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Department of Defense Joint Aircrew Survival Flight Vest

September 2022

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

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ABSTRACT

The purpose of this research is to analyze the feasibility of a joint aircrew survival flight vest program to satisfy the performance requirements across the military Services. The Department of Defense has multiple type, model, series aircraft in its inventory to meet the capabilities validated by the Joint Requirements Oversight Council. Each aircraft comes with a variety of Aviation Life Support Systems such as the aircrew survival flight vest. There are a variety of aircrew survival flight vests across the Department of Defense performing similar functions such as: ballistic protection, signaling, and communications, and providing flotation in a maritime environment.

In recent years, Defense Acquisitions Programs have been becoming more joint by increasing commonality to cut cost by reducing redundant programs among the different services. Currently, the various Aircrew Flight Vest which are being used remain under the control of several program executive offices.

This research examined the feasibility of a joint aircrew survival flight vest by using a combination of the case study method and the cost-effectiveness analysis. We concluded that a joint aircrew survival flight vest with a modular design would be the most effective option. The Services will have the flexibility to tailor the joint vest with modules to meet the performance specifications.

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ABOUT THE AUTHORS

Major Kenneth S. Bobby is from Queens, NY, began his military career in 2008 after receiving orders to the Naval Reserve Officer Training Corps at Embry-Riddle Aeronautical University in Daytona Beach, FL. He graduated with a Bachelor of Science in Aeronautical Science and was commissioned as a Second Lieutenant in 2011. After completing The Basic School and receiving the Military Occupational Specialty Aircraft Maintenance Officer in 2012, he received orders to MCAS New River and served as the Aviation Life Support Systems (ALSS) and Ground Support Equipment (GSE) OIC for Marine Aviation Logistics Squadron (MALS)-26. In 2013, he was assigned as the Assistant Aircraft Maintenance Officer (AAMO) for Marine Medium Tiltrotor Squadron (VMM) 162 and deployed to Moron, Spain, in support of Special Marine Air Ground Task Force-Crisis Response (SPMAGTF-CR).

In 2015, Maj Bobby received orders to VMM-363 at MCAS Miramar and was assigned as the AAMO. Maj Bobby also completed the MV-22 Aerial Observer (AO) syllabus. While at VMM-363 he deployed to SPMAGTF-CR-(CC) Central Command 16.2 and 18.1 in support of Operation Inherent Resolve.

In 2018, Maj Bobby reported to Marine Corps Recruit Depot San Diego (MCRDSD) and served as a Series Commander and Operations Officer for 3d Recruit Training Battalion. In 2021, Maj Bobby executed orders to NPS in Monterey, CA, to pursue an MBA in Acquisition and Contract Management program. After NPS, he will report to the Marine Corps Installations Pacific (MCIPAC) Regional Contracting Office in Okinawa, Japan, to serve as a Contingency Contacting Officer.

Major Bobby's personal awards include the Air Medal Flight/Strike Medal, the Navy and Marine Corps Commendation Medal, Navy and Marine Achievement Medal, and the Outstanding Volunteer Service Medal.

Capt Nicholas Chresaidos is from Paw Paw, IL, began his career as an enlisted Foodservice Specialist in the United States Marine Corps in 2008. He served with 3D Battalion, 4TH Marines in Twentynine Palms, CA, with whom he completed two combat tours in Helmand Province, Afghanistan. Next, he served with Combat Logistics

Battalion-453 (CLB-453) Headquarters and Service Company in Aurora, CO, as the Battalion Mess Chief. During his time with CLB-453 he attended Johnson & Wales University and graduated magna cum laude with a Bachelor of Science in Culinary Arts and Foodservice Management in 2016. Capt Chresaidos then attended Officer Candidate School and earned his commission in 2017 and upon graduating from The Basic School in 2018, served as the Assistant Supply Officer for Headquarters Battalion, 2D Marine Division and Supply Officer for 2D Reconnaissance Battalion, 2D Marine Division in Camp Lejeune, NC. Capt Chresaidos is currently attending the Naval Postgraduate School in pursuit of a Master of Business Administration degree in Acquisitions and Contract Management. Upon graduation he will be assigned to Headquarters and Service Battalion, Marine Corps Installations Pacific (MCIPAC) aboard Camp Butler, Okinawa, to serve in the MCIPAC Regional Contracting Office.

ENS Kevin Semma is from Redwood City, CA, enlisted in the United States Navy in 2012 as an Electronics Technician and served onboard the Los Angeles Class Submarine, USS Charlotte (SSN 766). He then attended the Naval Academy Preparatory School in 2016–2017. Afterwards, he attended and commissioned from the United States Naval Academy in 2021 where he graduated with a Bachelor of Science in Economics. Nearing his completion at USNA, he was selected to attend the Naval Postgraduate School to pursue an MBA in Acquisition and Contract Management. Upon graduation from NPS, he will attend flight school in Pensacola, FL, to begin his career as a Navy Pilot.

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I want to thank our thesis advisor, Dr. Robert Mortlock, for his support, guidance, and mentorship and our second reader, Mr. Cory Yoder, for his insights. This research would not be possible without the several program offices taking time out of their busy schedules to work with us.

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—Kenneth Bobby

Thank you to my wife, Rose, for her consistent support throughout my time at NPS and my career in the Marine Corps. Her constant devotion and understanding in the demands of military life have been crucial to my success thus far. I would also like to thank my friends and colleagues here at NPS as well as at my previous commands for providing much needed assistance throughout the research process.

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—Nicholas Chresaidos

I would like to thank to my wife, Veronya, for her love and support throughout my education process and ensuring that I stay focused and on track. Many thanks to the rest of my family for their continuing support in my time in the Navy to include my time here at the Naval Postgraduate School. I also thank my puppy, Kona the Goldendoodle, for providing me much-needed distractions from staring at a screen.

Thank you, Dr. Robert Mortlock, for your time and guidance throughout our thesis efforts. Your timely and constructive feedback is very appreciated. Our face-to-

face encounters were very beneficial in expanding my knowledge in acquisitions and furthered my insights and ability to contribute to this thesis.

—Kevin Semma

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LIST OF ACRONYMS AND ABBREVIATIONS

ACAT	Acquisition Category
AIR SS	Air Soldier System
AIRSAVE	Aircrew Integrated Recovery Survival Armor Vest and Equipment
A_o	Operational Availability
AoA	Analysis of Alternatives
APB	Acquisition Program Baseline
CAPE	Cost Assessment and Program Evaluation
CDD	Capability Development Document
CJCS	Chairman of the Joints Chiefs of Staff
COA	Course of Action
COTS	Commercial Off-the-Shelf
CPD	Capabilities Production Document
DAS	Defense Acquisition System
DoD	Department of Defense
DON	Department of the Navy
DOTMLPF	Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities
GAO	Government Accountability Office
ICD	Initial Capabilities Document
JCIDS	Joint Capabilities Integration and Development System
JROC	Joint Requirements Oversight Council
KPP	Key Performance Parameters
KSA	Key System Attributes
LCCE	Life-Cycle Cost Estimate
MDA	Milestone Decision Authority
MDD	Materiel Development Decision
MILCON	Military Construction
MOLLE	Modular Lightweight Load-Carrying Equipment
MSA	Materiel Solution Analysis
NAVAIR	Naval Air Systems Command
PPBE	Planning, Programming, Budgeting, and Execution

RAND	Research and Development
RDT&E	Research, Development, Testing, and Evaluation
RFP	Request for Proposal
SAR	Search and Rescue
SECDEF	Secretary of Defense
USD(AT&L)	Under Secretary of Defense for Acquisition, Technology, and Logistics
USMC	United States Marine Corps

EXECUTIVE SUMMARY

Aircrew survival flight vests from the Army, Air Force, Coast Guard and Navy/Marine Corps were analyzed to assess the feasibility of one joint vest to meet the performance specifications of all the Services. Using a cost-effectiveness analysis and assigning weighted values to specific criteria; design freedom, small arms and shrapnel protection, light weight, modularity, size fits the majority of the aircrew, maritime environment, total life-cycle cost, logistical supportability, training ability and contracting.

The research determined that the most effective option is a joint aircrew survival flight vest with a modular design. Modularity will enable the Services to customize the joint vest to achieve their specific performance requirements by adding or removing modules to the vest. Modularity will also enable the modules that attach to the vest to be updated as required instead of modernizing the entire vest or procuring a new one, reducing costs.

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I. INTRODUCTION

Aircrew members in each military Service of the United States wear an aircrew survival vest while conducting aviation operations to sustain life support while operating in harsh environments. Aircrew survival vests are also designed to increase the likelihood of survival for the individual during a catastrophic event. There are multiple different types of aircrew survival vests among the different branches of the Department of Defense (DoD). The typical vest allows for attaching additional gear and enables the aircrew to have small arms fire protection, communication to facilitate a search and rescue, flotation, and underwater breathing for maritime environments. Crew chiefs and aerial observers have a modified aircrew survival vest that allows them to perform operations in the cabin of the aircraft such as passenger support and weapon deployment while being tethered to the aircraft during flight. Figure 1 displays one crew chief guiding the pilots to the landing zone and the other crew chief deploying a ramp mounted weapon system while being tethered to the aircraft. The aircrew survival vest is a lifesaving, critical piece of equipment to the warfighter, and its capability is tested when the survival of the aircrew is at stake.

Figure 1. Crew Chiefs Assist the Pilots in Landing an MV-22 Osprey While Being Tethered to the Aircraft at an Undisclosed Location. Source: Ontiveros (2017).

In recent years, defense acquisition programs have been becoming more joint by increasing commonality to cut cost and increase efficiencies by reducing redundant programs among the different Services. Currently, the various aircrew survival flight vests that are being used remain under the control of several program executive offices. This research examines the feasibility of a joint aircrew flight vest for all the Services by performing a qualitative assessment using a cost effectiveness analysis and research on barriers to implementation.

A. COMMONALTY

Finding commonality in a program among the Services can decrease cost, reduce logistical constraints, and increase operational effectiveness. There is a variety of aircrew vests among the different Services being managed by different program offices. Each Service has their own way to procure and manage survival vests in their inventory. A joint aircrew survival vest can promote commonality among all the Services and the economic ordering while maintaining operational effectiveness: "Commonality is desirable because it can increase operational flexibility and reduce the procurement, logistical, and training burden" (Held et al., 2008, p. xi). A common part or weapon system used by multiple Services allows the DoD to leverage the logistical advantages of commonality and increase flexibility greatly.

However, in specific scenarios, commonality can actually produce unforeseen negative results, reducing the capability of the original design. "Commonality can decrease design freedom and occasionally operational capability by making different host 'systems' share a common component, even if the common component offers more inferior performance or fewer capabilities than does a unique component" (Held et al., 2008, p. 2). The performance and capability of a component or weapon system can suffer due to the overarching goal of commonality when used ineffectively. Commonality is a balance between capability and logistical flexibility of a desired weapon system.

B. GOALS

The purpose of this research is to analyze the feasibility of having one joint aircrew survival vest across all Services. Currently, each Service procures its aircrew vest individually to meet its specific requirements. The primary research question that this research aims to answer is:

- What is the most cost-effective option between a joint vest by a JPO or Service specific vests by Service PMOs?

The secondary research questions are:

- What are the barriers to implementation for the various options?
- What are the advantages and disadvantages of commonality and the adoption of a joint vest?

These questions will be answered through cost-effectiveness and barrier to implementation analyses and an assessment of the probable limitations in attempting to implement commonality in the survival vests through a Joint Program Office.

C. OVERVIEW

In Chapter I, we describe the different aircrew survival vests currently used by the Air Force, Army, Navy, and Coast Guard and how they support each Service's requirement. Chapter II explains the Acquisition Program Baseline (APB) and its significance to a program of record. Commercial off-the-shelf (COTS) technologies used in aircrew survival vests are surveyed. This research utilizes a case study–based approach along with a cost-effectiveness analysis to analyze the feasibility of a joint aircrew survival vest. Chapter III contains a literature review on the advantages and disadvantages of commonality from government and think tank reports. The main effort of this research, Chapter IV, is the cost-effectiveness analysis of the benefits of a joint aircrew survival vest. Finally, the last chapter ends with results, findings, and recommendations for future research.

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II. BACKGROUND

The DoD has many aircrew survival flight vests currently in use today. We chose to limit this research and focus on four of them: the Army's Air Soldier System (AIR SS), Naval Air Systems Command's (NAVAIR's) Aircrew Endurance Vest, the Coast Guard's Search and Rescue (SAR) Warrior Survivor Vest, and the Air Force's Aircrew Integrated Recovery Survival Armor Vest and Equipment (AIRSAVE). Each vest is procured by its respective Service to support the individual Service mission. These vests serve the same basic function of aiding in survivability for the aircrew. Although they serve the same basic purpose, each Service develops their own requirements for their respective vest to fulfill mission sets and physical parameters of the aircrafts.

A. THE BIG "A" ACQUISITION PROCESS

As shown in Figure 2, the Big "A" acquisition process consist of three processes: the Joint Capabilities Integration Development System (JCIDS); the Planning, Programming, Budgeting, and Execution (PPBE) process; and the Adaptive Acquisition Framework, also known as the "little 'a'" acquisition process. All three of these processes need to be functioning simultaneously in order for the acquisition program to be successful.

Depending on the funding level of an acquisition program, each one will fall into a different Acquisition Category (ACAT) and consequently be identified either as a Major Defense Acquisition Program (MDAP) or a major system. Each ACAT comes with different laws and regulations dictating how much oversight the acquisition program requires, which corresponds to the program's budget and risk.

ACAT I programs are MDAPs that have the highest level of oversight and funding:

> Estimated by the Defense Acquisition Executive (DAE) to require an eventual total expenditure for research, development, and test and evaluation of more than \$525 million in Fiscal Year (FY) 2020 constant dollars or, for procurement, of more than \$3.065 billion in FY 2020

constant dollars (Office of the Under Secretary of Defense for Acquisition and Sustainment [OUSD(A&S)], 2020b, p. 20).

ACAT II can be designated as an MDA or major system, they do not meet the requirements for ACAT I and require less funding: "Estimated by the DoD Component head to require an eventual total expenditure for research, development, and test and evaluation of more than $200 million in, or for procurement of more than $920 million in FY 2020 constant dollars" (OUSD[A&S], 2020b, p. 20). ACAT III does not meet the funding level as required by ACAT II and is not designated as a major system.

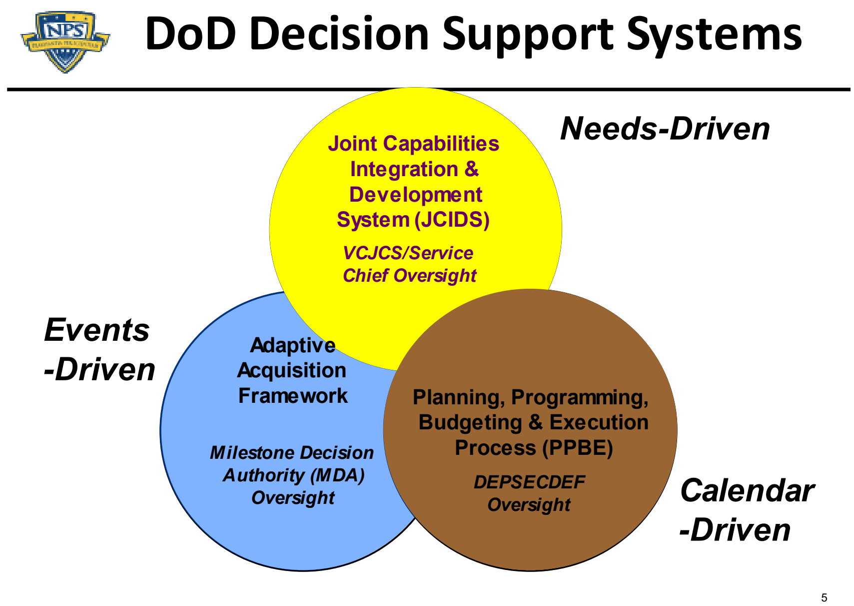


Figure 2. Big "A" Acquisitions Decision Support Systems. Source: R. Mortlock (PowerPoint slides 2022).

1. Joint Capabilities Integration and Development

The JCIDS is a requirement driven process and identifies requirement gaps:

> The purpose of JCIDS is to enable the Joint Requirements Oversight Council (JROC) to execute its statutory duties to assess joint military capabilities, and identify, approve, and prioritize gaps in these capabilities, to meet applicable requirements in the National Defense Strategy (NDS). (Joint Chiefs of Staff, 2018b, p. A-1)

The Doctrine, Organization, Training, materiel, Leadership and Education, Personnel, Facilities, and Policy (DOTmLPF-P) analysis is the first step in determining if a materiel or a nonmateriel solution can fill the gap. If a materiel solution is recommended, the acquisition process will begin: “JCIDS provides the baseline for documentation, review, and validation of capability requirements across the Department. Validated capability requirements documents facilitate DOTmLPF-P changes, guide the DAS, and inform PPBE processes” (Joint Chiefs of Staff, 2018a, p. D-1). Figure 3 shows the multiple processes within the DoD process interactions: “Of the interacting processes and activities, requirements (JCIDS), acquisition (DAS), and resources (PPBE) are the most tightly interactive and must work in concert to ensure consistent decision making while delivering timely and cost-effective capability solutions to the Warfighter” (Joint Chiefs of Staff, 2018a, p. D-4).

