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Investigating Capability Development Management for the Air Force Strategic Development Planning and Experimentation (SPDE) Office

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INVESTIGATING CAPABILITY DEVELOPMENT MANAGEMENT FOR THE AIR FORCE STRATEGIC DEVELOPMENT PLANNING & EXPERIMENTATION (SDPE) OFFICE

THESIS

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Abstract

The Air Force provides unique capabilities for the defense of our nation. Capabilities do not come to fruition instantly; they must go through a development process. Managing the development of a capability is a difficult but necessary task. In 2016, a report from the Air Force Studies Board prompted the Air Force to focus on the Capability Development Process and its improvement. In response to the report, the Strategic Development Planning & Experimentation (SDPE) Office was formed. The SDPE Office is tasked to support Enterprise Capability Collaboration Teams (ECCTs), which are, in turn, tasked to research and solve prominent issues articulated by Air Force leadership. To support ECCTs and the Capability Development Council, the SDPE Office must manage capability development. This research investigates how other Military Services and civilian service sectors handle capability development. The results from this analysis will provide the SDPE Office recommendations for managing responsibilities, based on the best practices found among the organizations studied.

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INVESTIGATING CAPABILITY DEVELOPMENT MANAGEMENT FOR THE AIR FORCE STRATEGIC DEVELOPMENT PLANNING & EXPERIMENTATION (SDPE) OFFICE

I. Introduction

1.1 Background

Strategic planning is difficult and time consuming, but necessary (Cohen, 2017). A primary strategic goal of the United States Department of Defense (DoD) can be summarized in past Deputy Secretary of Defense Work's words as "maintain[ing] our ability to project combat power into any area at the time and place of our own choosing" (Work, 2016: par. 39). One way that the DoD achieves this goal, is through funding Research and Development (R&D) and capability development (CD). Research and Development is defined as "any technologically related activity that has the potential to renew or extend present businesses or generate new ones, including core competency development, innovation, invention, product development, and process improvement" (Matheson and Matheson, 2016:1). Capability development is the complete process, from concept to "warfighter employment" (Air Force Studies Board, 2016: 96), that a capability goes through to be actualized, used by and relevant to the warfighter (Air Force Studies Board, 2016: 96). It is "designed to identify opportunities and provide solutions to mitigate risk associated with Joint warfighting capability gaps" (Department of the Air Force, 2016:21). Although R&D and CD have differences, treating them similarly benefits this research by allowing topics, that might have been considered irrelevant, into the realm of applicable study.

In the Air Force (AF), capability development stems from multiple sources. These sources range from top level guidance with documents such as the National Security Strategy, the Defense Innovation Initiative, and Air Force Strategic Master Plan, to operational and tactical level guidance including warfighter needs, capability gaps, and threats (Department of the Air Force, 2016:21-22; Department of Defense, 2014; Insinna, 2017). These various sources prompt an array of questions for the Air Force to answer with respect to capability development. A number of these questions are: What capability gaps exist? Which capabilities should be developed? When should a capability be developed? What happens if a capability falls through? The Air Force must approach capability development carefully, with all of the uncertainty and risk involved, for future mission success.

Capabilities exist within the Core Functions of the Air Force. These 12 Core Functions (bulleted list below) were divided among seven Air Force Major Commands (MAJCOMs) (bold headings) as seen in Table 1.

Table 1. Air Force Core Function Assignments

Air Combat Command (ACC)	**Air Education & Training Command (AETC)**	**Air Force Space Command (AFSPC)**	
• Air Superiority • Global Precision Attack • Global Integrated ISR • Command & Control • Personnel Recovery	• Education & Training	• Space Superiority • Cyberspace Superiority	
Air Force Materiel Command (AFMC)	**Air Mobility Command (AMC)**	**Air Force Special Operations Command (AFSOC)**	**Air Force Global Strike Command (AFGSC)**
• Agile Combat Support	• Rapid Global Mobility	• Special Operations	• Nuclear Deterrence Ops

A Core Function Lead (CFL) is assigned to each Core Function in a MAJCOM (Department of the Air Force, 2015:9). CFL-led MAJCOM Teams look within their areas of operation to determine what capabilities already exist and whether existing capabilities can fulfill the DoD-mandated Core Function requirements (Department of Defense, 2010:34; Department of the Air Force, 2011:43-53). Formally, a capability requirement is "a capability required to meet an organization's roles, functions, and missions in current or future operations" (Joint Chiefs of Staff, 2015b:GL-5). It "describes the ability to accomplish a task or mission, under a specific set of conditions or constraints and to a specified minimum standard considered effective and/or acceptable" ("AF Requirements," 2017:slide 9). Certain capability requirements are classified, while others are unclassified. Sometimes, an existing MAJCOM capability leaves a projected mission requirement unfulfilled. Still, other times, a MAJCOM simply may not have a capability required to meet Core Function objectives. The situations described in the previous sentences are examples of capability gaps, "the inability to meet or exceed a capability requirement, resulting in an associated operational risk until closed or mitigated" (Joint Chiefs of Staff, 2015b:GL-5). After a MAJCOM finds a gap, it investigates internal ways to develop capabilities and solutions to meet the need.

At times, capability gaps are found *across* MAJCOMs and Core Functions (not only for one individual Core Function or MAJCOM). To manage these multiple domain and multiple Core Function capability gaps and solutions, the Air Force instituted the Strategic Development Planning and Experimentation (SDPE) Office. For the last two years, the SDPE Office has worked with Enterprise Capability Collaboration Teams (ECCTs) through Experimentation campaigns to find and develop innovative and robust

capabilities to fill these capability gaps (Air Force Studies Board, 2016). For clarification, the phrase Strategic Development Planning and Experimentation can be separated into two parts: (1) Development Planning and (2) Experimentation. Development Planning (DP) is "a key process to support the Secretary of the Air Force and Chief of Staff of the Air Force in strategic decisions that guide the Air Force toward mission success today and in the future, within available funds and with acceptable risk" (Air Force Studies Board, 2014: 4). DP concentrates on "pre-acquisition" (Air Force Studies Board, 2014:i) guidance for Air Force senior leaders in strategic decision making. On the other hand, an experiment is "a systematic method for exploring assumptions under controlled conditions" (Air Force Studies Board, 2016:8) and an experimentation campaign is "a set of experiments intended to address a particular objective" (Air Force Studies Board, 2016:8). The SDPE Office manages both Development Planning and Experimentation across the Air Force.

The Air Force is not the only branch with a capability development process; other Military Services have processes and guidelines for developing capabilities for their functions and missions as well. Also, in the civilian sector, many studies on Research and Development portfolio management and capability development management have been conducted for analysis and improvement of the pursuing organization. Capability development is motivated by the DoD objective of ensuring that the nation is able to both defend itself and take action when necessary. The 2016 *Charter for Air Force Capability Development* articulates how capability development "includes all activities from opportunity or capability gap identification to warfighter employment" (Air Force Studies Board, 2016: 96). Ultimately, capability development must be monitored and managed

well to ensure that the best and most relevant capabilities are on time and ready for warfighter use.

