size, there is simply not enough source data to confirm the conclusions drawn from the analysis. Over time, it is possible to compare the conclusions of this report with future failed programs within the defined scope parameters to validate whether the common root causes are indeed present to support the current findings. Although this research did attempt to scope MDAPs to align as many variables as possible, the distinct differences between programs even within the current scope make the categorization of similar root causes of failure very difficult.

Lastly, although we conducted a complete analysis of the available information, it is still difficult to conclude that there is a direct correlation between root causes and program failures for individual programs. However, by finding commonalities between the root causes for failure in different programs, our conclusions are more robust and are applicable for future programs. It is critical to ensure that any future programs that learn from this study are of the same size and scope to ensure the variables are as similar as possible, and that the lessons learned incorporate common root causes for failure, not just isolated instances on single programs.

C. AREAS OF FURTHER RESEARCH

In addition to utilizing all open source and government data for research, conducting interviews and surveys with program stakeholders is another way to gather critical research material. This would allow for additional and potentially more candid responses from personnel with a vested interest in the programs. Suggested stakeholders include program teams, integrated product team (IPT) members, prime contractors, subcontractors, requirement users, and congressional stakeholders. With the additional research, it is possible to enhance the conclusions of this report by supporting or altering findings with additional data points.

Another research possibility is to conduct a project focused on defining what constitutes a successful MDAP program. After defining the parameters for success, it is possible select a set of MDAPs meeting the criteria for a successful program.

Furthermore, it is possible to research and identify whether any root causes for failure are present in the successful programs, which may indicate a false positive from this research report. Otherwise, the outcomes then support the research findings from this report, as root causes of failure are not present in successful programs. Additionally, it is possible to develop best practices or risk areas from this report to apply to future programs. This allows an opportunity to track the results of future programs that received training on potential root causes for failure.

Lastly, the congressional impact on acquisition programs is a critical area for further research. It is paramount to understand whether the control mechanisms utilized by Congress affect the program as intended, or are a detriment to future program success. Throughout the programs considered in our research, Congress took action to change the parameters of a program; however, no research indicates whether these actions were indeed effective in achieving the intended outcomes.

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