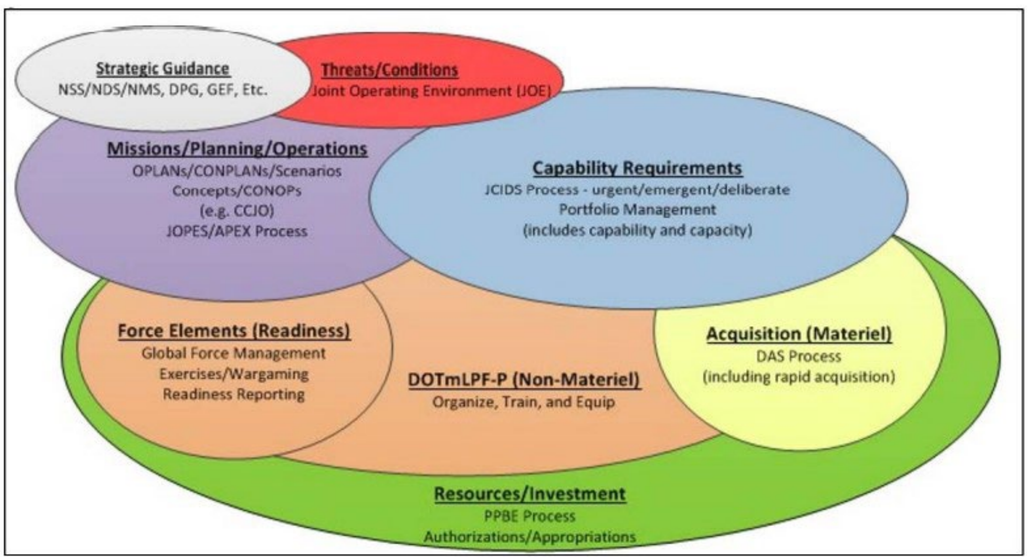


Figure 3. DoD Process Interactions. Source: Joint Chiefs of Staff (2018a).

2. Planning, Programming, Budgeting, and Execution

The Planning, Programming, Budgeting, and Execution process is the allocation of financial resources to the acquisition program. As shown in Figure 4, the PPB&E process itself is broken down into four separate phases with a process within each phase: Planning, Programming, Budgeting, and Execution. According to Candreva (2017), “PPBE is dedicated to the task of determining budgetary allocations for the manning, training, and equipment of the military and the operation and support of the defense systems that support national security objectives" (p. 195).

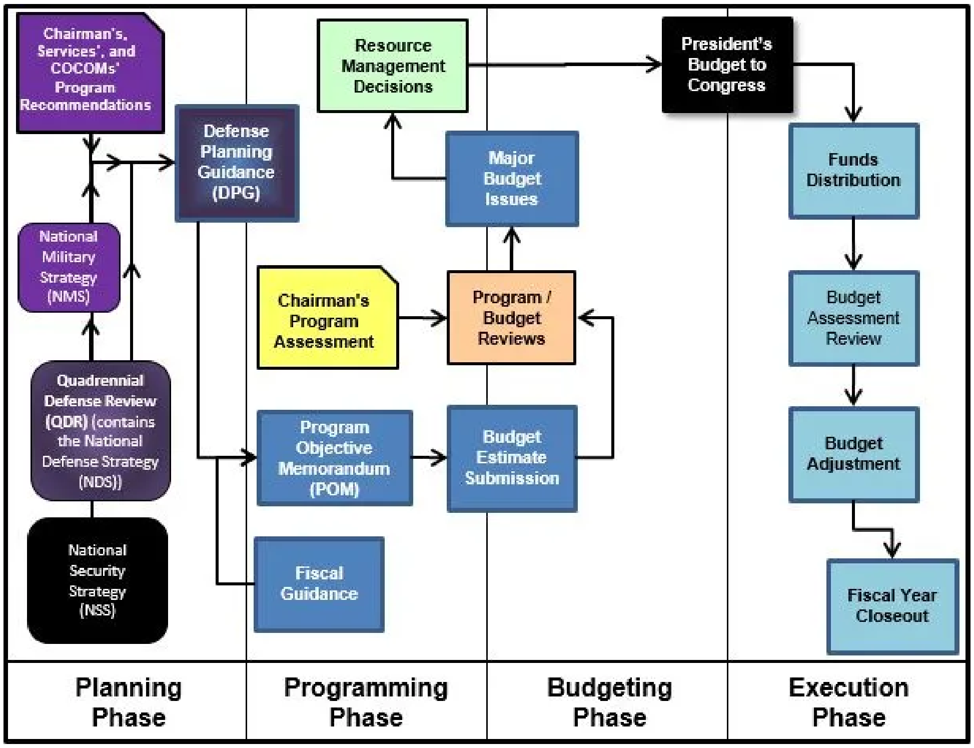


Figure 4. PPBE Process Flow Chart. Source: AcqNotes (n.d.)

a. Planning

According to McGarry (2022), "The Under Secretary of Defense for Policy conducts and coordinates the planning phase" (p. 8). The planning involves the review of several strategy documents as shown in Figure 4.

> The phase involves reviewing the President's National Security Strategy, the Secretary of Defense's National Defense Strategy, and the CJCS's National Military Strategy (NMS) to develop the Defense Planning Guidance (DPG) aligned with the Administration's policy goals and potential threats, force structure, readiness posture, and other factors (McGarry, 2022, p. 8).

After the National Planning Guidance is developed, "The Office of Secretary of Defense (OSD) provides fiscal guidance detailing projected funding for DoD components" (McGarry, 2022, p. 8). Candreva (2017) pointed out, "The goal of planning, with respect to allocation decision-making is to identify any gaps or overmatches between the NMS and the extant and programmed capacity and capabilities, and to produce objectives for the programming phase to address them" (p. 212).

b. Programming

The purpose of programming is to "allocate resources which are constrained by the Federal Government and appropriations rules, among programs across a midrange time horizon that best achieves the objectives defined in the Defense Planning Guidance" (Candreva, 2017, p. 215). Figure 4 shows that the Program Objective Memorandum (POM) is the result of the programming phase.

c. Budgeting

According to Candreva (2017), "The budgeting phase is about justifying the programming decisions in manner that supports the enactment (legitimation) phase of the budgeting process" (p. 225). This process helps Congress with ensuring that the taxpayers' dollars are being appropriated correctly to government programs. Candreva (2017) stated, "The primary aims of the budgeting are to ensure the budget justification books accurately describe the decision made in the POM and are aligned with the plans to accomplish the strategy" (p. 225).

d. Execution

McGarry (2022) explained, "During the execution phase, OSD and the DoD components evaluate the obligation and expenditure of funds, as well as program results" (p. 10). Execution is the last step of the PPBE process, and it's the result of the planning, programming and budgeting processes. As shown in Figure 4 the funds are distributed, the budget is assessed, and the budget is adjusted within the execution phase.

> The goal of the execution is to implement the programs and policies that were described in the budget as approved or modified in the authorization and appropriation process in order to deliver the desired military capabilities, and to feed information into subsequent rounds of the PPB process. (Candreva, 2017, p. 231)

3. Adaptive Acquisition Framework

"The AAF acquisition pathways provide opportunities for MDAs/DAs and PMs to develop acquisition strategies and employ acquisition processes that match the characteristics of the capability being acquired" (OUSD[A&S], 2020a, p. 4). Referencing Figure 5, PMs are empowered to select a pathway best fit for their program: "PMs, with the approval of MDAs/DAs, may leverage a combination of acquisition pathways to provide value not otherwise available through use of a single pathway" (OUSD[A&S], 2020a, p. 10).

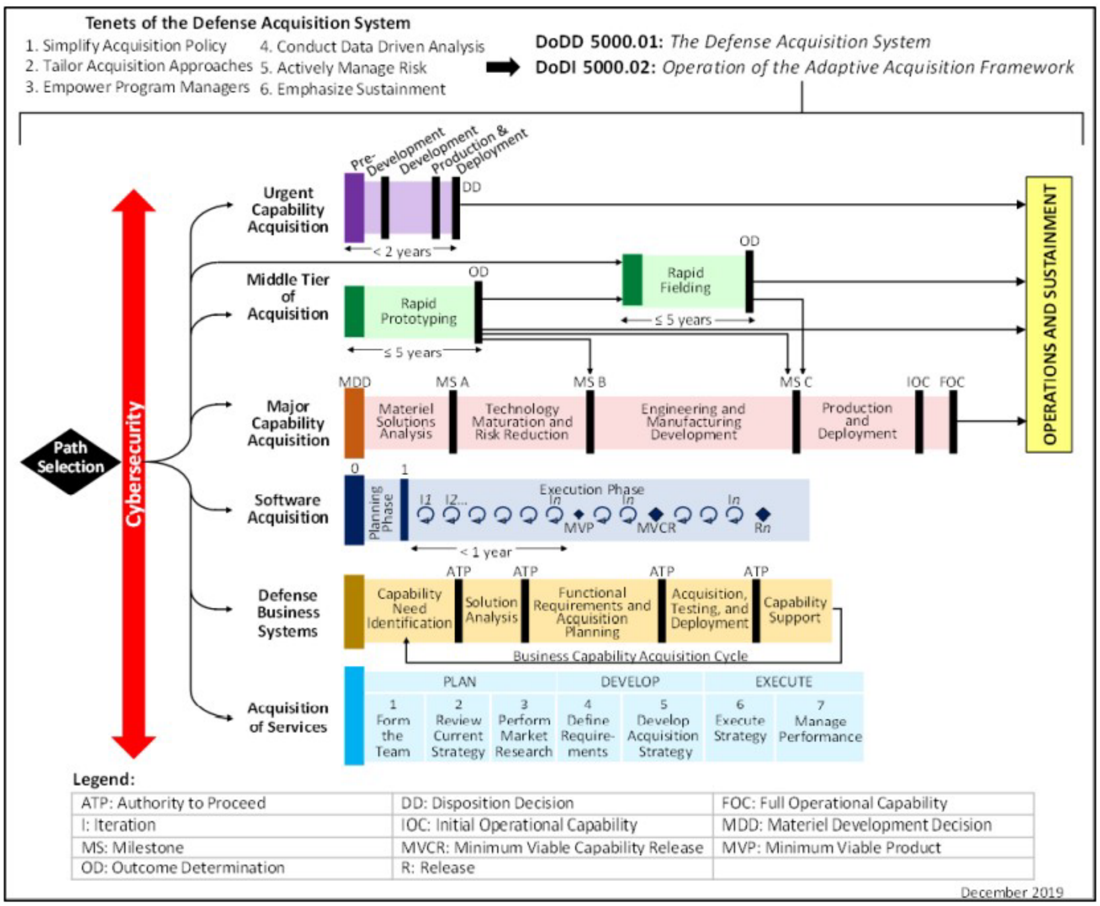


Figure 5. Adaptive Acquisition System. Source: OUSD(A&S, 2020a).

B. ACQUISITION PROGRAM BASELINE (APB)

The APB is an essential metric in which all major weapons systems are established early in the acquisition life cycle and states the threshold and objective value of the cost: "The Acquisition Program Baseline is an agreement between the Program Manager (PM) and the Milestone Decision Authority (MDA) that documents the program cost, schedule, and performance baselines" (Defense Acquisition University [DAU], n.d.-a). The APB is the plan of execution for the life cycle of the program and any changes require a deviation: "The APB is initially developed by the PM for the Milestone B decision" (DAU, 2004, p. 20).

The APB enables the PM to monitor the process of the program against a baseline to reduce risk and take corrective action when necessary:

> The PM is responsible for developing the APB. Key Performance Parameters from the validated Capability Development Document are listed, verbatim, in the APB. The APB serves as the basis for reporting to the MDA through the DoD management information system. (DAU, n.d.-a)

Many requirements from other documents are inserted into the APB. For example, key performance parameters (KPPs) "are copied verbatim to the APB from the Capabilities Development Document (CDD) and the Capabilities Production Document (CPD)" (DAU, 2004, p. 20). KPPs are initiated by the warfighter and are represented on the CDD. The contents of an APB include the schedule, performance requirements, and cost.

C. AIR SOLDIER SYSTEM

The Army currently uses the AIR SS. The AIR SS is an ACAT II program. According to the CDD, "The Air SS is an integrated, modular, mission tailorable Aviation Life Support Equipment (ALSE) and protective ensemble for aircrew Soldiers" (U.S. Army, 2011, p. ii). The AIR SS is designed for aircrew ranging from pilots, door gunners, flight surgeons, and flight medics who are supporting a wide range of operations, including "select manned aircraft in maneuver, maneuver support, and maneuver sustainment roles involved in missions ranging from Major Combat Operations, Stability Operations, Homeland Security, and Strategic Deterrence" (U.S. Army, 2018, p. ii). The Air SS allows for the following capabilities to the individuals donning it: "increased situational awareness; increased crewmember protection; reduced ensemble weight and bulk; common integrated helmet and helmet display systems;

advanced night vision; 3-dimensional (3-D) aural cueing; laser eye protection; environmental protection; survival (dismounted); flame resistance; combat identification and reliability" (U.S. Army, 2011, p. ii). These capabilities are designed to enhance the crewmembers' awareness and interface with their respective aircraft, which can help produce a more effective warfighter. This survival vest replaced the previous vests due to capability gaps, including a lack of helmet capabilities and situational awareness tools, as well as excess weight and bulkiness (U.S. Army, 2011, p. 1). The lack of situational awareness in aircrews has led to "98 aircraft accidents, 103 fatalities and a total cost to the Army of $1.23B from FY 2002–2010" (U.S. Army, 2011, p. D-1). The survival vest that Air SS was to replace did not allow for proper control movement nor situational awareness. These aspects took away from the ability of these aircrews to properly perform their duties as warfighters. The design features of the Air SS intended to alleviate the deficiencies of the previous vest are shown in Figure 6. The objectives for the Air SS aim to reduce the number of fatalities and aircraft accidents, as well as improve mission efficiency by

- Reducing weight/bulk to enhance Mobility, Performance, and Mission Effectiveness
- Integrate and optimize the full suite of Aviation Life Support Equipment to improve Mission Effectiveness, Safety, Survivability, and Situational Awareness
- Improve the ability to safely and effectively operate in degraded visual environments to reduce injuries and fatalities (U.S. Army, 2011, p. D-1)

Figure 6. Air SS Capability. Source: United States Army Acquisition Support Center (n.d.).

Tables 1–5 contain the costs, schedules, and KPPs that were defined by the APB for the Air SS survival vest. The unit cost given in Table 3 is for the vest itself without the additional equipment, this cost will be the number that is used in the analysis section. This research did not consider schedule as a factor in the analysis. For future research, it is recommended to utilize Table 4 and compare to a possible joint program to determine which program would be most time efficient:

Table 1. Cost ($ in Millions). Source: U.S. Army (2019).

Appropriation	Base Year Objective	Base Year Threshold	Then Year Objective
RDT&E Procurement	$96,732 $855,116	$106.405 $940,628	$94,584 $1,050,942
Total Acquisition Cost	$951,848	$1,047,033	$1,145,526
Operations & Support	$581,091	$639,200	$821,762
Total Life-Cycle Cost	$1,532,939	$1,686,233	$1,967,288

Note. RDT&E = Research, Development, Testing, and Evaluation.

Table 2. Quantity and Unit Cost ($ in Dollars). Source: U.S. Army (2019).

	RDT&E Quantity		Procurement Quantity	AAO Quantity	APUC Objective	APUC Threshold	PAUC Objective	PAUC Threshold
Calculated	0		20,759	20,759	41,192.54	45,311.82	45,852.31	50,437.55

Note. AAO = Approved Acquisition Objective; APUC = Average Procurement Unit Cost; PAUC = Program Acquisition Unit Cost.

Table 3. Aircrew Combat Equipment. Source: E. Gordon (email to author, August 4, 2022).

	Aircrew Combat Equipment
Unit Cost	$1,000

Table 4. Schedule. Source: U.S. Army (2019).

Schedule Event	Objective	Threshold
Materiel Development Decision	MAY 2011	NOV 2011
Milestone B	DEC 2010	JAN 2012
Limited User Test Completion	AUG 2014	FEB 2015
Operational Test & Evaluation	SEP 2015	MAR 2016
Initial Operational Test & Evaluation	MAR 2018	SEP 2018
Milestone C	OCT 2018	JUN 2019
Full-Rate Production	APR 2019	OCT 2019
Initial Operational Capability	APR 2020	OCT 2020
Full Operational Capability	SEP 2041	MAR 2042

Table 5. Key Performance Parameters. Source: U.S. Army (2019).