1.2 Problem

Since early 2014, there has been an increased focus to address the Capability Development Process of the Air Force due to a National Resource Council Air Force Studies Board report. One result of this increased focus was the recent (2016) stand up of the Strategic Development Planning and Experimentation (SDPE) Office. The SDPE Office is tasked to manage capability development and support ECCTs that research and provide solutions to significant issues articulated by Air Force senior leadership. Because of the newness of the organization and the limited time to explore external capability development management tactics, techniques, and procedures, the SDPE Office reached out to Academia for assistance. Thus, this research does two things: (1) investigates how other Military Services and a few civilian service sectors handle capability development and (2) provides the SDPE Office recommendations for managing responsibilities, based on the best practices found among the organizations studied.

This research problem was developed and formulated through multiple interviews with the Sponsor representative. Two interviews with the Sponsor were conducted; one in May 2017 and the other in August 2017. These interviews made the research problem concrete and revealed the Sponsor's concerns. The second interview brought clarification to the Sponsor's needs and the thesis was promptly adjusted to adhere to them. Both interviews were face-to-face with the student, advisor, and Sponsor representative in

attendance. They lasted about an hour each, with questions from the student and advisor being addressed by the Sponsor.

1.3 Justification for research

Managing the development of capabilities is difficult. What if the capability falls through? What if an emerging technology makes the capability obsolete? What if the capability takes longer than expected and does not get to the warfighter in time? What is Plan B? A few examples of crucial factors an organization must consider when managing capability development are deciding which capabilities would be best to invest in, and deciding the best time frame to invest. Similarly, questions of which capabilities should be shut down or modified need to be answered. The recent (2016) stand up of the Strategic Development Planning and Experimentation Office has created a need for researching how organizations outside of the Office, approached capability development. This research benefits the sponsor by looking at how sister Military Services, foreign militaries from a case study, and a few civilian sector organizations manage capability development in order to map the best and applicable practices to the Air Force.

1.4 Scope and Assumptions

Due to the vast possible sources for investigation, the scope limits the number of organizations studied in this research. These organizations include the Air Force, the Army, the Navy, foreign Military Services (from a case study), and a few Civilian service organizations. For addressing foundational understandings, we make an assumption that the current capability development management processes studied in the literature are not undergoing major changes due to unknown impending transformational technologies and

comparable uncertainties. Also, this research assumes that the mission of the SDPE Office will not change dramatically (to where this research becomes obsolete) within the timeframe of this research and presentation.

1.5 Approach

This research method gathers and analyzes documentation from military and civilian publications and articles to provide a solution to the problem statement presented in Section 1.2 of the Introduction. Articles were gathered through scholarly search engines, such as Google Scholar, the Defense Technical Information Center, and also through military publication search engines.

1.6 Research Questions and Objectives

The following questions provide the basis for this research:

Research Question 1:

How do other Military Services approach capability development management?

Research Question 2:

How do organizations from the civilian sector approach R&D portfolio management?

Research Question 3:

Are there any capability development management practices from other Military Services and civilian sector organizations that could be applied to the SDPE Office?

1.8 Thesis Preview

Chapter 2, the Literature Review, first synthesizes literature conveying the difficulty of managing capability development. Second, it dives into the background of Strategic Planning, Development Planning and Capability Development in the Air Force.

Third, it reviews the current capability development process used by the Air Force. Finally, it surveys how sister U.S. Military Services, three foreign Military Services, and a few civilian sector organizations manage capability development and Research and Development. The Analysis and Results section (Chapter 3) summarizes applicable tools and techniques for managing capability development and analyzes the overall trends and differences found in the research. Finally, the Conclusion (Chapter 4) presents the recommendations for the SDPE Office with practical implementation and wraps up the research with potential future work.

II. Literature Review

2.1 Introduction

2.1.1 Challenges in Capability Development and Management

The foundation for R&D is uncertainty. There would be no need to research or develop capabilities or products if everything was already known and understood (Matheson and Matheson, 2016:8). The development of a capability is surrounded by uncertainty. Changes in the warfighting environment, operational requirements or evolving technologies are a few of the uncertainties that affect capability development. One difficulty that Jain and Triandis note in their book *Management of Research and Development Organizations*, is deciding when to end a research and development effort "that does not seem to be solvable" (Jain and Triandis, 1997:13). Maintaining the researcher's "motivation and curiosity" (Jain and Triandis, 1997:4) is a challenge, but it is a source for advancing research and development through "scientific breakthroughs and product development" (Jain and Triandis, 1997:4). The unpredictability of circumstances and outcomes makes managing capability development a difficult task.

It takes time to develop capabilities, sometimes entailing "a decade or longer, which is beyond the lifetime of any administration" (Cohen, 2017:5). Keeping on track with timelines and deadlines is a challenge, especially with all of the uncertainties and risks that come with capability development. Also, if developing a capability requires action from multiple organizations, coordination can be a challenge, especially if a participating organization does "not have incentives to provide timely information" (Parnell and others, 2013:294). Sometimes, an interdependency, such as one capability

development project depending on the completion of another, can cause issues (Parnell and others, 2013:294). Also, predicting funding for development of a capability can be a challenge (Parnell and others, 2013:293).

Ultimately, Winthrop's words summarize the whole situation with capability development: "Predicting effectiveness for a technology, which has not yet been invented, against an unknown enemy, for an unknown battle, in an unknown environment is a daunting task. Yet, it is necessary to plan for an uncertain future" (Winthrop, 1999:3). The next section provides a brief history and background of capability development in the Air Force and the Department of Defense.

2.1.2 History and Background of Capability Development in the Air Force and DoD

Capability development stems from Strategic Planning, which is difficult because predicting the future is based on uncertainty (no human knows what is going to happen in the future). Still, Strategic Planning is essential and allows for the achievement of four tasks: "allocat [ing] and justify[ing] resources; structur[ing] the force; defin[ing] and shap[ing] the service's mission and even identity; and perhaps most importantly, creat[ing] a dialogue about the direction of the service" (Cohen, 2017:2). Cohen's analysis of the development of Strategic Planning in the Air Force covering the time frame from the end of the Cold War to the present, presented five lessons as a way forward in future Strategic Planning for the Air Force: "understanding the policy environment; encouraging ideas from the bottom; starting the strategy from the top; keeping the message succinct, substantive, and sharp; and focusing on process as much as product" (Cohen, 2017:2, 59-67). The last lesson is evident within the Air Force today

through its current Capability Development Process, but the process itself, as shown in the following paragraphs, needed development and has been developed over time.

Development Planning influences the Air Force's Capability Development Process through supporting senior leadership in strategic decision making (Air Force Studies Board, 2014:4), affecting which operational capabilities will be required to be developed in the long run. In the late 1970s, there was an emphasis on the process of Development Planning in the Air Force because General Slay, Commander of Air Systems Command at the time, understood and saw "the need for a better system to integrate the warfighter, S&T, and acquisition worlds" (Air Force Studies Board, 2014:15). In response to this need, the Vanguard program was introduced in 1978 and one major component was the tool nicknamed "Hooks and Strings" (Air Force Studies Board, 2014:14). This tool connected the combat commands, science and technology community, and acquisition centers by obtaining answers to questions such as "Do all Air Force advanced development (budget category 6.3) projects have a clear and recognized trace back to some stated Air force capability, deficiency, or operational requirement?" (Air Force Studies Board, 2014:14) and "Can assurance be provided that technology work accomplished or under way by the Air Force laboratories is not duplicated in contracts issued to defense contractors by Air Force program offices?" (Air Force Studies Board, 2014:14).

Vanguard had several advantages, many of which resemble how the Air Force approaches capability development today. One advantage of Vanguard was how it organized planning into three major "areas: (1) mission plans, (2) major force elements, and (3) functional plans" (Air Force Studies Board, 2014:14). These areas of focus grew

broader moving from “specific tasks” (Air Force Studies Board, 2014:14) with mission plans to broad tasks (functional plans) encompassing multiple missions (Air Force Studies Board, 2014:14). Another benefit from the Vanguard program was that an essential group of personnel was formed and gathered, and included members from a wide spread of fields, specifically intelligence, operations, acquisition, science and technology, industry, independent research and development, finance, logistics, and analysis, “who, together, identified the gaps, proposed solutions to mitigate the gaps, and built capability roadmaps that integrated technology needs and program needs over a 20-year period” (Air Force Studies Board, 2014:3). Finally, mandatory senior leadership meetings, that took budget and funding information into consideration, kept all of the Air Force domains and MAJCOMs accountable and involved in Development Planning (Air Force Studies Board, 2014:15).

Between the 1980s and the first decade of this century, attention for Development Planning (DP) reduced substantially due to a number of issues, including the downsizing and reorganization of the Air Force and a decline in funding for Development Planning (Air Force Studies Board, 2014:19-20). However, a fundamental analysis paper proposing an “operationally oriented process” (Kent, 1989:iii) for Defense planning in response to the disagreement between Congress and the defense community on the “relationship between U.S. military strategies and the defense budgets” (Kent, 1989:v) was published in 1989 by the late Glenn A. Kent. He was a defense policy strategist whose influence reached farther than his careers in the Air Force and the Research And Development (RAND) corporation alone. His analysis, titled “A Framework for Defense Planning” was completed for the Air Force, but is applicable to the other Services and the

DoD. His framework suggested the use of a capability hierarchy that "link[ed] strategies to tasks and programs" (Kent, 1989:16). In his words, "the approach provides a systematic tool for assessing the degree to which tasks are accomplished and operational objectives are achieved and for identifying problem areas" (Kent, 1989:16). The components of the capability hierarchy ordered from the operational level (low) to the strategic level (high) were: operational tasks, operational objectives, regional strategies, national military strategy, and finally the national security strategy (Kent, 1989:v-vi). Remnants of his "Force planning process" (Kent, 1989:16-18) and "Strategies-to-Tasks Process" (Kent, 1989:17-19) are observable in the interaction between the Air Force's current Strategy, Planning and Programming Process (SP3) and Capability Development Process.

Later in 2010, the Air Force Materiel Command Directorate of Intelligence and Requirements (AFMC A2/5) expressed the importance of Development Planning by publishing a Development Planning Guide (Intelligence, 2010). This guide framed Development Planning as an enabler for improving the acquisition process (Intelligence, 2010). Also, the early definition of Development Planning, represented in this Guide, encompassed many factors representative of capability development today, including cost, risk and performance assessments and "best practices and processes to ensure successful early acquisition planning" (Intelligence, 2010:1). As Development Planning went in and out of focus for a few years, its priority in the Air Force was firmly recognized in 2014 by the driving report titled: *Development Planning: A Strategic Approach to Future Air Force Capabilities* (Air Force Studies Board, 2014). This report was published by the Air Force Studies Board and the National Research Council. It

recommended that the *current* Air Force definition of Development Planning be established above all others and increased the awareness and importance of Development Planning and capability development across the entire Air Force.

In all branches of the military, before a capability can be developed, its requirement must be validated by senior leadership. After a capability requirement is validated, various organizations within a Military Service begin investigating in capability solutions. Defined by the Joint Chiefs of Staff are the two major approaches to filling capability requirements in the Department of Defense: *materiel* and *non-materiel* solutions. A *materiel* solution refers to "correction of a deficiency, satisfaction of a capability gap, or incorporation of a new technology that results in the development, acquisition, procurement, or fielding of a *new* item" (emphasis added) (Department of the Air Force, 2013:81). On the other hand, a *non-materiel* solution addresses capability development through eight categories distinguished by the following acronym: DOTmLPF-P (Joint Chiefs of Staff, 2015b). The eight categories are designated as follows: D – Doctrine, O – Organization, T – Training, m – materiel, L – Leadership and Education, P – Personnel, F – Facilities, and P – Policy. Please note that the "m" for materiel in the DOTmLPF-P acronym is distinct from the major approach to filling a capability requirement described earlier. Although both result as a physical item or software, the *DOTmLPF-P materiel* "is restricted to commercial or non-developmental items that may be purchased commercially or by purchasing more systems from an existing materiel program" (Department of the Air Force, 2013:82). Also, some references in this research distinguish these joint capabilities by using a capital M, Materiel, to refer to a *new* system, and a lower-cased m, materiel, to refer to a

commercial off-the-shelf (COTS) system. Unless otherwise noted, the term *materiel* in this research refers to the first definition (not DOTmLPF-P).

As mentioned above, the DoD handles capability gaps and opportunities through two major approaches: *non-materiel* and *materiel*. *Non-materiel* capability solutions come about through DOTmLPF-P changes, while *materiel* capability solutions come about through the Joint Capabilities Integration and Development System (JCIDS) process. The following section dives deeper into DOTmLPF-P changes, while the subsequent section reviews the JCIDS process.

Gaining capability through a *non-materiel* approach is possible by modifying a DOTmLPF-P area. The following section provides example scenarios in which capability requirements, gaps and opportunities were filled through Joint DOTmLPF-P changes. On a side note, the term "joint" in this research refers to a combination of DoD Military Services (i.e. does not include other departments in DoD or any external departments).

Doctrinal change.

Over time, the Army's sustainment doctrine contained over 100 manuals for topics ranging from field operations to tactics, techniques and procedures. Because of the vast amount of sustainment doctrine, soldiers found it hard to digest, keeping them from understanding the concepts and applying them where necessary. The capability gap of having insufficient awareness of sustainment doctrine in the community was addressed in 2012, when the Army published the Doctrine 2015 Initiative to consolidate doctrine for easier review and continuous updating (Hodge, 2012). Once the doctrine was reduced and released, sustainment soldiers gained the capability of quickly and sufficiently digesting doctrine in order to apply it when necessary.