KPP/KSA	Description
KPP 1. Net Ready	• The capability, system, and/or service must support Net-Centric military operations. The capability, system, and/or service must be able to enter and be managed in the network and exchange data in a secure manner to enhance mission effectiveness. It must be able to continuously provide survivable, interoperable, secure, and operationally effective information exchanges to enable a Net-Centric military capability.
KPP 2. Force Protection	• Protect from the effects of incendiary weapons and thermobaric down to first degree burns over all the body areas. • Less than 10% body surface area severe burns. • Protect against direct impact from small arms rounds equal to the protection provided by the Army Combat Helmet. • Protect the user's head in a crash (not to exceed 150Gs at a velocity of 6 m/s).
KPP 3 Compatibility	• The Air SS shall be compatible with the 5th percentile female to 95th percentile male anthropometric range of aviation Soldiers for all Army rotary and fixed wing aircraft except the AH/MH-6 aircraft. The system shall not prevent use of, nor hinder operation of flight controls, displays, and switches. It shall not impede ingress and egress from aircraft beyond established standards (30 second egress requirement) for all Army rotary and fixed wing aircraft. • 1st percentile female to the 99th percentile male.
KPP 4. Shared Awareness/Situational Understanding	• Shall enhance the aviator SA thru an increased field of view (FOV) over the current HGU-56/P flight helmet and by providing a helmet display system. The Air SS will provide SA information via a heads-up display capability. It shall increase the crewmember's ability to more rapidly detect and process information pertaining to the status of aircraft systems, threat and friendly forces, the operating environment, and mission data.
KPP 5. Weight and Bulk Reduction	• Provide a 40% reduction in weight and bulk over the current AW system.
KSA 1. Restraint Systems	
KSA 2. Geospatial Data Exchange	

Note. KSA = Key System Attributes.

Table 6, provided by the CDD for the Air SS, gives the breakdown of the number of Air SS required by the Army for each platform.

Table 6. Total Air SS Basic of Issue Breakdown by Platform. Source: U.S. Army. (2011).

Aircraft (A/C) Type	# of A/C	# of Positions per A/C	Total # of Positions	× 1.5 or 1.85	Total # Required
AH-64 series	670	2	1,340	1.5	2,010
CH-47 series (front)	441	2	882	1.5	1,323
CH-47 series (rear)	441	3	1,323	1.85	2,448
OH-58D	341	2	682	1.5	1,023
UH-60 series (front)	1,908	2	3,816	1.5	5,724
UH-60 series (rear)	1,908	2	3,816	1.85	7,060
UH-72 series	255	3	765	1.5	1,148
UH-72 series (Medevac series)	90	4	180	1.5	270
AH/MH-6	46	2	138	1.5	207
C-12	130	2	260	1.5	390
RC-12	48	2	96	1.5	144
UC-35	28	2	56	1.5	84
EO-5	8	6	48	1.5	72
C-23	45	4	180	1.5	270
				Total Air SS Required	22,173

The total cost allotted to the Air SS program was constrained to $1.36 billion (Army procurement appropriations) and $116.4 million for research, development, testing, and evaluation (RDT&E) for FY2013–FY2023 in FY2011 dollars (U.S. Army, 2011, p. D-2). In conducting the cost–benefit analysis, the Army compared four alternative courses of action (COAs) to compare to the base case (COA 1), which does not address the capability gaps of the Air Warrior. COA 2 utilizes a minimal implementation approach that fulfills 40% of the Air Warrior capability gaps. COA's 3 and 4 fulfill 50 and 75 respectively, leading to additional costs. COA 5 was a hybrid approach that only met 70 percent of the capability desires but more cost effective than COA 4. They compared the COAs by rating them on a scale from 1 to 5 in three separate categories, including Life-Cycle Cost Estimate (LCCE) rating, gap mitigation, and technical scores.

Total Capability Score = System LCCE rating + Gap Mitigation Rating + Technical Score

The findings were that the COA containing a hybrid approach was the preferred alternative. These findings are described in the CDD:

- Meets cost target and affordability
- Acceptable technology risk
- Mitigates only 8% less gap risk than optimal, but at 24% less cost
- No impact on CDD
- Will require only minimal re-scoping of materiel developer's approach. (U.S. Army, 2011, p. D-16)

This information is important for the study because it provides an insight of considerations taken into account when the Army acquires their vests. See Table 7 for a breakdown of the Air SS life-cycle costs under the hybrid COA.

Table 7. COA 5: Life-Cycle Costs. Source: U.S. Army. (2011).

Air Soldier – Hybrid Implementation		
Base Year FY2011	Objective	Threshold
Total RDT&E (FY2011–FY2020)	$107,772	$118,549
Total Procurement (FY2012–FY2023)	$1,347,357	$1,482,092
Total Military Personnel	$0	$0
MILCON	$0	$0
Total O&M	$1,325,100	$1,457,610

Air Soldier – Hybrid Implementation		
Total Life Cycle FY2011 ($K)	**$2,780,229**	**$3,058,251**

D. NAVAIR AIRCREW ENDURANCE SURVIVAL VEST

The Aircrew Endurance (AE) Survival Vest is used by the Navy and Marine Corps aircrew who operate multiple tilt-rotor and rotary wing aircraft as depicted in Figure 7. The AE Survival Vest replaced the legacy AIRSAVE survival vest: "AE Survival Vest attained initial operational capability (IOC) November 27, 2013" (Naval Air Systems Command [NAVAIR], 2013). The purpose of the AE Survival Vest was to improve the vest integration and functionality with the aircrew: "The AE Survival Vest was designed to increase mobility for the aircrew, decrease the load carried and decrease the musculoskeletal strain" (Perryman, 2010, p. 1). Since the Marine Corps and Navy operate in the littoral regions of the world, the vest is configured to carry a flotation device and underwater breathing device: "The AE mobile aircrew vest weighs 29.6 pounds and the AE seated version 19.5 pounds—about 7 pounds lighter than legacy AIRSAVE survival vests" (NAVAIR, 2013). The AE Survival Vest allowed for more mobility and dexterity compared to the AIRSAVE survival vest. The vest comes in two versions, one designed for the pilot and the other version designed for the crew chiefs: "Worn over the flight suit, the vest provides protection from shrapnel and bullets. The mobile crewman configuration provides an 80-inch tether connection to the aircraft allowing crewmembers to move freely about the cabin as they carry out normal duties" (NAVAIR, 2013). The mobile aircrew configuration has a quick release to have the aircrew egress from the aircraft in an emergency. The vest is capable of carrying survival requirements such as "emergency-signaling devices, radios, medical kit, emergency underwater breathing devices and an inflatable life preserver and a harness used for hoisting the aircrew into a rescue helicopter" (NAVAIR, 2013).

Figure 7. Aircrew Wearing the AE Survival Vest. Source: NAVAIR (2013).

The Acquisition Program Baseline is presented in Table 8 and shows the performance, schedule, and cost bases.

Table 8. Acquisition Program Baseline. Source: NAVAIR (2011).

Aircrew Endurance Acquisition Program Baseline Revision of January 12, 2010		
	Objective	Threshold
Performance	1) The Aircrew Endurance system shall reduce physical stress on rotary wing aircrew when flying missions up to 6 hours in duration. 2) Hard Armor: Hard armor shall not allow full ballistic penetration after a minimum of 3 impacts (2 @ 0 degree obliquity and 1 @ 30 degree obliquity) from NATO 7.62mm M-80 ball, Soviet 7.62mm 54R ball, U.S. 5.56mm M85 ball, 7.62 APM@ (only 2 impacts). 3) Soft Armor: Ballistic body protection from 9mm small arms weapons, fragmentation, and spall.	1) The Aircrew Endurance system shall reduce physical stress on rotary wing aircrew when flying missions up to 4 hours in duration. 2) Hard Armor: same as objective. 3) Soft armor: Same as objective.
Schedule	Milestone (MS) C August 2008	MS C August 2008

Aircrew Endurance Acquisition Program Baseline Revision of January 12, 2010		
	Aircrew Mission Extender Device (AMXD) Acquisition Decision Review (ADR) October 2008	AMXD ADR October 2008
	AMXD Initial Operating Capability (IOC)* September 2009	AMXD IOC September 2009
	Vest/Armor Engineering Demonstration Model (EDM) ADR July 2010	Vest/Armor EDM ADR January 2011
	Vest/armor Milestone (MS) C / Full Rate Production (FRP) May 2011	Vest/Armor MS C/FRP November 2011
	Vest/Armor IOC** April 2012	Vest/Armor IOC** October 2012
Cost Base Year FY08$ 1,157 AMXD Units 9,118 Vest/Armor Units	Total RDT&E $6.654M Total Procurement (OPN) $30.623M AMXD Production Unit Cost $3,828 Vest/Armor Production Unit Cost $2,100	RDT&E $9.066M Procurement $29.121M AMXD Prod Unit Cost $4,211 Vest/Armor Prod Unit Cost $2,310

*IOC will be achieved when 10 systems have been fielded

**IOC will be achieved with fielding to one operational/deployable Marine Corps CH-53 squadron

Taken from the Milestone C Decision are the KPPs, KSAs and their objectives and thresholds shown in Table 9.

Table 9. AE KKPs and KSAs. Source: Capecci (2011)

KPP	**Objective**	**Threshold**
Endurance	Reduce level of physical stress on rotary wing/tilt rotor aircrew caused by heat retention from the bulk and multiple layers of existing ALSE on missions up to 6 hours duration without supplemental cooling.	Reduce level of physical stress on rotary wing/tilt rotor aircrew caused by heat retention from the bulk and multiple layers of existing ALSE on missions up to **4** hours duration without supplemental cooling.
Hard Armor	Hard armor shall meet the small arms protective requirements of the Enhanced Small Arms Protection Insert (ESAPI)	Same as objective.
Soft Armor	Soft armor shall provide ballistic protection to the torso form 9mm caliber small arms weapons and fragmentation from exploding munitions.	Same as objective.
KSA	**Objective**	**Threshold**
Armor tailorability to mission	Armor protection will be modular in design and configurable to provide mission-specific levels of protection for each crew position. Armor will be designed to minimize bulk and allow completion of all flight tasks.	Same as objective
Armor/ALSS Compatible	Armor protection will be compatible with existing approved aircrew survival equipment to include fielded cooling systems.	Same as objective
Removal of armor in water survival	Jettisoning of hard armor while wearing vest during water survival. Compatible with water survival procedures.	Non-jettisoning of hard armor while wearing vest during water survival. Compatible with water

KPP	Objective	Threshold
		survival procedures.
Universal color, camouflage with unaided eye and vision technology	External surfaces of the vest system will be a universal color and texture that is least detectable with vision enhancement technology, including night vision devices and infrared.	External surfaces of the vest system will be a universal color and texture that is least detectable by the unaided eye in the majority of global dry land terrain
Modular to allow tailoring	Vest system will be modular to allow tailoring to accommodate aircrew members in different aircraft types, threat scenarios, operational missions and worldwide natural environments.	Same as objective
Fit/Sizing	AE system shall fit the central 90% of male population, and central 90% of female population	AE system shall fit the central 90% of combined male/female population
Fire Protection	The vest system will be resistant to flash fires	Same as objective
M9 pistol holster	The vest system shall have provisions for an M9 pistol holster.	Same as objective.
Ammunition carriage	Enable aircrew to carry two two 5.56mm magazines (30 rounds per magazine).	Enable aircrew to carry two 9mm magazines (15 rounds per magazine).
Survival equipment	The vest system will provide the capability to carry required and optional survival equipment. The vest will provide the capability to mount life support equipment as currently provided by the AIRSAVE vest.	Same as objective.
Hydration compatible	The vest will provide integration with a water reservoir to provide hydration during flight.	Same as objective.
Hoisting	The vest system will incorporate a lifting system that maximizes hoisting performance without sacrificing mission endurance.	Same as objective.

E. COAST GUARD SAR WARRIOR SURVIVAL VEST LPU-27

The SAR Warrior survival vest is utilized for Coast Guard rotor wing aircraft aircrew members. Figure 8 is a schematic of the Coast Guard's SAR Warrior Vest: "When worn correctly the design is sufficient to keep an aircrew member in a head back, airway open position in a moderate sea-state whether conscious or unconscious" (United States Coast Guard [USCG], 2011, p. 2-28). Due to the operational requirements of the Coast Guard, armor plates are not required: "The weight of the LPU-27/PE is 12.5 pounds including equipment and provides 65 pounds of buoyancy" (USCG, 2011, p. 2-28).

> The LPU is built in three main assemblies: the carrier vest assembly, the flotation collar assembly, and the survival equipment. The carrier vest assembly is the central assembly of the LPU and comes in one size fits all. The flotation collar assembly has three subassemblies: flotation bladder, flotation casing, and holster. The LPU-27PE flotation bladder is a dual-chamber bladder. The upper and lower chambers of the bladder are inflated mechanically through CO2 inflation assemblies. (USCG, 2011, p. 2-29)

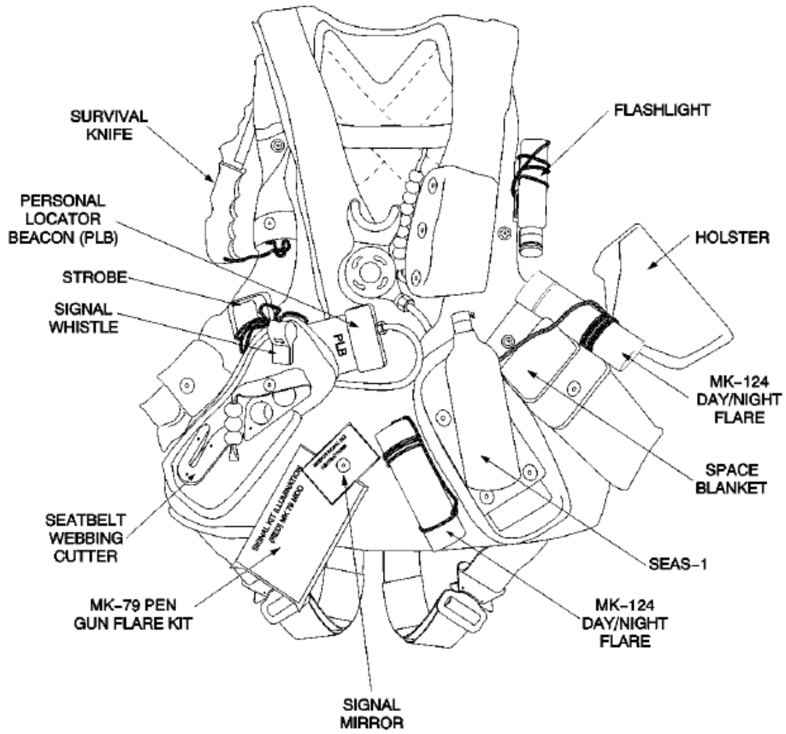


Figure 8. LPU-27 SAR Warrior Survivor Vest. Source: USCG (2011).

According to market research that the Coast Guard was conducting on SAM.gov in 2015, the Coast Guard was looking for a vendor that can provide the SAR Warrior Aircrew Flotation Vest. The average unit cost for the vest was pulled from an email from the Coast Guard PM. Table 10 presents the SAR Warrior Aircrew Flotation Vest requirements and unit cost.

Table 10. Coast Guard SAR Warrior Vest Requirements and Cost. Source: SAM.gov (2015) and D. Mosler (email to author, May 12, 2022).

Coast Guard SAR Warrior Vest Fixed and Rotary Requirements
1. The vest shall be compatible with current flight ensemble for SAR, including Airborne Use of Force (AUF) missions requiring holsters, ammunition, and body armor. The U.S. Coast Guard (USCG) flight apparel consists of an aircrew dry coverall worn with insulating layers, SPH flight helmet and summer and winter weight flight gloves.
2. The vests shall have a built-in hoisting harnesses, including leg straps and hoisting loops compatible with current hoisting equipment and hook (NSN: 1680–01-HS1 7762) installed on both Breeze Eastern and Goodrich (UTS) hoists.
3. All vest chassis material and webbing shall be fire retardant to the commercial standard MVSS 302.
4. The vests shall provide Modular Lightweight Load-Carrying Equipment (MOLLE) mounting system for survival item storage pockets, allowing replacement of worn pockets. The pocket storage shall allow for the following survival items: • Aqua Lung SEA Emergency Breathing System • ACR 406 Beacon • ACR Firefly Strobe • MK – 129 Day / Night Flare • MK-80 Pencil Flare Kit • Signal Mirror • Signal Whistle • Aircrew Folding Knife NOTE: Some items may be combined with other items in pockets, with the exception of the Self-Contained Emergency Air System (SEAS).
5. The vest shall provide a means of mounting an aircrew tether / restraint device directly to the vest chassis, negating the need for the current gunners belt used by USCG aircrew. A tethering device shall be offered as a separate add-on kit meeting the following requirements: • Tether mounting point on upper back between shoulder blades (most desired to minimize injury if the member falls). • Two step quick release handle system with the ability to be installed on the front side of the vest, in an easily accessible location in case of an emergency. • Tethering system shall be rated by the manufacturer at a minimum of a 3,000-lb break load and a 300-lb operational load with a safety factor of 10.
6. The vest shall include a flotation collar design that will significantly reduce or eliminate flotation collar profile above the wearer's shoulders. The collar cannot contact the aircrew helmet (HGU-56P or SPH-5CG GENTEX Helmet models).