Organizational change.

In relation to the rise in cyber attacks around the globe over the years, a capability gap of disjoint cyber forces was identified in the DoD. In 2009, the then United States Secretary of Defense directed the U.S. Strategic Command (STRATCOM) to establish CYBERCOM (Cyber Command), a joint subcommand, for addressing the capability gap of disjoint cyber forces and cyber vulnerabilities ("U.S. Cyber," 2016). In 2010, CYBERCOM was fully operational and the U.S. Department of Defense gained the capability of having a unified structure to perform joint military operations (defense and offense) in the cyber environment.

Training change.

In 2014, then Chairman of the Joint Chiefs of Staff General Martin E. Dempsey deliberated over the capability requirement for a future "ISR Joint Force" (Chairman of the Joint Chiefs of Staff, 2014:ii) in the *Intelligence, Surveillance, and Reconnaissance Joint Force 2020 White Paper*. Accordingly, a capability solution was implemented through regular Joint training exercises by the United States Special Operations Command (USSOCOM) in order to solidify joint Service collaboration and preparation for deployments. In particular, the USSOCOM Emerald Warrior 17 Training Exercise joined DoD conventional and special operations forces to incorporate "ISR Integration" (Holochwost, 2017: par. 6) of the MC-12 Aircraft, among other objectives; enhancing the ISR Joint Force capability that General Dempsey addressed in the paper mentioned earlier.

Materiel change.

In the late 1990s, the Navy's E-2 Hawkeye Mission Computer platform ran into a capability gap that "inhibited the ability to integrate modern, more advanced Command, Control, Communications, Computers, Intelligence and Surveillance (C4IS) weapons systems into the aircraft" ("E-2C," 2004:par. 5). To address the capability gap, the Navy worked with Northrop Grumman and developed a "Mission Computer Replacement" that used commercial off-the-shelf technology, allowing the aircraft to gain more reliability capability.

Leadership and Education change.

Officer leadership and education has evolved since the inception of each of the U.S. Military Services, but the requirement for educated and skilled leaders in the military to execute the President's orders in defending our nation has not changed (U.S. Const. art. II, sec. 3). This capability requirement is filled when various commissioning sources, i.e. a U.S. Service Academy, Reserve Officers' Training Corps (ROTC), or Officer Candidate School (OCS), supply the Military Services with critical thinking leaders with every Officer graduate.

Personnel change.

The Armed Forces need experienced and skilled military professionals in the workplace. Over time, the Department of Defense found a capability gap of losing professionals due to various individual life circumstances. In order to combat the loss of personnel, the DoD investigated various ways of retaining talent and experience in the Military Services, and as a result, the Career Intermission Program (CIP) was piloted in 2009 (United States Congress, 2008:Sec. 533) and extended to 2019 (United States Congress, 2014:Sec. 522). CIP gives each Military Service the capability of retaining a

certain amount of talent and technical expertise that would have been lost through separation (Navy Military Personnel Plans and Policy Director, 2017).

Facilities change.

From the 1940s to 1950s, the Navy built piers to enable ships to dock at bases for entry and departure (Cole and Farmer, 2007:1). Rising water levels at Naval bases and aging/degrading facilities created the capability requirement for better piers (Parker, 2017). In order to fulfill the need for upgrading and/or acquiring new piers, the Naval Station Norfolk "[chose] to replace its aging piers with double deck piers" (Cole and Farmer, 2007:1). These new double deck piers equip the Naval Station Norfolk to have the capability to face rising water levels with advanced protection and more efficient operations.

Policy change.

Recognition of the capability gap of potential loss of talent, motivated then Secretary of the Air Force Deborah Lee James to enact a Policy Memorandum involving new accessions into the Air Force in 2017 (Secretary of the Air Force, 2017). It allowed waivers on a case by case basis, for previously disqualifying medical matters, such as eczema and ADHD. The policy change also relaxed tattoo limits. These changes gave the Air Force the capability to "recruit and retain America's top talent, with the intent of ensuring that Air Force policy reflects a logical and evidence-based approach that is representative of today's society while also supporting the AF mission" (Secretary of the Air Force, 2017:Attachment).

The previous examples demonstrate how the DoD has successfully filled capability requirements and gaps through *non-materiel* solutions. The following

paragraphs give a brief overview of how *materiel* capability requirements and solutions are "identif[ied], assess[ed], validat[ed], and prioritize[ed]" (Joint Chiefs of Staff, 2015b:1) through the JCIDS process. The Joint Capabilities Integration and Development System (JCIDS) process is the formal procedure used for critically examining a *materiel* capability requirement before it undergoes the DoD Acquisition Process to result in a joint *materiel* capability solution. JCIDS is one of the three processes that make up the framework for the DoD Acquisition Process, as seen in Figure 1.

Figure 1. DoD Acquisition Process Framework ("JCIDS Process Overview," 2017)

The other two processes in the DoD Acquisition Process Framework are the Defense Acquisition System (DAS) process (not to be confused with the overall DoD Acquisition Process) and the Planning, Programming, Budgeting, and Execution (PPBE) process (*Defense Acquisition Guide*, 2017:Ch 1-3.2). As seen in Figure 1, all of these processes intertwine and affect each other (Department of Defense, 2017b:5). This framework shows how capability development is one of the many parts of an acquisition process.

At the beginning of the JCIDS process, capability needs and opportunities are identified by various entities including the Military Services, Combatant Commands (CCMDs) and Functional Capability Boards (Joint Chiefs of Staff, 2015a:page A-1). Afterward, these operational requirements are assessed, analyzed and compared by various tools, such as Capabilities Based Assessments (Joint Chiefs of Staff, 2015c:page C-B-1) and Capability Portfolios (Joint Chiefs of Staff, 2015c:pages B-1, B-5; Department of Defense, 2017a:2). Finally, the capability requirements are routed up through various Review Boards to result in a prioritized list of validated capability requirements that would best benefit the DoD overall (Joint Chiefs of Staff, 2015b:1-2). Now that the history and background of strategic planning, development planning, and capability development in the Air Force and DoD is familiar, the next section expands on the current status of capability development in the Air Force.

2.2 Current Air Force Capability Development Management Methods

Air Force capability development is organized as "an iterative, need-driven cycle" (Department of the Air Force, 2016:21). The needs for capability development are products of strategic-level guidance and planning events. These events tackle high-level problem areas and future objectives by considering inputs from various Air Force "entities," (Department of the Air Force, 2016:22) including Major Commands (MAJCOMs), Headquarters Air Force (HAF), Capability Development Working Group (CDWG) and Core Function Leads (CFLs) (Department of the Air Force, 2016:22).