Coast Guard SAR Warrior Vest Fixed and Rotary Requirements
7. The flotation collar shall be protected by a cover made of fire-retardant material and secured by a quick burst zipper. The vest hook and pile (Velcro closure) is the least desired cover closure method.
8. The flotation bladder shall be a two-cell design with flotation cells arranged front to back and meeting the following requirements: • Inflation of the primary cell will be by means of a CO2 cartridge inflator with oral inflation valve provided in case of emergency. • Inflation of secondary cell will be by means of oral inflation valve. • Primary and secondary cell oral inflation tubes will be differentiated by color: black for the primary cell, and red for the secondary cell. • Bladder shall provide a minimum of 35 lb of buoyancy when inflated via CO2 cylinder or oral inflation. • Bladder shall provide a flotation angle of no more than a 60-degree angle between the body vertical axis and horizontal axis, keeping the survivor in a face-up position. • Bladder, mounted on vest with all pockets and survival items, will self-right unconscious survivor in 5 seconds or less. • Bladder shall inflate to design shape within 10 seconds of actuation.
9. The USCG prefers a weight of approximately 6.8 lb or less. (The approximate weight of the current system is 6.8 lb, without added survival equipment.)
10. Vest chassis shall be a “one size fits most” vest with a maximum of three adjustment points (not including leg straps) to provide a snug fit.
11. The desired vest color range is dark (midnight) blue to black. Specific color types will be evaluated for color compatibility with current USCG color schemes.
12. Fixed wing vest additional requirements: The vest shall have built-in leg straps to aid in body positioning when the bladder is inflated.
13. Unit cost will be $900.

F. AIRCREW INTEGRATED RECOVERY SURVIVAL ARMOR VEST AND EQUIPMENT

The Air Force currently utilizes AIRSAVE for their fixed wing aircrew. The AIRSAVE was initially used by the Navy and later adopted by the Air Force to replace its two survival vest variants. Figure 9 depicts the AIRSAVE used by the Air Force. After conducting flight tests, “The AIRSAVE is operationally effective for A-10, B-1, B-2, B-52, F-15C/E, F-16 (Block40/50), and F-22; and operationally suitable with limitations for this same list of aircraft” (Vanherck, 2016, p. 2). The AIRSAVE allows for modularity and flexibility to enable customization among various aircrew and aircraft.

> The vest incorporates a MOLLE system allowing for a variety of pockets positions and has three adjustments for better fit. This reduces bulk in the cockpit, creating less interference with controls and allowing better visibility of displays. The weight of the vest is distributed around the waist instead of hanging on shoulders. The four inner pockets are designed to hold the majority of survival components, only the radio, spare batteries, and weapons are attached to the outside of the vest. (Mosle, 2016, p. 1)

The AIRSAVE survival vest is procured either by the Air Force or Defense Logistics Agency (DLA) by solicitating bids from industry: “The unit cost for an AIRSAVE is $400” (C. Tobin, email to author, May 17, 2022). According to the synopsis/pre-solicitation notice from the DLA, “This acquisition is for the manufacture and delivery of the AirSave Survival Vest, Type I & Type II. This acquisition will be issued as a total small business set aside. All material shall be contractor furnished” (SAM.gov, 2022). There are multiple contract opportunities on SAM.gov where the government intends to award a sole source. According to SAM.gov, “This purchase will be made under Simplified Acquisition Procedures as authorized by FAR 13.106-1(b)(1). Due to AFI 11–301 V2, this is the only equipment allowed to be used in the F-15E” (SAM.gov, 2020).

Figure 9. AIRSAVE. Source: Mosle (2016).

The Air Force and DLA post solicitations with detailed specifications on SAM.gov for AIRSAVE. Table 11 summarizes the Air Force's requirements for the AIRSAVE from the purchase description. The unit cost was obtained from a personal email with the DLA.

Table 11. USAF AIRSAVE Requirements. Source: SAM.gov (2014) and C. Tobin (email to author, May 17, 2022).

USAF Purchase Description Vest, AIRSAVE	
Classification	The vest shall be of one type in one size with two expansion panels in order to fit all size aircrew, in all conditions.
Intended use	The vest covered by this specification is intended to be worn as part of the Air Force AIRSAVE system for military aircrewmen. It is intended to provide a modular pocket system and a platform for both soft and hard body armor.
Accessories. These items shall be available for separate/individual purchase.	1. Expansion Panel, 1 Modular Lightweight Load-Carrying Equipment (MOLLE) - Small 2. Expansion Panel, 2 MOLLE - Large 3. Pocket, General - Small 4. Pocket, General - Large 5. Pocket, Radio 6. Horizontal Mounting Panel 7. Crew Regulator Unit/Joint Helmet Mounted Cueing System (CRU/JHMCS) Attachment

USAF Purchase Description Vest, AIRSAVE	
	8. Helmet Mounted Integrated Targeting System (HMIT) Attachment
Vest	The mesh vest shall have four sewn-in inside expandable pockets and various modular removable pockets (General Pocket, Large; General Pocket, Small; and Radio Pocket) and optional components (Horizontal Mounting Panel, CRU/JHMCS, and HMIT Attachment). The modular removable pockets shall be unattached when delivered. The vest shall be adjustable under each arm and in the back by reeving together overlapping vest panels. For additional adjustability, the Expansion Panel may be added to the vest's front.
Unit Cost	$400

G. PROGRAM'S REQUIREMENTS COMPARISON

The requirements from the four KPPs above were compared to gauge what requirements are important to each of the Service's programs. This comparison demonstrates the requirements that are similar and the gaps between the different programs. This information will guide the analysis section in determining which requirements will be necessary in a joint vest program and will dictate sacrifices that individual Services would need to make to support a joint program.

Table 12 compares the common requirements from the KPPs of the current survival vest programs that were deemed the most important. The "x" represents that the program's KPP has the respective requirement listed.

Table 12. Service Requirement Comparison

Requirements / Service	Modularity	Size fits majority of aircrew	Design Freedom	Ballistic Protection	Flotation	Light Weight
Air Force	x	x				
Army	x	x		x		x
Coast Guard	x	x	x		x	x
Navy/Marine Corps	x	x	x	x	x	x

H. COMMERCIAL OFF-THE-SHELF ITEMS

In the JCIDS process after the capability gap assessment determines a gap, then the DOTMLPF assessment determines the need for a materiel solution, then the first choice before a development program is COTS. Acquiring items commercially is an option available to the government and is part of the market research process as depicted in

Figure 10.

- COTS items means any item of supply (including construction material) that is
    - A commercial item (Item that can be sold, leased, or licensed to the general public);
    - Sold in substantial quantities in the commercial marketplace; and
    - Offered to the Government, under a contract or subcontract at any tier, without modification, in the same form in which it is sold in the commercial marketplace (R. Mortlock, PowerPoint slides, 2021)

Commercially available items reduce risk with respect to performance, cost, and schedule: "The head of the agency shall acquire commercial products, commercial services, or non-developmental items when they are available to meet the needs of the agency" (FAR 12.1, 2022). The advantages of COTS are quicker acquisition of the product, mature technology, and lower life-cycle cost due to the availability commercially. The disadvantages of COTS are "reduction of quality, effectiveness, environment, safety, reliability, and durability, the vendors can embed proprietary functions into COTS products, limiting supply sources, vendors do not have to provide design information, licensing agreements vary and can be very restrictive" (R. Mortlock, PowerPoint slides, 2021). Figure 10 displays the procurement process of COTS.

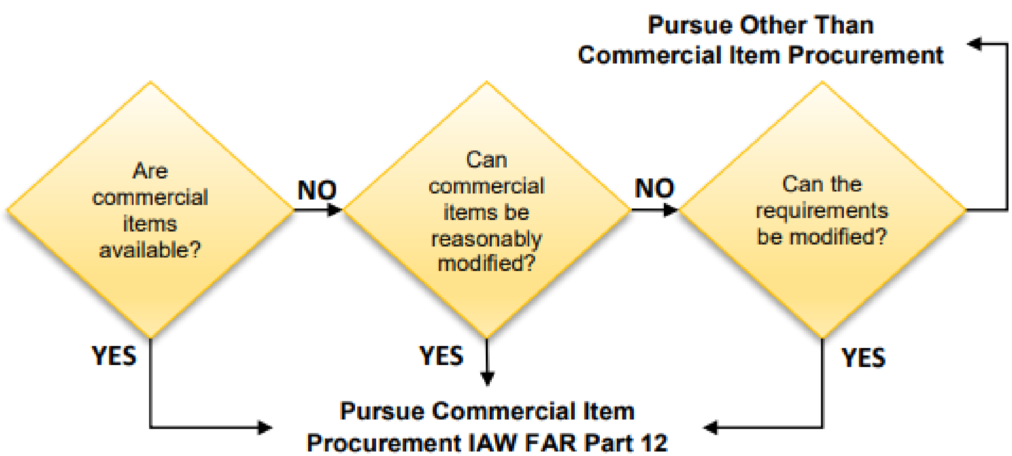


Figure 10. Market Research. Source: R. Mortlock (PowerPoint slides 2021).

I. JOINT PROGRAM MANAGEMENT

The DoD has been utilizing joint acquisition programs to reform the traditional acquisition program. The Defense Acquisition University's (DAU's) *Joint Program Management Handbook* defines joint PM as "any defense acquisition system, subsystem, component, or technology program that involves formal management or funding by more than one DoD Component during any phase of a system's life cycle" (DAU, 2004, p. 1). Examples of joint programs include the "Joint Tactical Unmanned Aerial Vehicle (JTUAV), Joint Lethal Strike (JLS), V22 Osprey, Joint Surveillance Target Attack Radar System (JSTARS), Joint Tactical Radio System (JTRS), and the Joint Strike Fighter" (DAU, 2004, p. 3). The DoD's reasoning for utilizing joint programs includes the following:

- Provide a new joint warfighting capability;
- Improve component interoperability and reduce duplication among the components;
- Reduce development and production costs;
- Meet similar multi-Service requirements; and
- Reduce logistics requirements through standardization (DAU, 2004, p. 2)

The structure of a joint program includes a centrally managed component and other "participating" components (DAU, 2004). They all assist in managing the programs with the goal of acquiring a program that meets all stakeholder requirements. There is a joint PM assigned that is responsible for maintaining documentation, managing RDT&E and the funds involved, performing milestone reviews, reporting to the DoD acquisition chain, and coordinating with the participating components (DAU, 2004).

The DoD recognizes that joint program management comes with its issues—one being that communications are difficult due to the nature of having multiple Services working on a single program. Maintaining a smaller team has been proven to benefit the program. Funding joint programs also brings complications. Since one central component is responsible for sourcing the funding, any other components would be liable for costs even if they desire to withdraw from the program. This policy is in place to limit costs and schedule risks. Having different Services under a single program is difficult to manage because of differing requirements and political dynamics.

This chapter provides context needed to understand the scope of the research. We have defined and explained certain aspects relevant to the study, including Big "A" acquisition, APB, COTS, and joint program management. We have also introduced and provided information regarding costs, schedules, and performance metrics for the four different survival vests we are analyzing. This information will be used in further chapters to compare and contrast the four programs and to make a recommendation based on the feasibility of a joint survival vest program. The next chapter provides a synopsis on several literatures that were reviewed to gather a greater understanding of research done in the past relevant to joint programs.

III. LITERATURE REVIEW

The reports that follow were chosen to ensure the reader has a full understanding of previous research pertaining to seeking commonality in defense acquisitions programs by government and nongovernment organizations. The prominent organizations featured in this section are the Research and Development (RAND) Corporation and the Naval Postgraduate School (NPS), as well as an industry journal organization known as *CrossTalk: The Journal of Defense Software Engineering* and the Center for New American Security (CNAS). The RAND Corporation is a "research organization that develops solutions to public policy challenges to help make communities throughout the world safer and more secure, healthier, and more prosperous. RAND is nonprofit, nonpartisan, and committed to the public interest" (RAND Corporation, n.d.). The RAND Corporation has researched the DoD, national security, and military acquisitions and procurement. NPS provides graduate-level training to mid-grade officers in various defense topics, including acquisitions.

A. THE RAND CORPORATION

In 2011, the RAND Corporation released a research brief called *The Advantages and Disadvantages of Seeking Commonality in Military Equipment* "to help the Army determine how to more effectively incorporate the full range of commonality considerations in weapon system development and acquisition" (Leuschner, 2011, p. 1). The DoD and the Army have increased acquisition programs based on common components such as the Army Stryker armored combat vehicles: "Commonality can increase operational flexibility and reduce procurement, logistical, and training costs and burdens. However, commonality can also decrease design freedom and occasionally negatively affect operational capability by forcing design compromises to accomplish multiple missions" (Leuschner, 2011, p. 1). Commonality can increase cost due to overly complex design to satisfy the requirements of several variants. Another negative aspect of commonality is that "some variants end up with excessive functionality" (Leuschner, 2011, p. 1). Excessive functionality adds to the cost and inflexibility of the end user.

The article discussed four types of commonalities: hybrid, modular, family, and differentiated: “A hybrid approach combines multiple capabilities that are normally separated into a single system” (Leuschner, 2011, p. 1). Hybrid enables flexibility, but the report noted the cost of additional weighted and degraded capabilities. A modular system “allows functions to be exchanged within one system” (Leuschner, 2011, p. 1). The modular system enables the removal of unnecessary modules for missions that do not require it. This system is suitable for missions with predictable operational tempo and lead time switching modules. A family refers to a “group of systems that share a platform” (Leuschner, 2011, p. 1). A family makes sense logistically but can result in sacrifices for mission success for the sake of commonality. A differentiated system is “distinguished by its unique platform, components, and capabilities in pursuit of specialization” (Leuschner, 2011, p. 1).

Typically, more significant commonality can decrease the cost, but RAND’s research showed that it could have the opposite effect: “Depending upon how it is implemented and the specific applications, commonality can also increase costs” (Leuschner, 2011, p. 2). The researcher identified four areas where it could be advantageous to engage in commonality: complex and expensive items, high-demand items that have similar specifications, items that are burdensome for operations or maintenance, and logistically burdensome items: “Complex, expensive items present opportunities for reducing costs by spreading the R&D cost over multiple systems (e.g., a new family of weapon platforms like the Future Combat System)” (Leuschner, 2011, p. 2). The F-35 and the future of vertical lift are examples of complex and expensive items. According to Leuschner, “High-demand items that have similar specifications can lead to reduced costs through economies of scale, lower inventory levels, increased purchasing power, and lower order costs (e.g., certain vehicle engines, tires)” (Leuschner, 2011, p. 2). Leuschner (2011) also stated, “Items that are burdensome for operations or maintenance training should be made common to save on the training burden and personnel needs” (p. 2). Ground support equipment are commonality items that allow different aircraft types to be served from the same system: “Logistically burdensome items, such as tires, tracks, engines, and transmissions, tend to dominate bulk storage, which can be problematic given the Army’s storage constraints for mobile field warehouses" (Leuschner, 2011, p. 2). Leuschner (2011) added a caveat to the four categories of pursuing commonality by stating, "The advantages of commonality must be traded off against the Army's desire for maximum operations capability" (p. 2).

B. NAVAL POSTGRADUATE SCHOOL

NPS educates mid-grade officers from the U.S. military and its Allies on matters of national defense on a graduate program level. Hundreds of military officers graduate NPS and return to the operating forces each year with advanced degrees to deliver innovative solutions to maintain superiority in all domains of warfare: "The Naval Postgraduate School provides defense-focused graduate education, including classified studies and interdisciplinary research, to advance the operational effectiveness, technological leadership and warfighting advantage of the Naval service" (Naval Postgraduate School [NPS], n.d.).

1. The Cost of Commonality: Assessing Value in Joint Programs

In the thesis *The Cost of Commonality: Assessing Value in Joint Programs,* the researchers discussed the benefits and setbacks of commonality. Some airliners in the airline industry enjoy the benefits of commonality by flying one aircraft, such as Southwest flying the Boeing 737. The flight crews, ground crews, and maintainers only must be trained on one type of aircraft, enabling flexibility by creating a large pool of certified personnel. Flying one aircraft allows the airline to buy one kind of aircraft part that could be used interchangeably by all the aircraft: "In the military, such consolidation strategies can result in fewer necessary certifications and potentially fewer military occupational specialties needed for operators and maintainers" (Jessup & Williams, 2015, p. 7).

The cost of commonality often is realized from the complexities of major projects such as the Joint Strike Fighter (JSF): "The DoD is pursuing joint solutions with perhaps insufficient insight into the associated risks of these complexities" (Jessup & Williams, 2015, p. 7). The JSF was one solution for all the branches but has been criticized due to the schedule delays and cost overruns, but Congress continued to appropriate funding for the program.

> Military services are independent stakeholders who join in strategic alliance for joint programs. Thus, interdependence develops among services that typically have competing goals and requirements. This creates a challenging environment for system development and program management. As a result, joint programs tend to experience higher research, development, testing, and evaluation (RDT&E) costs and extended schedules. (Jessup & Williams, 2015, p. 9)

Organizational behaviors also play a role in executing large complex programs. As the environment becomes more increasingly complex, the ability to reach peak performance decreases.

> As the number of competing goals increases, the ability of an organization to maximize need-fulfillment through a process of optimization diminishes. It is most often replaced with satisficing—a solution that permits the satisfaction of all needs at a minimum specified level. (Jessup & Williams, 2015, p. 9)

In this case, commonality takes precedence for operational effectiveness for the stakeholder or specific branch, and as commonality increases, the benefits for the users tend to decrease.

> Such networks generate considerable risk in the value chain as parochial interests create incentives for opportunistic behavior at the expense of collective optimization. The associated transaction costs and suboptimal performance can have dramatic adverse effects. These conditions often lead to divergence over time, in which the commonality of original designs, and thus the intended benefit, is diluted. Where achieved, commonality benefits can be further offset by the reduced utility of non-specialized products. (Jessup & Williams, 2015, p. 12)

The authors performed case studies on three joint programs: the Tactical Fighter, Experimental; JSF; and the JTRS: "Secretary of Defense Robert McNamara's Tactical Fighter, Experimental (TFX) program demonstrates acutely the challenges of pursuing joint commonality" (Jessup & Williams, 2015, p. 12). TFX was a foreshadowing of potential issues for future joint programs.

Jessup & Williams (2015) stated, "In 1961, initial optimism fostered a common goal of one aircraft to meet the requirements of all four Services. Within 5 months, the

DoD narrowed the program's scope to include only Air Force and Navy specifications" (Jessup & Williams, 2015, p. 12). Eventually, the secretary of defense (SECDEF) gave guidance for commonality, focusing on Air Force requirements: "As a result, the Air Force eventually procured 562 of the initially anticipated 1,762 aircraft while the Navy program was canceled due to an inability to meet user requirements" (Jessup & Williams, 2015, p. 13). The cancellation of the program cost the taxpayers millions of dollars, "estimated at $400 million in FY1969 dollars, or $2.6 billion in FY2015 dollars" (Jessup & Williams, 2015, p. 13). The failures of achieving commonality in the TFX were felt years after the program's inception: "Each service developed unique platforms, and the residual lack of commonality in the joint environment perpetuated operational inefficiencies" (Jessup & Williams, 2015, p. 13). The failure to achieve commonality in the TFX resulted in a lack of common parts and a reduction in operational effectiveness by trading commonality for an effective weapons system: "Congressional investigations of the TFX contract later revealed that the Air Force received a compromised and dramatically less capable system in the F-111A than if an independent program had been pursued from the outset" (Jessup & Williams, 2015, p. 13). Throughout the development of the TFX, the program began to diverge into two smaller programs with a focus on Air Force requirements until the Navy canceled the program.

> When the commonality of parts falls below a specified threshold, the systems are no longer common. The program is then de-scoped and partitioned into multiple programs. The earlier in the life cycle this decision can be made, the greater the costs savings to the program and the broader portfolio. (Jessup & Williams, 2015, p. 13)

The JSF is another MDAP that suffered from divergence. The goal of the JSF is to "develop and field an affordable, highly common family of next-generation strike aircraft for the United States Navy, Air Force, Marine Corps, and allies" (Jessup & Williams, 2015, p. 13). With three branches of the military, along with Allied nations', cost savings were expected due to flying the same airframe along with a massive worldwide logistical chain to support the aircraft around the world: "The JSF has become the most expensive and ambitious DoD acquisition program in history with an estimated acquisition costs of nearly $400 billion" (Jessup & Williams, 2015, p. 14). The commonality for the F-35 increased cost due to the needs of the different variants for the three branches.

> Much of the cost increases have come through a differentiation of technology needs for the three variants, such as the United States Marine Corps (USMC) requirement for short take-off and vertical landing (STOVL) and the individual software requirements to support all variants. (Jessup & Williams, 2015, p. 14)

The STOVL requirement from the Marine Corps put the F-35 at risk if this technology maintains commonality with the other variants due to the significant modifications required: "Concerned about the resulting program risk, the Secretary of Defense placed the STOVL variant on a two-year probation and decoupled the program variants in 2011" (Jessup & Williams, 2015, p. 15). The decoupling of the STOVL led to the Marine Corps variant success but increased cost and schedule delays. "The required modifications, however, ultimately correspond to a decrease in commonality among the variants and a significant increase in the complexity of the USMC variant" (Jessup & Williams, 2015, p. 14).

The JTRS was the third case study the researchers discussed: "[JTRS] Ground Mobile Radio program was intended to provide a radio that would be interoperable with both advanced networking and legacy waveforms to support operations in an Internet-like environment for battle command, sensor-to-shooter, and survivability applications" (Jessup & Williams, 2015, p. 15). The number of stakeholders in this program was tremendous, and they ranged from the different Services, the different systems, and the different contractors: "The requirement existed for overall integration of capabilities and products from Boeing, Northrup Grumman, Rockwell Collins, BAE Systems, Harris Communications, General Dynamics, and Thales Communication" (Jessup & Williams, 2015, p. 15). These factors added the complexity of attempting a program with commonality to meet the requirements of all the Services: "Acting Undersecretary Frank Kendall canceled the program in 2011 due to 'inadequate affordability analysis at inception' and 'the technical challenges of mobile ad hoc networks and scalability" (Jessup & Williams, 2015, p. 16).

The researchers concluded, “Current military CBAs and other DoD analyses fail to account for inherent complexity risks, which often diminish or outweigh the economic and operational benefits of commonality in joint programs” (Jessup & Williams, 2015, p. 33). Failure to account for complexity risk can lead to a cascading effect of increased cost, schedule delays, and reduced capability to the warfighter: “This cost of commonality, when overlooked, leads to suboptimal program solutions with detrimental effects on cost, schedule, and performance parameters” (Jessup & Williams, 2015, p. 33).

2. The Joint Program Dilemma: Analyzing the Pervasive Role that Social Dilemmas Play in Undermining Acquisition Success

In the thesis *The Joint Program Dilemma: Analyzing the Pervasive Role that Social Dilemmas Play in Undermining Acquisition Success,* the authors highlighted the social trap known as “Tragedy of the Commons.” They explained the social dilemma as when “an individual desires a benefit to himself that will cost everyone else—but if all in the group succumb to the same temptation, then everyone is worse off” (Cohen et al., 2013, p. 102). Using this description in the context of a joint program, the researchers use the following explanation:

> The stakeholder programs that depend on a joint system may be skeptical, fearing the needed capability will neither meet their needs, nor be delivered as promised. Stakeholders pressure the Joint Program Office (JPO) to accommodate individual requirements, and the JPO may reluctantly agree, driving up cost, schedule, complexity, and risk—thus realizing the stakeholders’ worst fears. These performance issues encourage stakeholders to leave the joint program, potentially rendering it both operationally unattractive and financially infeasible. (Cohen et al., 2013, p. 100)

This research utilizes a casual loop diagram (CLD) to obtain an understanding of the dilemma by conducting independent technical assessments and consulting various joint programs. The CLD has refined the theory of the dilemma through multiple workshops containing both joint-program experts and decision-makers. The data gathered in this diagram are further implemented into a system dynamics model to help validate it. With the guidance of this model, mitigations to the dilemma can be explored through different approaches (Cohen et al., 2013). The authors recognized the intention of joint programs is centered on "(1) reducing costs by developing one system as opposed to several differing ones and (2) improving interoperability by providing a single system or capability that can be used for multiple purposes in multiple contexts" (Cohen et al. 2013, p. 101). However, their intuition is that joint programs are not efficient and use the CLD to exploit the deficiencies.

The results of the model indicated four main reasons for the diminishing results of joint programs. The first influence was "complexity-induced rework" (Cohen et al., 2013, p. 113). This implies that the various custom requirements developed by program stakeholders lead to increased defects and decrease efficiency in development. Another primary cause is the "JPO staffing effects on program execution" (Cohen et al., 2013, p. 113). There is a shortage of JPO staff, which has led to less responsiveness to demands of developers. This lack of response results in a decrease in productivity. This shortage has also resulted in shortcuts taken in review processes leading to additional rework. The third finding was "pressure-induced rework" (Cohen et al., 2013, p. 113). The timeline for joint programs is beyond the capability of many of these programs. These joint programs are pressured to work on a compressed schedule, which in turn leads to shortcuts being taken by management in quality control. These shortcuts result in rework. The final reason given for diminishing returns is "pressure-induced attrition" (Cohen et al., 2013, p. 114). The pressure applied on workers by compressed schedules has led to lower retention rates. People leaving the workforce slows down productivity.

This research organizes possible solutions to the "Tragedy of the Commons" by three classes: motivational, strategic, and structural (Cohen et al., 2013). Implementing motivational and strategic changes may be simple but does not have as much of an effect as structural policies. The first approach suggested is *altruistic punishment.* This approach entails punishing stakeholders who would like to withdraw from a joint program. They would still incur further costs despite exiting the program. This will instill motivation for stakeholders to stick with a program, which would decrease the amount of schedule extensions and additional costs from setbacks of those pulling out. A strategic approach that the research recommends is to incentivize those in the joint program. The researchers believe a reward system within the program would be beneficial but do not provide any tangible examples. This research proposes these broad mitigation ideas without offering specific examples of policies that can be implemented to improve the execution of joint programs.

3. Joint Primary Aircraft Training System Program

An additional NPS thesis reviewed was *Acquisition and the Joint Primary Aircraft Training System (JPATS) Program* by Kenneth W. McKinley. This research took the form of a case study and examined the results of the acquisition reform regarding program effectiveness, cost, schedule, and performance (McKinley, 2000). The JPATS is a joint Navy and Air Force ACAT IC program that was designed to replace the outdated Air Force's T-37B and Navy's T-34C, which were used as training aircraft for Air Force and Navy pilot students. The existing T-37B and T-34C did not meet the progressing requirements. It was deemed that their training effectiveness, safety, performance/design, and supportability of the existing system was no longer acceptable and did not meet Air Force and Navy requirements.

The JPATS's T-6A Texan II was designed to meet both Air Force and Navy requirements as the new training aircraft. Along with the contractor containing the capacity to meet the proper requirements, the two highest priorities that determined the source selection were proposals that displayed the lowest developmental risk and lowest total cost. The success of the JPATS program reform was measured based on the following 11 metrics: regulatory and statutory relief, Request for Proposal (RFP) preparation and content, ground-based training acquisition impacts, program office manning levels, contract administration services impacts, baseline cost metrics, program costs comparison, program funding stability, would cost analysis, earned value reporting system versus cost/schedule control systems criteria, and contractor team composition (McKinley, 2000). These metrics were used to compare the JPATS program to baseline aircraft procurement programs. The results would measure the relative cost effectiveness of the reform.

The results of the JPATS program demonstrated that the reform only benefited two of the 11 metrics. The first metric that was successful was the administration services impact. Management was cut by 25,872 hours (McKinley, 2000, p. 59). Efficient use of integrated management proved that less government oversight was needed and would lead to less costs. The other metric that proved successful was the earned value management system (EVMS). There was a reduction of 11,448 hours, demonstrating that there are benefits with applying commercial practices (McKinley, 2000, p. 67). Utilizing EVMS allows for "enhanced management visibility and control of cost/schedule performance while eliminating non-value added, detailed reporting" (McKinley, 2000, p. 67). The remaining nine metrics did not have the success that JPATS anticipated under the reform.

McKinley (2000) pointed out various flaws in joint programs that most likely led to certain metrics not being met. Joint programs are aimed to streamline the acquisition process for stakeholders that require similar products. However, because of the different management structures between the Navy and Air Force, there are different processes and requirements between them, which has led to funding and prioritization issues. The different requirements between the two also risk the possibility of aircraft with different configurations (McKinley, 2000). McKinley (2000) argued that it takes more than a streamlined procurement process to make the acquisition more efficient. It requires Service specific procedures to be more lenient to dissolve the boundaries that are restricting the potential efficiencies that joint programs were designed to provide. One suggested way to reduce excess efforts and program costs due to specific Service requirements is to utilize single process initiatives to remove redundancies.

C. *CROSSTALK: THE JOURNAL OF DEFENSE SOFTWARE ENGINEERING*

The 2007 journal article titled "The Acquisition of Joint Programs: The Implications of Interdependencies" detailed factors that indicate whether joint programs have a substantial impact on the Big "A" acquisition process (i.e., cost, schedule overruns) versus single-Service programs (Brown et al., 2007). Utilizing data from 84 ACAT I programs (39 joint efforts and 45 single-Service efforts), with an average total program cost of $18 billion, the authors analyzed each program for occurrences of acquisition schedule and RDT&E cost breaches (Brown et al., 2007). During the analysis, the authors operated under the trend at the time of acquisition goals leaning more toward joint programs than single-Service programs, in an effort for the DoD to optimize program acquisition efforts and achieve universal or interoperable solutions to requirements common to different Services (Brown et al., 2007). However, the complex nature of the acquisition process, federal regulations, and individual Service regulations make it difficult to achieve a common acquisition strategy that also streamlines the acquisition process and saves federal tax dollars.

During their analysis, the authors utilized schedule, RDT&E breaches, and a category labeled as "other breaches" (Brown et al., 2007), which encompasses a wide variety of breaches that do not fall into the categories of schedule or RDT&E, as dependent variables in a statistical analysis (Brown et al., 2007). Their independent variables (constants) were program size (dollar value), maturity (technological maturity), stage (in the acquisition process), and status (single/joint). Utilizing the analysis of variance (ANOVA) process, the authors determined that the program status was an indicator of schedule and/or RDT&E breach (Brown et al., 2007)—meaning that, in general, joint programs encounter more schedule and RDT&E breaches than that of single-Service programs regardless of the constant variables of size, maturity, and stage.

It is suggested that some individuals in the DoD acquisitions arena criticize joint programs for taking longer than single-Service programs due to the increased complexity and requirements of unique acquisition strategies, while others see joint programs as no different than single-Service programs with respect to the Big "A" acquisition process (Brown et al., 2007). It is also explained that joint capabilities by design are interdependent. Interdependency is defined as the extent that one program or system relies on activities of another program or system for mission accomplishment, such as technical interfaces (C2), or they can be based on finances, materiel, or tasks (Brown et al., 2007). These interdependencies also come with additional costs in the form of transaction costs, which can present themselves as costs of negotiation, costs of enforcing agreements, and transfer of data or capital and in the form of additional labor costs as necessary (Brown et al., 2007).

Diving a little deeper into their analysis, the authors also determined that for the programs that displayed a schedule breach, the average schedule slip lasted 57 months, and the average cost of the schedule breach was $1.8 billion (Brown et al., 2007, p. 23). This is a significant indicator that joint programs may be more costly in terms of funding and time than single-Service programs. However, this study does not indicate whether the cost of schedule or RDT&E breaches outweighs the benefits of joint programs that are developed to satisfy the requirements of multiple Services and/or agencies within the DoD while achieving necessary interdependencies and limiting redundancy in the acquisition process.

D. CENTER FOR NEW AMERICAN SECURITY

In 2019, CNAS published a report discussing the need for optimization within the Big "A" acquisition system to streamline decision-making processes and stay ahead with respect to great power competition (Blume & Parrish, 2019). The authors summarized and shed some light on the Big "A" acquisition process that will aid in understanding some of the complexity inherent in DoD acquisitions, including joint acquisition programs. The Big "A" acquisition process contains three subprocesses within that must be followed for MDAPs from requirement generation through system disposition; these subprocesses are known as the JCIDS, the PPBE process, and the acquisition process (known as little "a" acquisition; Blume & Parrish, 2019).

The JCIDS, also known as the requirements process, is used for determining what the DoD will buy and is the first step in military capability development (Blume & Parrish, 2019). It enables combatant commands to push new joint requirements instead of depending on individual Services to do so. This is done by publishing an annual integrated priority list (IPL) or joint capabilities gap assessment (CGA; Blume & Parrish, 2019), or it can also be done through joint operational planners. Individual Services and defense agencies can push requirements as well through the JCIDS for validation or to introduce new product technology (Blume & Parrish, 2019). Once the requirement is initiated into the JCIDS process, the Joint Staff J8 compiles the requirements data into portfolios and initiates a review process, with the JROC chair being the key decision-maker regarding the requirements as valid or not valid, then generates required capabilities documents (Blume & Parrish, 2019). The requirement is then initiated into the PPBE process, if designated as urgent or emergent; then it will be assigned a higher priority for JCIDS and acquisition processes (Blume & Parrish, 2019).