The Air Force Capability Development Process is shown in Figure 2, which depicts how actions and events feed into (illustrated by the arrows) each other. The Air

Force Capability Development Process starts by laying out all of the capabilities that are currently available, and then aligning them with Air Force Strategy (Step 1). Next, gaps and opportunities in capability are identified, and then prioritized (Step 2). Following prioritization, the Capability Development Working Group examines all of the information gathered about the needs of the Air Force and recommends to Senior leaders (Secretary of the Air Force and Chief of Staff of the Air Force), a limited number of primary "focus areas" (Department of the Air Force, 2016:23) that impact multiple domains of the Air Force (Step 3). Then, Air Force Senior leaders select the areas they deem to have greatest precedence (Step 4) and Analysis teams, including Enterprise Capability Collaboration Teams (ECCTs), are formed and instituted to tackle and mitigate those issues/opportunities (Step 5). After ECCTs/Analysis teams are coalesced, "Capability Development Plans and Roadmaps" (Department of the Air Force, 2016:24) are created and submitted to Senior leadership for review and approval (Step 6). Once a Capability Development Plan (CDP) is approved, "Development Planning and Experimentation" (Department of the Air Force, 2016:23) is initiated through "non-materiel and JCIDS acquisition processes" (Department of the Air Force, 2016:25; Directorate, 2017) and Courses of Actions (COAs) are researched, analyzed, developed, and tested by the ECCTs/Analysis teams (Step 7). Periodic reviews by the Capability Development Council (CDC) and Senior leadership focus on: "ECCT progress" (Department of the Air Force, 2016:25) and possible changes to Strategic priorities.

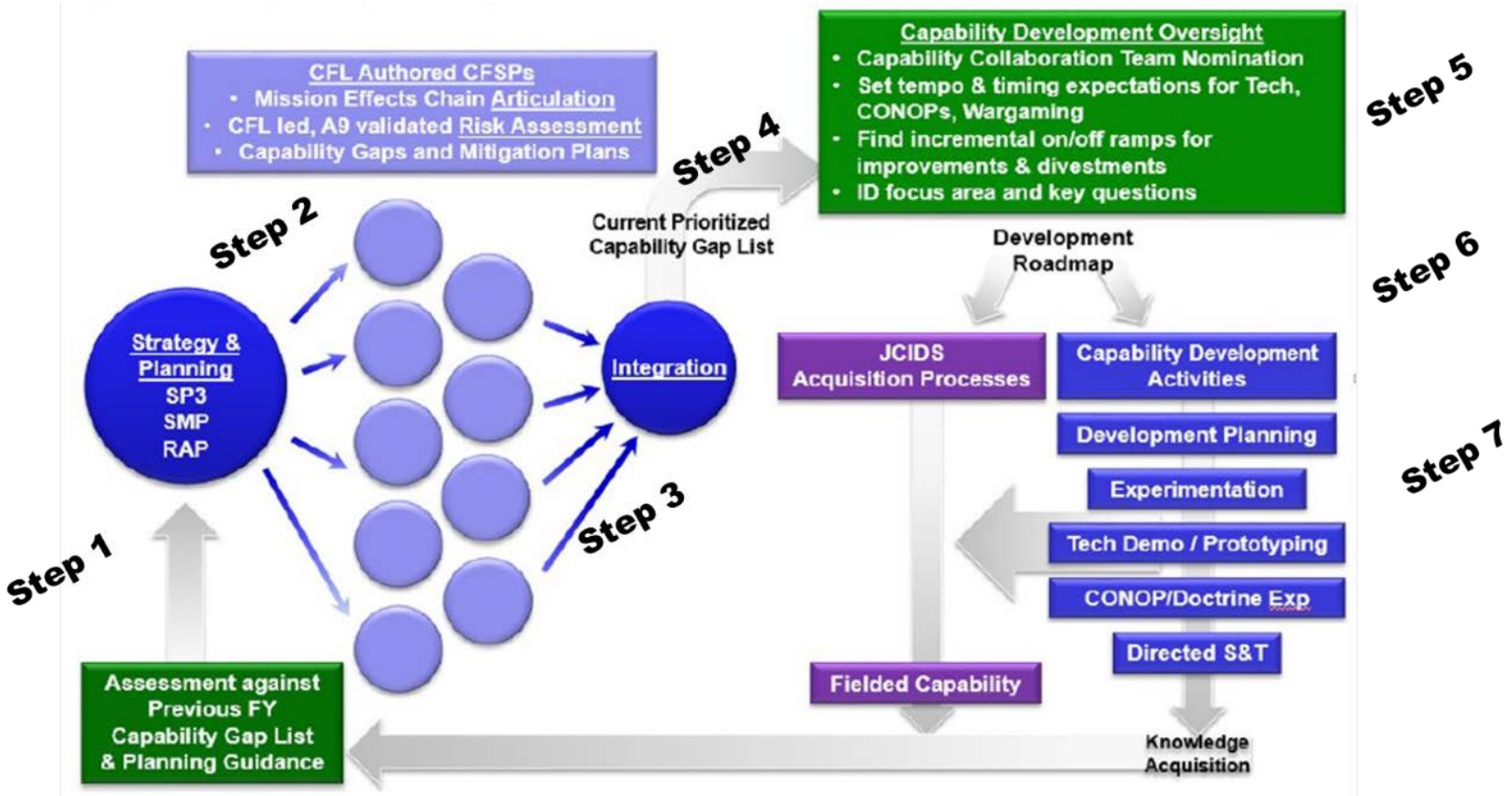

Figure 2. Air Force CD Process Overview (modified from Fig. 5.2 of AFGM 2016-90-1101)

The SDPE Office is involved in steps four through seven of the Capability Development Process. After senior leaders select the "focus areas" in step four and institute the ECCTs in step five, the SDPE Office is notified and begins supporting and managing the ECCT and monitoring progress of achieving the goals set forth by senior leadership. In step six, the SDPE Office keeps record of the Capability Development Plan(s) for future reference. In the final step, the SDPE Office sponsors Experimentation Campaigns and keeps records of ECCT research and analysis. Even after the ECCT is decommissioned after a year, the SDPE Office is responsible for continuity and expertise of ECCT knowledge, documentation, recommendations, etc. Considering all this, the Air Force Capability Development Process gives a general overview of how the Air Force currently manages capability development and provides a basis for understanding and comparing other methods of management.

A related method for managing capability development is making use of a Value Hierarchy Model, a tool found in the Operations Research Decision Analysis (DA) field. The following paragraphs briefly summarize Decision Analysis, explain Value Hierarchy Models, and lastly describe an Air Force application of Value Hierarchy Models. According to Keeney, Decision Analysis is "a philosophy, articulated by a set of logical axioms, and a methodology and collection of systematic procedures, based upon those axioms, for responsibly analyzing the complexities inherent in decision problems" (Keeney, 1982:806). The analysis in DA is meant to "illuminate complexity and provide insight" (Keeney, 1982:803). The guiding motivation for Decision Analysis is to consistently and continually make better decisions. Oftentimes, an organization's success is based off of its decision-making ability, which involves *how* it approaches decisions

and how it strives to *improve* decision-making. Typically, as an organization continues making better (good and sound) decisions, more successful outcomes (rather than unsuccessful) result (Parnell et al., 2013). One method for helping make better decisions is Value-Focused Thinking (VFT).

The Value-Focused Thinking approach to decision making made a large impact in the Decision Analysis field. Keeney sums up the difference between VFT and traditional Alternative-focused thinking: "Value-focused thinking involves starting at the best and working to make it a reality. Alternative-focused thinking is starting with what is readily available and taking the best of the lot" (Keeney, 1992:6). In the end, Value-Focused Thinking "should lead to better consequences" (Keeney, 1992:viii). One tool used for deconstructing complex decisions through VFT for better decision making is the Value Hierarchy Model.

The Value Hierarchy Model was created to help a Decision maker(s) (DM) evaluate decision alternatives based off his or her values/criteria/objectives. A Value Hierarchy Model is structured in layers that become increasingly detailed moving from the decision to be made (first, most broad layer), to the Decision maker's values immediately after, followed by the middle level objectives and criteria, and finally to the last level of evaluation measures. An example of a Value Hierarchy that was used to analyze a decision to buy the best word processor software (Kirkwood, 1997:15) is represented in Figure 3.

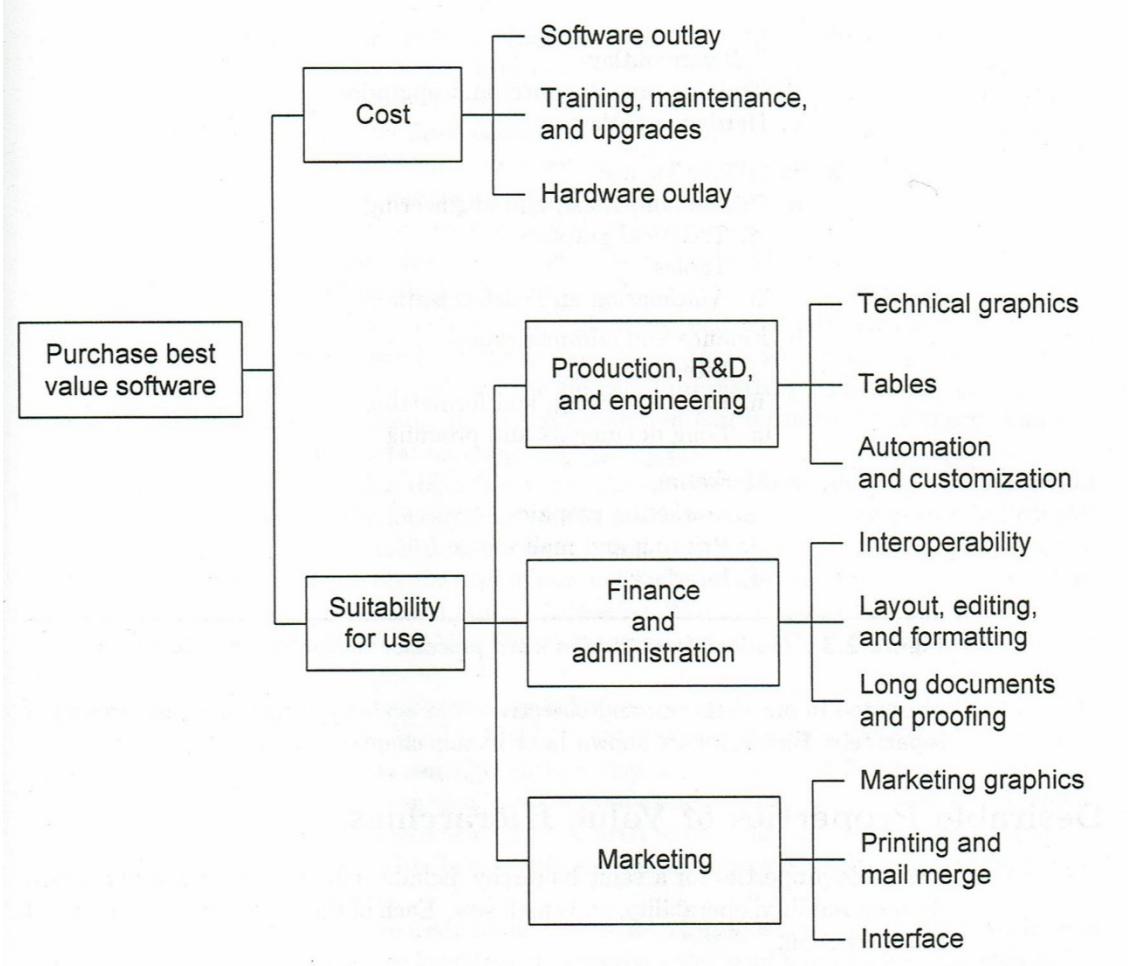

Figure 3. Word Processor Decision Value Hierarchy Example (Kirkwood, 1997:15)

The company utilizing the Value Hierarchy in Figure 3, values both "cost" and "suitability for use" (Kirkwood, 1997:15) for deciding which word processor to purchase. Each of those values can be further decentralized into various objectives and criteria. Finally, the tail ends of the objectives contain reasonable measures for evaluating how well the corresponding objective or criteria is met.

An example of a VFT Value Hierarchy Model used for Air Force capability management is found within Winthrop's thesis titled: *Technology Selection for the Air Force Research Laboratory Air Vehicles Directorate: An Analysis using Value Focused*

Thinking (Winthrop, 1999). His Sponsor, the Air Force Research Laboratory (AFRL) Air Vehicles Directorate, was responsible for deciding on technology investments for the future. Therefore, Winthrop created a "Technology Selection Model" (a Value Hierarchy variant) that integrated and utilized Air Force level values to evaluate various technology investment options (Winthrop, 1999:3). Value Hierarchy Models are still used today and one containing SDPE and Air Force values, objectives, and evaluation measures could be used as a tool to manage capability development. Attention to capability development is not only restricted to the Air Force; the Army and the Navy concentrate on capability development as well.

2.3 Capability Development in Sister Military Services

2.3.1 Army

TRADOC, one of the Army's three Commands, stands for Training and Doctrine Command. It focuses on "chang[ing] the Army for the Future" ("TRADOC," 2017) through four priorities: Design, Acquire, Build, and Improve as seen in Figure 4. Figure 4 also displays TRADOC's Army Capabilities Integration Center (ARCIC), which is a Core Function Lead that was instituted in 2006 (Department of the Army, 2006b). ARCIC supports the Army through concept and capability development, evaluation, and integration "across DOTMLPF, functions and formations – to provide Soldiers and units the capabilities they need to support Combatant Commanders" (Department of the Army, 2013:16). ARCIC's Capabilities Development Directorate is divided into nine divisions that focus on perspectives ranging from the "Reliability, Availability and Maintainability (RAM) requirements and policy" ("Capabilities Development," 2018) to the "human

dimension ... encompassing the cognitive, physical, and social components to optimize the performance of Soldiers, leaders, and teams" ("Capabilities Development," 2018; Department of the Army, 2006a:6). These divisions and directorates support the Combined Arms Center's (CAC) Centers of Excellence (CoEs) (Department of the Army, 2013:138). These CoEs are divided by the Army's functional areas, such as Fires, Maneuver, and Cyber, as seen in Figure 4.