The PPBE process is the next step in Big “A” acquisitions. This is where the DoD decides how much of the validated requirements resulting from the JCIDS process it will purchase (Blume & Parrish, 2019). PPBE entails

- the SECDEF providing annual guidance on what is required for each Service’s Future Years Defense Program (FYDP) 5-year plan, known as the Defense Planning Guidance (DPG; Blume & Parrish, 2019);
- each Service building their Program Objective Memorandum (POM), detailing their requirements;
- the Office of the Secretary of Defense (OSD) reviewing each POM and the SECDEF deciding which requirements are valid for budget submission, followed by each Service submitting their budget estimates;
- the OSD forwarding the submission to the White House Office of Management and Budget (OMB) for review; and
- the President submitting their budget request to Congress, which in turn passes authorization and appropriations for each requirement as bills that are subsequently signed into law by the president (Blume & Parrish, 2019).

This process on average takes between 1.5 to 2 years after the JCIDS process validates the requirements (Blume & Parrish, 2019). This lengthy process makes it difficult to make program changes in response to changing threats or technological advancements, which can result in programs that become obsolete before they are even fielded to the warfighter.

Finally, the requirement, once validated by JCIDS and assigned an authorization and appropriation by Congress, then enters the acquisition process, where the DoD will determine how the DoD will purchase a requirement (what type of contract [s]) and from whom (which government contractor [s]; Blume & Parrish, 2019). This process follows several milestones to completion: Milestones A through C (Blume & Parrish, 2019). Milestone A entails technology development and risk reduction; if the technology exists then it will entail maturation of the required technology until it is proven capable of use by the required system (Blume & Parrish, 2019). Next, additional funding is allocated for movement into Milestone B. This milestone entails determining the engineering and manufacturing requirements necessary and developing any infrastructure required to build the required system (Blume & Parrish, 2019). This phase also includes narrowing down the number of contractors, if more than one is being utilized, to the select few that will continue through production and sustainment (Blume & Parrish, 2019). Milestone C is the production phase. Upon production completion, the system is fielded to requiring services and/or units for use by the warfighter (Blume & Parrish, 2019). This milestone also includes life-cycle sustainment and system disposition once it has reached the end of its lifespan (Blume & Parrish, 2019). Overall, the Big "A" acquisition process can be very intricate and costly and can take years to complete—that is, if the acquisition is not canceled or started over due to changing requirements or significant schedule delays.

This literature review provides context for research previously completed that allows for an understanding of the issues and benefits related to joint acquisitions. Many of the previous studies suggest that there are many complications involved in joint acquisition management. While in theory joint management should streamline the process of some acquisitions, studies suggest that they only lead to further inefficiencies. We use the results of our analysis of survival vests in the next chapter to validate information provided in this literature review.

IV. ANALYSIS

A cost-effectiveness analysis was conducted to capture and compare the criteria between a joint-driven aircrew survival vest and a Service-driven aircrew survival vest for each of the Air Force, Army, Coast Guard, and Navy/Marine Corps. The criteria were selected from the RAND article *The Cost of Commonality: Assessing Value in Joint Programs* (Jessup & Williams, 2015), requirements from the Services, and operational experience. Each criterion was given a weighted value based on assumptions of the important requirements of procuring an aircrew survival vest. In order of most to least critical, the requirements selected are, fits the majority of the aircrew, modularity, small arms and shrapnel protection, design freedom, light weight, maritime environment, total life-cycle cost, logistics supportability, trainability, and contracting—which may lead to the leading Service of the program to favor their own Service's requirements.

A. COST-EFFECTIVENESS ANALYSIS

Cost-effectiveness analysis is a method to assist in selection of several courses of action as portrayed in Figure 11. According to a 1965 RAND report by Quade, "One of the first and most important tasks of the analyst is to attempt to discover what objectives the decisionmaker is, or should be, trying to attain through this policy, and how to measure the extent to which they are, in fact, attained" (p. 5). Different courses of action or materials are examined on how efficient they can achieve the performance parameters. In the report, Quade (1965) emphasized, "The alternatives are the means by which it is hoped the objectives can be attained" (p. 5). The alternatives do not have to perform the same functions, but they do attempt to achieve the objective. He further expressed, "Cost is the choice of a particular alternative for accomplishing the objectives implies that certain specific resources can no longer be used for other purposes" (p. 5). Cost is typically measured in terms of money allocated for the alternatives. Quade pointed out, "A model is a simplified representation of the real world abstracts the features of the situation relevant to the question being studied" (p. 5). The means to the model can take many forms, as needed by the researchers. Quade illustrated, "The means of representation may vary from a set of mathematical equations or a computer program to a purely verbal description of the situation, in which judgement alone is used to predict the consequences of various choices" (p. 5). Finally, the criterion is a standard that the alternatives are measured against. Specific criteria can be weighted heavier based on the significance the decision-maker places on it. Quade argued, "It provides a means for weighing cost against effectiveness" (p. 6).

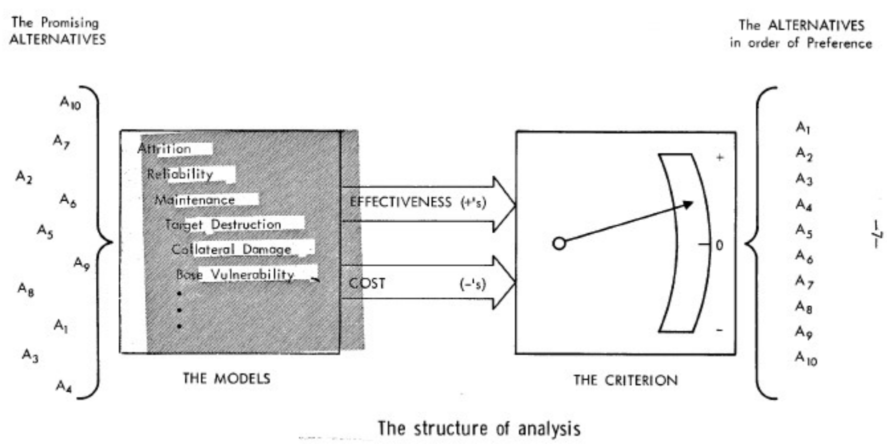


Figure 11. The Structure of Analysis. Source: Quade (1965).

The limitations of the cost-effectiveness analysis are the degree of importance the decision-makers give to the criteria. The decision-makers are using their experience, intellect, and information currently available in selecting the alternatives and criteria. Quade (1965) insinuated, "In military cost effectiveness analysis, measure of effectiveness are at best reasonable satisfactory approximations for measuring such vaguely defined objectives as deterrence or victory" (p. 12). As a good start, cost-effectiveness analysis can point organizations in the right direction to select the best course of action with the information available at the time.

B. CRITERIA DEFINED

Below are the criteria for the analysis and the reasoning for their selection. We determined criteria selection was based on the important background information of the literature review chapter and the researchers operational experience.

1. Design Freedom

Design Freedom or operational flexibility allows the vest to be designed for a specific purpose or mission which is defined in the KPP. Design Freedom reduces the negative aspects of commonality by limiting unnecessary capabilities and preventing a gap in capabilities that are typically experienced in a joint program.

2. Small arms and shrapnel protection

Small arms and shrapnel protection or ballistic protection is important due to the aircrew operating in a non-permissive environment. The aircrew may receive small arms fire from the enemy and/or shrapnel from ammunition or foreign object debris (FOD). It is important that the vest can reduce risk of injury from enemy fire.

3. Light weight

The weight of the vests is typically listed as KPPs or requirements in the contract. With a lighter vest, the aircrew has more endurance to perform their missions at an effective rate. Lighter vests decrease the physical strain on the shoulders and lower back of the aircrew. This has the long-term effect of keeping the aircrew medically qualified to fly.

4. Modularity

Modularity enables flexibility without reducing or having an excess of capability. Each mission can be tailored by either attaching or detaching modules. For example, aircrew returning from a mission over urban terrain can be quickly reconfigured to remove ceramic plates and install LPUs and oxygen bottles to fly over water.

5. Size fits the majority of aircrew

The aircrew survival vest must properly be fitted to the aircrew to be functional. It can lead to catastrophe if the vest is unable to fit the war fighter because none of the other criteria will have any relevancy because of the user's inability to wear the vest in combat. The size of the vest needs to fit the majority of the aircrew either by having different sizes such as small, medium and larger or enabling the vest to expand by using straps or by some other means.

6. Maritime environment

With most of the world's population living near the coast and littorals being a potential contested environment, operating in a maritime environment is paramount to project U.S. power. Aircrew operate over water and therefore the aircrew survival vest must be configured to enable their survival if they need to ditch at sea. Additionally, the vest must maximize their chances of survival if the aircrew submerges with the aircraft after a mishap. Maritime environment configurations involve the use of an LPU for flotation and an oxygen bottle, allowing the aircrew a few minutes to escape the fuselage and swim to the surface.

7. Total Life Cycle Cost

Total Life Cycle Cost (LCC) is the cost of the entire program, "including costs for research and development; testing; production; facilities; operations; maintenance; personnel; environmental compliance; and disposal" (Defense Acquisition University n.d.-b). LCC is important because with constrained budgets, the program with the most economic LCC may have the preferred funding over programs with a more desirable capability. Any programs with excessive costs may be put on the congressional oversight list.

8. Logistics Supportability

Logistically supporting the survival vest is essential in order to maintain a level of mission capability to support the aircrew and flight operations in order to prevent hot-seating flight vest or reducing the sorties that may be caused by the lack of mission capable vest for pilots to fly. The aircrew survival vest will be located at operational flying squadrons and at various maintenance units for repair. Some will also be located on a ship at sea or an austere environment in a nonpermissive environment. The vest must be able to maximize the space available on the shelf for spare parts. Additionally, the ability to perform maintenance on the vest at the lowest maintenance level closest to the warfighter reduces the down time between maintenance.

9. Trainability

The ability to efficiently train everyone involved in the process of getting a mission capable vest to the warfighter is important to keep cost down. Maintenance personnel must learn how to inspect and repair the aircrew vest at their primary military occupational school and follow-on schools. Supply personnel must learn how to properly store the vest to maintain its shelf life. Aircrew must be trained on the proper wear, adjustments, and operations of the aircrew survival vest such as demonstrating their ability to inflate their LPUs in a maritime environment.

10. Contracting

Contracting is important because it allocates funding to the vendor to provide the vest per the government's requirements. The government must ensure that the contract has the correct specifications in order for the vendor to build the requirements desired by the warfighter. Ensuring the contracting team is capable and meeting the needs of all stakeholders is vital.

C. ANALYSIS DISCUSSION

The joint and Service options criteria were ranked by risk of implementation. Risk levels of 3 as low risk, 2 as medium risk, and 1 as high risk were assigned, as shown in Table 13, with low risk being most desirable and high risk being least desired. The options then had all their assigned risk for each criterion added up which gave them an effectiveness score. This resulted in a joint vest with the highest effectiveness, followed by the Navy/Marine Corps, then the Army and then Air Force, and finally the Coast Guard's vest had the least effectiveness. The data was normalized, resulting in a further breakdown of the risk data for each option, as shown in Table 14. The joint vest had the effectiveness with an assigned value of 0.242, followed by the Navy/Marine Corps with a score of 0.209, then the Army with a value of 0.199, and the Air Force and Coast Guard respectively with values of 0.179 and 0.169. The data were then graphed on a cost-effectiveness chart where the x-axis is the unit cost for a vest and the y-axis is the Measure of Effectiveness (MOE) based on the normalized data of the criteria. The unit cost of the joint aircrew survival vest was assumed to be higher than the other vest due to the expected capabilities of all the Services.

Table 13. Cost-Effectiveness Analysis of a Joint Aircrew Survival Vest with criteria equally weighted

Criteria / Options	Design Freedom	Small arms and shrapnel protection	Light Weight	Modularity	Size fits the majority of aircrew	Maritime Environment	Total Life Cycle Cost	Logistical Supportability	Trainability	Contracting	Total
Joint	2	3	2	3	2	2	3	3	3	3	**26**
Air Force	3	2	3	2	2	1	1	1	2	2	**19**
Army	2	3	1	3	2	1	2	2	2	2	**20**
Coast Guard	2	1	3	2	2	3	1	1	2	2	**19**
Navy and Marine Corps	2	3	1	3	2	3	2	2	2	2	**22**

Table 14. Cost-Effectiveness Analysis of Joint Aircrew Survival Vest With Weighted Criteria

Criteria / Options	Design Freedom	Small arms and shrapnel protection	Light Weight	Modularity	Size fits the majority of aircrew	Maritime Environment	Total Life Cycle Cost	Logistical Supportability	Trainability	Contracting	Total	Normalized
Weighted Criteria	2	2	1.5	3	3	1	2	2	1	1		
Joint	4	6	3	9	6	2	6	6	3	3	**48**	**0.242424242**
Air Force	6	4	4.5	6	6	1	2	2	2	2	**35.5**	**0.179292929**
Army	4	6	1.5	9	6	1	4	4	2	2	**39.5**	**0.199494949**
Coast Guard	4	2	4.5	6	6	3	2	2	2	2	**33.5**	**0.169191919**
Navy and Marine Corps	4	6	1.5	9	6	3	4	4	2	2	**41.5**	**0.20959596**

1. Fits the Majority of the Aircrew

The ability of the aircrew survival vest to fit the majority of the aircrew population is one of the most important criteria. We gave this criterion a weight of three due to being vital such that if the vest does not fit the aircrew, the vest is not functional. There are two methods to ensure the vest can adequately fit the aircrew. First, the vest can have adjustable straps to increase or decrease the size of the vest. However, the constraint with this option is that the vest may not be able to adjust for the population at the extreme ends (i.e., extra-small or extra-large). The second method is to have different sizes of vests ranging from extra small to extra-large, and a normal distribution of individual sizes can be used to develop the quantity needed for each size. The joint vest has the highest risk for this option because the normal distribution will be attempting to capture aircrew sizes within the DoD and Department of Homeland Security (DHS). Size as the variable and the risk of inadequately or excessively ordering the correct quantity for the specific size can result in additional costs because of storing the additional vests or reordering the current size needed.

2. Modularity

Modularity was also given the highest weight with a 3 due to it being one of the most important criteria. Modularity enables flexibility in the aircrew survival vest without increasing the cost dramatically due to the ability to add and remove components for specific mission requirements. The Navy/Marine Corps and Coast Guard would most likely have life preserver units (LPUs) listed as a subcomponent of the vest because they are primarily at sea and in the littorals, while the Army and Air Force would most likely not have that requirement. Modularity allows for all the Services to have the same fundamental vest with the ability to tailor the vest by adding modules for their mission set without comprising performance for the sake of commonality. The joint, Army and Navy/USMC was given a low-risk rating for modularity because it is listed as a KPP. The Air Force and Coast Guard received a higher risk rating because they are COTS products and the deigns are contingent on commercial availability.

3. Small Arms and Shrapnel Protection

Small arms and shrapnel protection or ballistic protection was assigned a moderate weight of 2 due to the requirements for the other Military Service vests and the significance of performing combat missions. The aircrew survival vest in all the branches listed some form of soft armor to stop small arms and shrapnel protection as a requirement. Some of the requirements did state the ability to install ceramic plates to stop 5.56 and 7.62 rounds, but will be included in the modularity section. Aircrew members operate in high-risk aviation environments where some items can become shrapnel and present a danger to the aircrew, such as foreign object debris (FOD). The Army and Navy/USMC and the joint vest have a lower risk of implementing due to the nature that the majority of missions will be flown within proximity to ground fire. Military aircrafts operate in austere environments, and they land on sand, gravel, and unimproved roads, away from the safety of a FOD-free runway. The probability of the rotor wash sending a projectile towards the aircraft or aircrew, which can cause injury, is much higher. During emergency landings, some rotors are designed to break apart on impact, causing shrapnel to fly everywhere; therefore, the vest must protect the aircrew from this unlikely possibility. Aircrew also operate weapon systems from the aircraft, and they must be protected from any risk the weapons pose to the aircraft, such as malfunctions. Military aircraft, especially rotor-wing, operate in pairs at low level and can often engage ground targets simultaneously, resulting in the possibility of rounds and shrapnel ricocheting off the target towards the other aircraft.

4. Design Freedom

Design freedom was also weighted with a 2 due to the importance of designing the aircrew survival vest to perform the desired requirements. The ability to design the aircrew survival vest to achieve the KPPs reduces the performance risk of the program. Design freedom is more prominent with the individual Service vest, but it was a higher risk for the joint vest because of the incorporation of multiple requirements to perform a wide arrange of missions. The goal of commonality is to achieve a common cost-affordable product for all the Services but may inadvertently create an inferior product. The design freedom for the joint vest will be severely restricted due to the goal of achieving the KPPs from all the Services, and commonality may result in a higher cost for a less capable joint vest. A joint vest may result in some Services having excessive functionality that is not required and other Services receiving a substandard vest. The joint vest received an elevated risk rating due the possible negative aspects of commonality. Additionally, the Navy/USMC received an elevated risk ratings due to the maritime and small arms and shrapnel protection requirements reducing flexibility. The Coast Guard also received an elevated risk rating due to limiting their design for light weight and maritime operations.