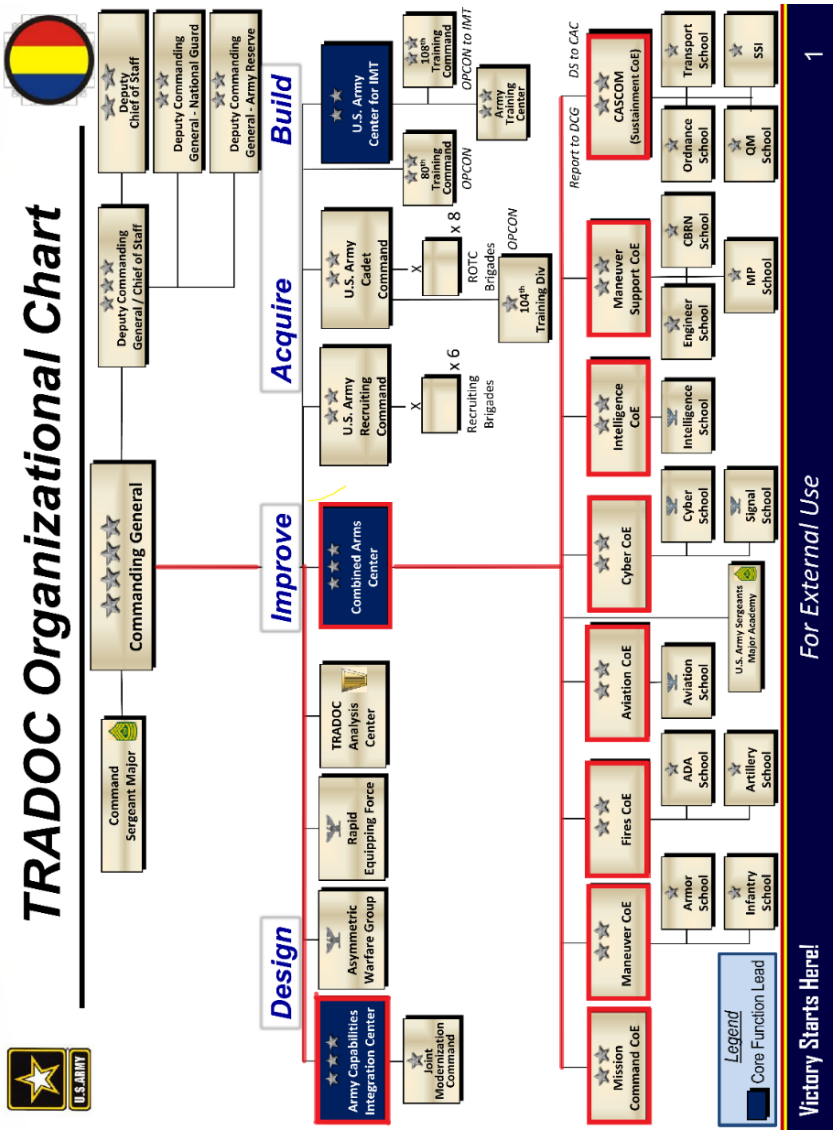

Figure 4. TRADOC Organizational Chart (adapted from ("TRADOC," 2018))

The Army manages capability development in three phases: (1) *Concept Development*, (2) *Capabilities Determination*, and (3) *Capabilities Integration* (Department of the Army, 2013:9-12). As a brief introduction, concepts were contemplated in 1979 by then Army TRADOC Commander, General Donn A. Starry in his Commander's Notes Number 3 titled, "Operational Concepts and Doctrine" (Army Commanding General, 1979). The Joint Chiefs of Staff *Guidance for Developing and Implementing Joint Concepts* specifies that a joint concept "identifies a current or future military challenge and proposes a solution to improve the joint force's ability to address that military challenge. A joint concept may also propose new ways to employ the joint force based on future technology" (Joint Chiefs of Staff, 2016:GL-4). Taking both of the previous references into consideration, the Army recognizes that concepts define four areas: "how the force functions (operational concept), the timeframe and conditions it must be able to operate in (the OE), its physical and organizational characteristics (design parameters and architecture), and what it must be able to execute (required capabilities) in terms of performing missions or producing effects" (Department of the Army, 2013:33). The development of concepts in the Army is based off of the Joint Concept Development Process. This process is part of the Joint Concept Life Cycle, as seen in Figure 5. The Joint Concept Development Process starts with "identify[ing] future military challenges" and ends with "concept approval" (Joint Chiefs of Staff, 2016:A-6). Note that a Joint Concept General Officer Steering Committee (JC GOSC) is responsible for "guidance and oversight of the JCD [Joint Concept Development] Program" (Joint Chiefs of Staff, 2016:D-3).