5. Light Weight

Throughout the KPPs, the weight of the vest was mentioned as a requirement for all four Services. The weight of the vests is important because the heavier they are, the more physical strain it will induce on the aircrew. The weight of the vest is concerning when aircrew are flying 8 to 10-hour missions in a full combat load; it can cause fatigue among the aircrew and possible musculoskeletal injuries over time. The requirement documents show the Services are attempting to reduce the weight of the vest without decreasing performance. Light weight was weighted as 1.5 due to the importance of this requirement but may be given a lower priority to prevent putting other performance requirements at risk such as ballistic protection Light weight is a subjective term that can have different meanings depending on which branch of Service is developing the requirement, and it can also be influenced by adding and removing modules through modularity. The joint vest has the highest risk for the lightweight criteria due to all the requirements of the Services. It is likely that the vest will weigh more than the current vests due to requirements creep. Coast Guard has the lowest risk level due to the lack of combat requirements reducing the weight of their vest and the need to perform water rescue.

6. Maritime Environment

The maritime environment criteria were weighted as 1 because mostly the Navy/USMC and Coast Guard perform missions in this domain and have flotation criteria due to the additional complexities of the vest performing in a maritime environment. The vest will need to be capable of withstanding either fresh or saltwater immersion and have the tensile strength to have the individual hoisted out of the water. The vest will need an LPU to facilitate flotation of the individual under a combat load. We assumed the LPU is not built into the vest but instead it can be attached and removed, taking advantage of modularity. The Air Force and Army have a high risk in this area due to not being their primary area of operations.

7. Total Life Cycle Cost

Total Life Cycle Cost was given a weight of 2 due to the need to fund a aircrew survival vest. We assumed the joint vest has the lowest procurement cost because it will be taking advantage of commonality to develop a product among the Services. The research and development (R&D) cost will be shared by the Services instead of each Service spending R&D costs to develop their own aircrew survival vest. The vest and the subcomponents of the vest—such as the buckles, straps, and modules—will be high demand items resulting in procuring items through economy of scale. Assuming the aircrew flight vests will be manufactured through uninterrupted repetition, the learning curve and improvement curve theories will be more advantageous in decreasing overall cost. The Air Force and Coast Guard are rated at a risk level of high for LCC because they are COTS items. COTS are usually less expensive up front but due to obsolescence and vendors departing, the industrial base may be more expensive over time to maintain COTS products.

8. Logistics Supportability

Logistics supportability was given a moderate weight of 2 because of the need to support the vest throughout its life cycle. The logistical cost risk for the joint vest is low because the program will be taking advantage of commonality to streamline the logistics chain. The DoD supply chain will be required to only carry one type of joint aircrew survival vest and only one type of spare parts, thus reducing the burden of the supply system to carry multiple spare parts for multiple systems. The vest parts will be interchangeable and reduce the amount of inventory space required for warehouses to store spare parts. Additionally, repairs facilities at the intermediate level and depot level will only need to inspect and repair one type of product, which will increase the possibility for Lean Six Sigma and continuous process improvement. The Air Force and Coast Guard was given a high-risk rating because the vest are COTS products and there is a possibility of the vendor departing the market, resulting in a gap of logistical supportability and even obsolescence.

9. Trainability

Trainability was given a weighted criteria of 1 because it is important but not significant compared to the other requirements. The trainability risk for the joint vest is lower with respect to the other vest because with everyone using the same vest, the training requirements throughout the Services will be similar and the Service members will be trained and certified on one joint aircrew survival vest. It will streamline the training efforts for survival vests which will reduce costs. It is feasible for the lead Service to host the Military Occupational Specialty (MOS) school for enlisted Service members to be trained, setting one standard.

10. Contracting

Contracting was weighted as 1 because it is essential but regulated by the Federal Acquisition Regulations which means there is limited room for flexibility. Contracting was listed as low for the joint vest and as moderate risk to the individual Service vests. The joint vest will take a greater advantage of the learning curve effect and economic ordering due to the volume of vests required for all the Services. Additionally, instead of having multiple aircrew vests managed by all the Services, the Joint vest will decrease the number of contracts required resulting in a reduction of contract administration burden in supervising performance requirements. In attempting to have the Services agree to a joint product, the DoD bureaucracy adds significant risk. Additionally, the Coast Guard is part of DHS, therefore two sperate federal departments will attempt to develop common requirements for the joint vest. The lead Service of the joint aircrew survival vest can unknowingly have a bias towards their own Service, resulting in that Service's requirements having priority and, therefore, the other Services will be funding a substandard system for their mission. As mentioned earlier by Jessup & Williams (2015), "These conditions often lead to divergence over time, in which the commonality of original designs, and thus the intended benefit, is diluted. Where achieved, commonality benefits can be further offset by the reduced utility of non-specialized products" (p. 12).

D. FINDINGS

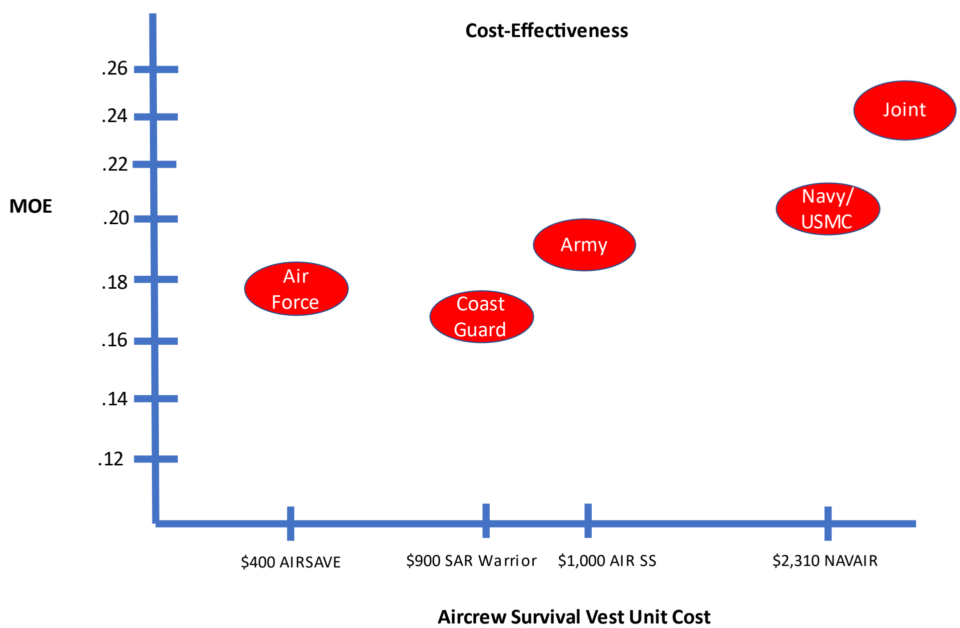
The following section contains the findings based on the analysis described previously. The findings are divided by joint and individual Services and describes where each vest ranks against each other dependent on MOE and costs.

1. Joint Aircrew Survival Vest Measures of Effectiveness and Cost Graph

The joint aircrew survival vest measures of effectiveness and cost graph (Table 15) illustrates the MOE of each vest with respect to cost. Ideally, in a perfect world assuming equal effectiveness minimum cost is preferred and assuming equal cost maximum effectiveness is preferred. With multiple data points the superior solution has the highest MOE with the lowest cost. Table 15 shows that the Air Force's vest dominates the Coast Guard vest by having a higher MOE for a lower cost. Therefore, the

Coast Guard vest should not be selected over the Air Force vest based upon this chart. The Army's vest has a higher MOE and higher cost with respect to the Air Force's vest therefore it needs to be decided if the marginal cost is worth the marginal benefit. The Navy/USMC's vest option has a higher MOE and cost compared to the Army's option. With a difference of 0.02, the marginal benefit gained from the Air Force's vest to the Army's vest is greater than the marginal benefit gained from the Army's to the Navy/USMC's vest with a difference of 0.01. The marginal cost from the Army's to the Navy/USMC's option is a $1,310 increase per unit as the marginal cost from the Air Force's to the Army's vest is $600 per unit. The joint vest has a theoretical highest MOE and cost compared to the Navy/USMC's option making it the most capable but most costly option. Decision makers will need to decide is the cost worth the benefit for the additional capability. The Army might need or want to pay the additional cost for a Navy/USMC vest because performing maritime flights are not their highest priority for their mission set.

Table 15. Joint Aircrew Survival Vest Measures of Effectiveness and Cost



2. Joint Aircrew Survival Vest

Ideally, the most effective vest has the lowest cost and the highest MOE, but in this case, there are five options with various MOEs and costs. The joint aircrew survival vest had the highest MOE, but it also has the greatest unit cost. It has the highest risk of implementation due to the desire to achieve commonality across the DoD and DHS for the Coast Guard. To implement the joint aircrew survival vest, the cost will need to be justified by the MOE it will achieve.

3. Navy/USMC Aircrew Survival Vest

The Navy/USMC aircrew survival vest had the second highest MOE and was the second most expensive vest. The Navy and USMC operate in maritime and combat environments and, therefore, have additional requirements to perform missions in these areas.

4. Air Force Aircrew Survival Vest

The Air Force's survival vest had the fourth highest MOE, and it also had the second cheapest unit cost. Initially, the Air Force's vest would be the best option due to its low unit cost, but the reduction in MOE compared to the Navy/USMC and the joint vest would need to justify the risk of performance for the cost savings.

5. Coast Guard Aircrew Survival Vest

The Coast Guard's aircrew survival vest has the least MOE and is the least expensive vest. The Coast Guard mostly performs missions in a permissive environment and, therefore, does not have the same rigid combat requirements as the other Services. Therefore, the vest is designed to be lightweight and provides flotation for the aircrew.

6. Army Aircrew Survival Vest

The Army's aircrew survival vest, the ACE, has the third highest MOE and is the midpoint for unit cost. Typically, the Army executes missions overland in rotary aircraft, which fly slower and lower than fixed-winged aircraft. This makes small arms protection and light weight the most significant factors due to the aircraft flying within range of small arms fire and the longer flight time to travel the same distance as fixed-winged aircraft.

E. BARRIERS TO IMPLEMENTATION

Every potential new strategy or change to organizational procedures or routine comes with a variety of barriers to implementation that could stall or even completely stop the new strategy from being executed. These barriers, considered inertia, can either be cognitive or action-oriented in nature (Gavetti, 2005). For the purposes of this research, we focus on aspects of action inertia that can create organizational barriers to implementation of a joint aircrew flight vest acquisition program as a detailed discussion of cognitive inertia, and its applicability to such a program is beyond the scope of this research. It is important to keep in mind that examples of potential barriers to be discussed are hypothetical and speculative and may or may not exist within each program office.

1. Action Inertia

Action inertia exists as a roadblock to executing a new strategy or plan and can affect any organization, primarily the individuals responsible for executing the strategy (Gavetti, 2005). Action inertia can come in the form of sticky routines, ingrained organizational culture, or leadership failures (Gavetti, 2005), each of which has its own unique characteristics to consider when leaders are implementing new strategies within their organizations.

2. Sticky Routines

Sticky routines exist due to complex organizational processes translating into various repetitive tasks that then become part of a routine (Gavetti, 2005). When the organization adapts such a routine, no one person has complete knowledge over the entire process. Hence, changing any individual part of the process becomes more complicated and may yield second or third order effects that no one person within the organization can anticipate (Gavetti, 2005). For instance, the Big "A" acquisition process consists of several different routine processes that each major acquisition program must follow: the JCIDS, PPBE, and acquisitions processes. If a change is made in the JCIDS process, that could require additional changes in the PPBE and acquisitions processes to ensure that each process continues to flow without interruption. Additionally, if a PM for one of the aircrew flight vests mentioned determines that it may be beneficial to attempt a joint program with the other Services, the entire acquisition process will need to be started over from requirements generation. This would significantly increase the acquisition lead time and possibly overall acquisition life-cycle cost.

3. Ingrained Culture

The next aspect of action inertia is ingrained culture. This inhibits implementation due to an organizational culture that is so strong and embedded within the organization that any attempts at making changes will be roadblocked by that culture, particularly when the organization has been successful (Gavetti, 2005). For example, one Service may view itself as the nation's superior fighting force with common perceptions that they have higher standards than other Services, making them special. This type of culture, cemented through hundreds of years of battlefield experiences and overall success, can make it very difficult for PMs to develop a joint aircrew flight vest that is too similar to other Services. They might think they look too similar or need special equipment that makes them stand apart from the other Services. Regardless of the Service, this type of ingrained culture can be a significant roadblock to cooperation between PMs. Also, substantial collaboration inhibits progress on joint acquisition programs.

4. Leadership Failure

Leadership failure is the final aspect of action inertia (Gavetti, 2005). Leadership down to the lowest levels is crucial when implementing new programs or strategies. If leaders fail to communicate the desired end goals or paths to get there, lack charismatic authority, or cling to how things currently are in the organization, the process of change can be severely impaired (Gavetti, 2005). Leaders can be attached to their current organizational state, particularly if they helped create that state. Suppose a PM or acquisition team leader is attached to a particular acquisition program and resists the possibility of a joint program, such as a joint aircrew flight vest over a Service specific vest. In that case, it could be because they helped create the current program and are unwilling to change something they created (Gavetti, 2005), putting their own priorities above that of the organization. Another possibility for leaders failing to implement or resisting the implementation of a new acquisition strategy is fear of the unknown (Gavetti, 2005). Their current single-Service program is known, and the process of managing it is familiar and could be simpler than managing a joint program. These could be significant barriers to joint program implementation.

Barriers to implementation can exist in any organization, at various levels, and in various forms. Those most applicable to implementing a joint program fall under action inertia. Action inertia can present itself in various forms, from heavily used and complex routines to an ingrained organizational culture or even leadership resistance to change. These barriers can make even the simplest of changes seem overly grueling, complicated, or time consuming and can cause changes to fail. Suppose a joint acquisition program is to succeed over a Service-specific program. In that case, PMs will need to be able to identify where these barriers could be within their own organizations so that they may be reduced or eliminated throughout the acquisition process and determine if the juice is worth the squeeze to pursue a joint aircrew flight vest.

5. Analysis of Barriers to Implementation

We research the barriers to implementation because it analyzes a non-materiel feasibility of a joint vest or Joint Program Office. The barriers to implementation that were analyzed were action inertia, ingrained culture, and leadership failure. Each barrier to implementation received a risk rating of either 1 for low risk, 2 for elevated risk, or 3 for high risk with their associated Service as indicated in Table 16. A weighted criteria was assigned to each barrier to implementation based on the researcher's perception of importance to effect change within an organization which is shown in Table 17. Action inertia was weighted at 1.5, ingrained culture was weighted at 2, and leadership failure was weighted at 1. We analyzed the barriers the individual Service Program Offices will face when implementing the joint vest. It was determined that the Air Force has the highest risk for barriers to implementation out of any service followed by the Coast Guard, and the Navy/Marine Corps and Army both having the lowest risk levels. Barriers to implementation from a theoretical Joint Vest Program Office was also analyzed and received a risk higher than an of the services. Table 18 shows a graphical representation of the barriers to implementation.

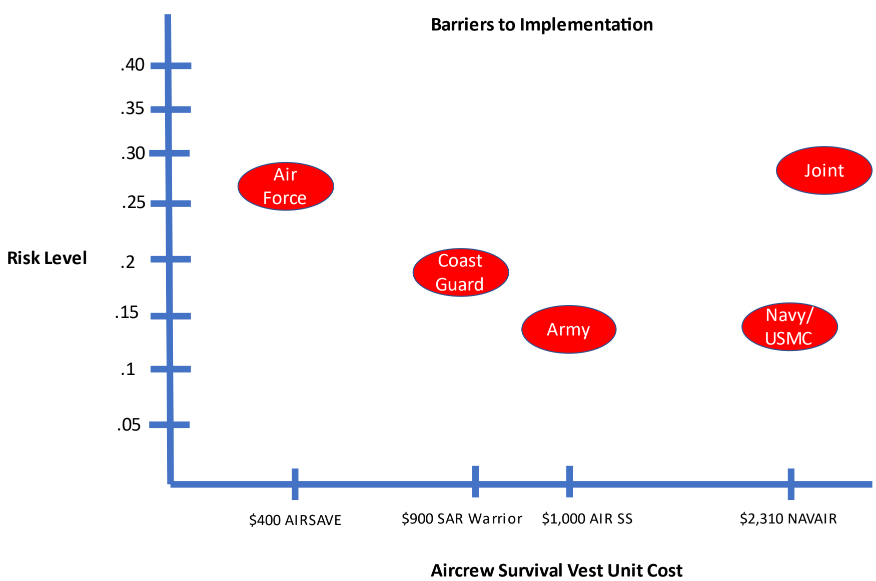
Table 16. Barriers to Implementation Analysis.

Barriers / Services	Action Inertia	Ingrained Culture	Leadership Failure	Total
Joint	3	3	2	8
Air Force	3	3	1	7
Army	2	1	1	4
Coast Guard	3	1	1	5
Navy and Marine Corps	2	1	1	4

Table 17. Barriers to Implementation with Weighted Criteria

Barriers / Services	Action Inertia	Ingrained Culture	Leadership Failure	Total	
Weighted Criteria	1.5	2	1		Normalized
Joint	4.5	6	2	12.5	0.287356322
Air Force	4.5	6	1	11.5	0.264367816
Army	3	2	1	6	0.137931034
Coast Guard	4.5	2	1	7.5	0.172413793
Navy and Marine Corps	3	2	1	6	0.137931034

Table 18. Barriers to Implementation Chart.



a. Joint Vest Program Office

The joint vest program office received the highest risk level out of any program office. Attempting to lead a Joint Service acquisition program with three stakeholders from the DoD and one from DHS can be a very overwhelming task. The joint vest program office was rated as a high risk for action inertia because it will be challenging to execute a new strategy in large organizations that have been executing their strict processes for a long time. Ingrained culture also received a high risk due to attempting to change the culture in four Services. The Services have been executing individually, fulfilling their own program requirements and the Joint Program will attempt to develop new requirements and establishing new processes. Leadership failure was ranked as an elevated risk due to the fact the Joint PM will have many barriers to overcome, leading a program that provides capabilities for four services.

b. Air Force

The Air Force has a high risk for action inertia and ingrained culture, and a low risk for leadership failure. The Air Force spends billions of dollars to procure and maintain weapon systems through the Big "A" acquisition process and their own instructions. The Air Force maintains air superiority and global air dominance, and it will be challenging to work jointly, potentially sacrificing that status. Leadership failure was the lowest risk due to PMs being statutorily mandated to execute a program.

c. Coast Guard

The Coast Guard had the next highest risk for implementation. The Coast Guard has a high risk for action inertia and a low risk for ingrained culture and leadership failure. Due to the Coast Guard being part of DHS, with different funding, procedures, and policies from the DoD, this increases the action inertia. The Coast Guard has a low risk for ingrained culture and leadership failure because the organization is relatively small and can accept and adapt to change quickly, and—again—the PM is statutorily obligated to execute the program.

d. Navy/Marine Corps

The Navy/Marine Corps has the lowest risk for implementation. Action inertia and ingrained culture have a low risk level because the Navy and Marine Corps have experience working together as two separate branches, and executing a joint vest program would not lead to a dramatic shift in procedures. The Navy/Marine Corps are always innovating, and as long as the maritime requirements are addressed, they are more likely to accept the joint vest program. Leadership failure is low risk because of the PM's responsibility to lead the program.

e. Army

The Army also has the lowest risk for barriers to implementation. Action inertia and ingrained culture has an elevated risk level due to the fact the Army is willing to innovate, but since it is the largest Service, it can be a challenge to steer the organization. Leadership failure is a low risk due to the PM's statutory requirements.

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V. CONCLUSION AND RECOMMENDATIONS

The preceding chapters contain background information to establish necessary knowledge to understand this research, a literature review presenting past research on DoD commonality, and a data analysis discussing the findings of the feasibility of a joint DoD program for aircrew survival vests. This chapter provides the answers to the research questions stated in the introduction, concluding thoughts, and recommendations for actions and future studies.

A. ANSWERS TO RESEARCH QUESTIONS

The following section summarizes the answers to the research questions defined at the beginning of the paper. These answers are based on the analysis of the data used to determine the feasibility of utilizing a joint survival vest program.4

1. What is the Most Cost-Effective Option Between a Joint Vest by a JPO or Service Specific Vests by Service PMOs?

Specific vests by Service PMOs are more cost-effective than a joint vest by a JPO but a joint vest provides more capability. A joint vest with a modular design would be the most effective option. Services will have the flexibility to spend money to add specific capabilities to the joint vest to achieve their KPPs. The Services will also have the flexibility not to purchase capabilities they do not need saving money and maintaining their budgets. Services can customize the vest for their mission profiles such as inserting hard armor, attaching LPUs or removing not essential gear to make it as light as possible. Modularity will also enable the modules that attach to the vest to be updated as required instead of modernizing the entire vest or procuring a new one, saving cost.

2. What are the Barriers to Implementation for the Various Options?

The barriers to implementation for the various survival vest program options include action inertia, sticky routines, ingrained culture, and leadership failure. The joint vest program resulted in the highest risk in barriers to implementation due to the nature of implementing requirements set by four differing Services who value different attributes along with opposing cultures. Of the Services, the Airforce contains the highest risk in barrier to implementation of a joint program because of their ingrained culture and action inertia in their acquisition processes. The Coast Guard follows with their high-risk in action inertia because they are in the DHS rather than the DoD. The Army and Navy/Marine Corps have the same level of relatively lowest risk due to their low risk in leadership failure along with history in joint programs.

3. What are the Advantages and Disadvantages of Commonality and the Adoption of a Joint Vest?

The advantages of commonality include developing a more effective product that incorporates inputs of multiple Services. Utilizing commonality also bypasses inefficiencies, including managing multiple redundant programs that have similar characteristics within the DoD. Commonality provides the ability for individual programs to avoid the tedious logistical and procurement troubles in an acquisition.

The major benefit of a joint aircrew survival vest is that it would be more effective than the current individual Service-driven vests. It would contain additional capabilities to meet requirements set by all Services involved. A joint program could be beneficial to the Navy and Marine Corps because the cost will not be significantly beyond what they are paying for their current vest, and they will utilize the benefits of a joint program.

The disadvantages of commonality include the compromises taken by the Services to either pay extra costs for capabilities not necessary or to settle for a design that does not enhance their mission set capacities. In a joint program there are more stakeholders, which makes it more difficult to come to an agreement. The need to have all participants on board in decision-making can potentially lead to schedule delays. Decision-making also faces delays because of the coordination efforts with the other Services involved.

The major drawback in a Joint vest program is the cost for each Service to implement a non-modular joint vest; the program would not be cost-effective. The Air Force and Coast Guard would have capabilities that may be beyond what they desire and would result in additional costs for enhancements that are not necessary for their mission sets. The difference in desired requirements would lead to complications, which would result in schedule delays. With this in mind, there are barriers to entry, including the hesitancy to allow for a particular Service to serve as the lead role in the acquisition process.

A joint aircrew vest would be beneficial if all Services had the same requirement parameters for their vests. This would ensure that there are no excess costs beyond what is needed and would ensure a streamlined and efficient acquisition for their vests. This use of commonality could be efficient if there were multiple joint aircrew vests dependent on the aircraft platform where there are aligned mission sets. For example, it may be feasible to have a joint vest for the aircrew specially designed for all rotary aircrafts throughout the Services. The joint vest would need to be interoperable with the aircraft and the aircrew's interaction with the aircraft. A joint vest that restricts the pilot's head movement due to the vest interfering with the helmet or restricting the aircrew in any way would be counterproductive.

B. CONCLUSION

Throughout this research, there are several key points identified among the requirements for the different aircrew survival vests throughout the Services. Each Service has their own particular set of requirements for their mission set. A joint vest with a modular design is the most effective with respect to the materiel. Although it may look economically feasible to implement a joint aircrew survival vest program, friction points can develop along the way that can delay or cancel the program, as seen in previous joint programs. Examples of these friction points specific to the joint survival vest include a likely disagreement in requirements for a joint vest regarding the mission set. Although a joint vest would have advanced capabilities and greater effectiveness, it is unnecessary and costly to some of the Services that contain less requirements for their vests. Having a lead Service responsible for the procurement of the joint vest would also likely lead to biased requirements and skewed results in the product.

C. RECOMMENDATIONS

Below are recommendations for future research on the analysis of a joint aircrew survival vest. This research focused on analyzing four aircrew survival vests to all aircraft in the DoD and DHS. Future research can concentrate on potential impacts of the joint aircrew survival vest on existing systems. Further research can focus on the cost/benefit interacting a joint ACAT III program or below into several ACAT I programs. Finally, subsequent research can analyze the feasibility of a joint aircrew survival vest for type of aircraft across the DoD and DHS,

1. Potential Impacts of the Joint Aircrew Survival Vest on Existing Systems

Future research is recommended on the impact of the joint aircrew survival vest on existing systems across all the Services. More thorough research should be conducted on the effects and limitations of one vest across multiple fixed-wing, rotor-winged and tilt-rotor aircraft. The impact of the joint vest on subsystems such as helmets, hard body armor, and so on, should also be researched. Doing this will give better insight on the practical benefits and drawbacks of a common joint vest.

2. The Cost/Benefit of Commonality on a Joint ACAT III or Below

Future research is recommended on the cost/benefit of a joint ACAT III program or below that will integrate into multiple ACAT I programs. The joint aircrew survival vest is relatively inexpensive in relation to the ACAT I aircraft programs, but both systems will need a level of interoperability. More detailed research is recommended on the cost/benefit of modifying ACAT I aircraft programs to be interoperable with the joint vest.

3. Further Research of the Feasibility of a Joint Aircrew Survival Vest for Various Types of Aircraft

Future research is recommended to analyze the feasibility of different joint aircrew survival vests, each associated with a type of aircraft. One joint vest for all type, model, series aircraft in the DoD and Coast Guard may have more negative results than positive ones because performance requirements can be reduced for the sake of commonality. A more reasonable approach can be developing several joint aircrew survival vests for aircraft with similar performance and mission requirements in order to not sacrifice requirements for commonality.

LIST OF REFERENCES

AcqNotes. (n.d.). *PPBE process: PPBE process overview*. https://acqnotes.com/acqnote/acquisitions/ppbe-overview

Blume, S. V., & Parrish, M. (2019). *Make good decisions, DoD: Optimizing core decision making processes for great-power competition*. Center for New American Security. https://www.cnas.org/publications/reports/make-good-choices-dod

Brown, M. M., Flowe, R. M., & Hamel, S. P. (2007, May). The acquisition of joint programs: The implications of interdependencies. *CrossTalk: The Journal of Defense Software Engineering*, 20–24. https://apps.dtic.mil/sti/citations/ADA487683

Candreva, P. J. (2017). *National defense budgeting and financial management*. Information Age Publishing.

Capecci, T. (2011). Aircrew endurance (AE) Milestone C (MS C) decision. Naval Air Systems Command.

Cohen, J. B., Collins, M. L., Marchetti, J. D., Moore, A. P., & Novak, W. E. (2013). *The joint program dilemma: Analyzing the pervasive role that social dilemmas play in undermining acquisition success*. NPS Archive: Calhoun. https://calhoun.nps.edu/bitstream/handle/10945/34557/NPS-AM-13-C10P01R07-036.pdf?sequence=1&isAllowed=y

Defense Acquisition University. (n.d.-a). *Acquisition program baseline*. Retrieved August 12, 2022, from https://www.dau.edu/glossary/Pages/GlossaryContent.aspx?itemid=26791#:~:text=The%20PM%20is%20responsible%20for%20developing%20the%20APB.,the%20MDA%20through%20the%20DoD%20management%20information%20system.

Defense Acquisition University (n.d.-b) *Life cycle cost (LLC).* Retrieved August 23, 2022, from https://www.dau.edu/acquipedia/pages ArticleContent.aspx?itemid=419.

Defense Acquisition University. (2004). *Joint program management handbook* (3rd ed.) [Handbook]. https://www.acqnotes.com/Attachments /DAU%20 Joint%20Program%20Management%20Handbook.pdf

Department of the Navy. (2010, January 26). *Requirement for aircrew endurance: Man mounted*.

FAR 12.1, *Acquisition of Commercial Products and Commercial Services*. (2022). https://www.acquisition.gov/far/part-12#FAR_Subpart_12_1

Gavetti, G. (2005). Strategy formulation and inertia. *Harvard Business Review*.

Held, T., Newsome, B., & Lewis, M. W. (2008). *Commonality in military equipment: A framework to improve acquisition decisions* (Report No. MG-719-A). RAND. https://www.rand.org/pubs/monographs/MG719.html

Jessup, R., & Williams, J. (2015). *The cost of commonality: Assessing value in joint programs* [Master's thesis, Naval Postgraduate School]. NPS Archive: Calhoun. http://hdl.handle.net/10945/47969.

Joint Chiefs of Staff. (2018a). *Charter of the Joint Requirements Oversight Council (JROC) and implementation of the Joint Capabilities Integration and Development System (JCIDS)* (CJCSI 5123.01H). Joint Staff. https://www.acq.osd.mil/asda/jrac/docs/CJCS-Instruction-5123.01H.pdf

Joint Chiefs of Staff. (2018b). *Manual for the operation of the Joint Capabilities Integration and Development System*. Joint Staff. https://jitc.fhu.disa.mil/isg/downloads/Manual-JCIDS_31Aug2018.pdf

Leuschner K. J. (2011). *The advantages and disadvantages of seeking commonality in military equipment* (Report No. RB-9623-A). RAND. https://www.rand.org/pubs/research_briefs/RB9623.html

McGarry, B. W. (2022). DoD Planning, Programming, Budgeting, and Execution (PPBE): Overview and selected issues for Congress (GAO-R7178). Government Accountability Office.

McKinley, K. W. (2000). *A case study: Acquisition reform and the joint primary aircraft training system (JPATS) program* [Master's thesis, Naval Postgraduate School]. NPS Archive: Calhoun. https://calhoun.nps.edu/handle/10945/9296

Mosle, W. B. (2016, August 15). *Safe-to-fly recommendation for AIRSAVE survival vest* [Memorandum]. Department of the Air Force.

Naval Air Systems Command. (2011). Life cycle sustainment plan for the aircrew endurance, man mounted program.

Naval Air Systems Command. (2013, December 18). Navy's redesigned Aircrew Endurance Survival Vest reaches key milestone.

Naval Postgraduate School. (n.d.). *Mission.* Retrieved August 12, 2022, from https://nps.edu/mission

Office of the Under Secretary of Defense for Acquisition and Sustainment. (2020a). *Operation of the adaptive acquisition framework* (DoD Instruction 5000.02). Department of Defense. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500002p.pdf

Office of the Under Secretary of Defense for Acquisition and Sustainment. (2020b). *Major capability acquisition.* (DoD Instruction 5000.85). Department of Defense. https://www.esd.whs.mil/Portals/54/Documents/DD/issuances/dodi/500085p.pdf?ver=2020-08-06-151441-153

Ontiveros, J. (2017). *No comm, no problem [Image 4 of 7]*. Defense Visual Information Distribution Service. https://www.dvidshub.net/image/4011655/no-comm-no-problem

Perryman, G. A. (2010). *Requirements for aircrew endurance: Man mounted*. Naval Air Systems Command.

Quade, E. S. (1965). *Cost effectiveness: An introduction and overview* (Report No. P-3134). RAND. https://www.rand.org/pubs/papers/P3134.html

RAND Corporation. (n.d.) *About the RAND Corporation*. Retrieved June 3, 2022, from https://www.rand.org /about.html

SAM.gov. (2014, October 30). *USAF Airsave Type II survival vest*. https://sam.gov/opp/4af3c5622d4aaf86a9b3e6b263ec8f26/view

SAM.gov. (2015, April 7). *Aircrew flotation vest.* https://sam.gov/opp/b498d52673 a5e05f636d258bb8c62948/view#general

SAM.gov. (2020, August 31). *Intent to sole source: Airsave vest.* https://sam.gov/opp/d8e0cbcf37b242ef8fb4657a308f952c/view

SAM.gov. (2022, January 5). *Airsave survival vest, Type I & Type II.* https://sam.gov/opp/0db24d7c19e94925af1afbd9677ab2ad/view#general

United States Army Acquisition Support Center. (n.d). *Air Soldier System (Air SS)*. Retrieved August 20, 2022, from https://asc.army.mil/web/air_ss/

United States Coast Guard. (2011). *Aviation Life Support Equipment (ALSE) manual* (COMDTINST M13520.1C). U.S. Department of Homeland Security. https://media.defense.gov/2017/Mar/29/2001723709/-1/-1/0/CIM_13520_1C.PDF

U.S. Army. (2011). *Capability development document for Air Soldier System (Air SS)*.

U.S. Army. (2018). *Capability production document for Air Soldier System (Air SS)*.

U.S. Army. (2019). *Acquisition program baseline: Air Soldier System (Air SS)–Increment 1A*.

Vanherck, G. D. (2016, June 10). *Fielding recommendation for Aircrew Survival Armor Vest and Equipment (AIRSAVE) Force Development Evaluation (FDE)*. Department of the Air Force.

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