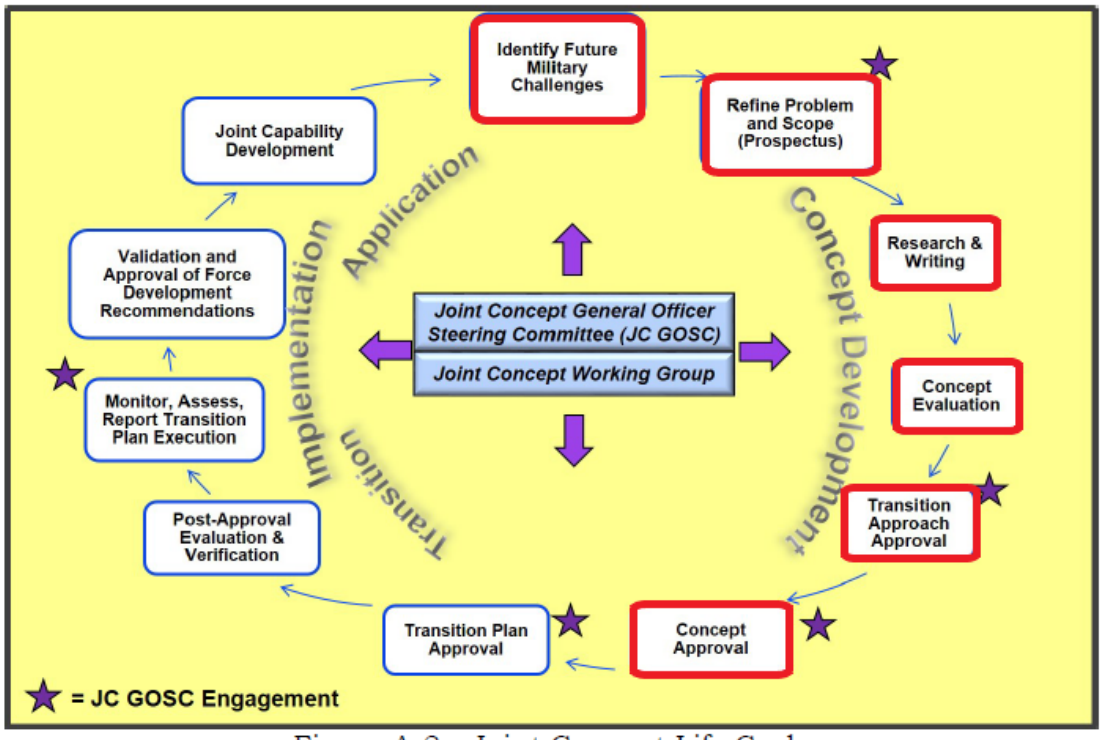

Figure A-2. Joint Concept Life Cycle

Figure 5. Joint Concept Life Cycle (Joint Chiefs of Staff, 2016:A-6)

One of the things that the Army Concept Framework (ACF) identifies and produces is required capabilities. The ACF organizes concepts into four sections: (1) the Army Capstone Concept (ACC), (2) the Army Operating Concept (AOC), (3) Army Functional Concepts (AFC), and (4) advisory documents (i.e. “white papers and concept of operations (CONOPS) papers” (Army Training and Doctrine Command, 2014:9)). The amount of detail describing concepts increases as one moves from the Army Capstone Concept (section 1) of the ACF, to the Army Functional Concepts (section 4). The Army Capstone Concept gives a general overview of “how the future Army, as part of the joint force, will operate across the range of military operations” (Army Training and Doctrine Command, 2014:8). The Army Capstone Concept guides the Army Operating Concept and both, in turn, guide the Army Functional Concepts. Required capabilities are detailed

enough in the Army Functional Concepts, that Capabilities Based Assessments (CBAs) can be created from them (Army Training and Doctrine Command, 2014:8-9). A CBA is defined as "an analytic process that identifies capability requirements and associated capability gaps" (Joint Chiefs of Staff, 2016:GL-3). The Army Concept Framework and the Army Concept Development Process are embedded in the "Concept" portion of the Army's Concept to Solutions Roadmap, displayed in Figure 6.

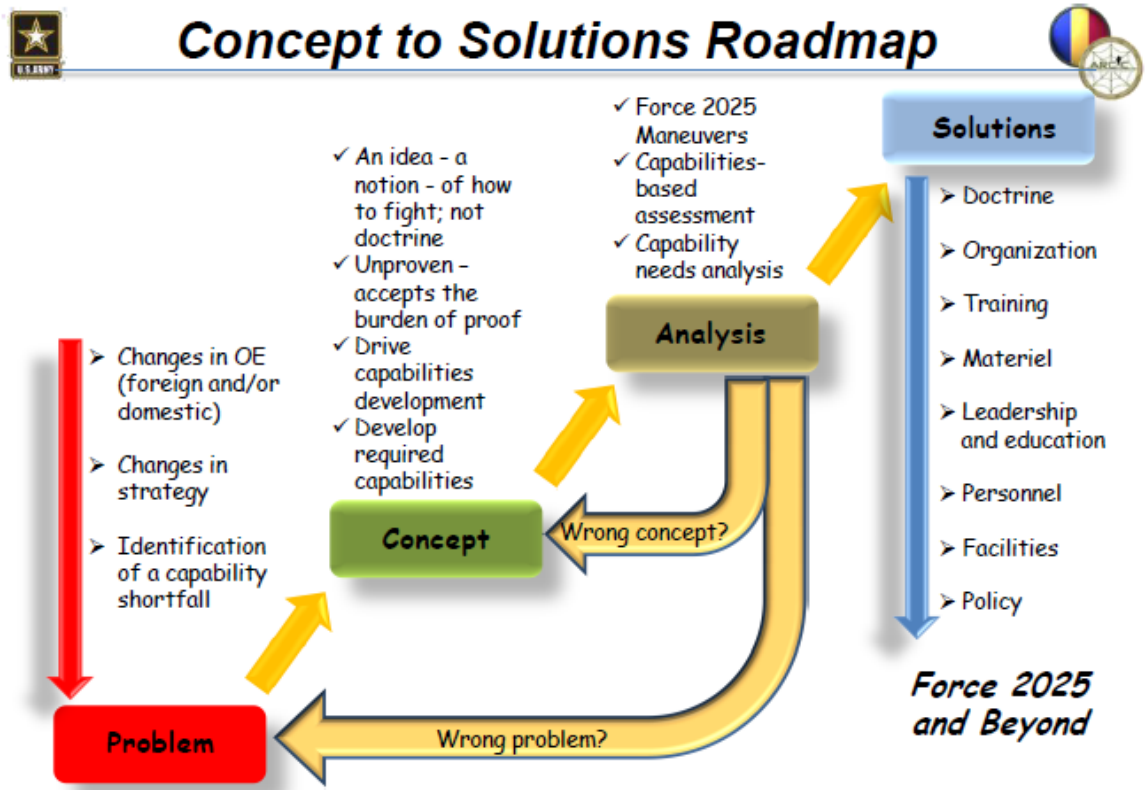

Figure 6. Army Concept to Solutions Roadmap (Army Training and Doctrine Command, 2014:10)

The Army's capability development management phases of *Concept Development*, *Capabilities Determination*, and *Capabilities Integration* are embedded in the Army Concept to Solutions Roadmap. In the Army's Concept to Solutions Roadmap,

concepts are based on problems/challenges that come up due to a number of reasons, such as changes in the Operational Environment, weaknesses in current capabilities, or changes in strategy directed by higher level leadership (Army Training and Doctrine Command, 2014:10). The drafted concepts address the problems. Afterward the concepts are evaluated during the "Analysis" phase to ensure that the concepts themselves, and the associated capabilities are qualified for further development (*concept development*). Finally, once the "concept-required capabilities" (Joint Chiefs of Staff, 2016:A-3) are determined (*capabilities determination*), they are integrated "to merge, de-conflict, and synchronize functional, organizational, and DOTMLPF capability requirements and solutions to unify and improve warfighting capabilities" (Department of the Army, 2013:41) (*capabilities integration*). The next section investigates how the Navy manages and organizes capability development and integration.

2.3.2 Navy

The Department of the Navy is organized into three overarching areas: Executive, Shore Establishment and Operating Forces ("United States Government Manual," 2017:Department of the Navy). Each of these areas has entities that contribute to developing and integrating capabilities for the Navy. For the Executive area, the Office of Naval Research (ONR) researches, provides, and manages capabilities for the Navy. The Navy's Shore Establishment contains several Systems support components for the Navy's Operating forces (referred to as the "Fleet"), as highlighted in the Shore Establishment row in Figure 7.

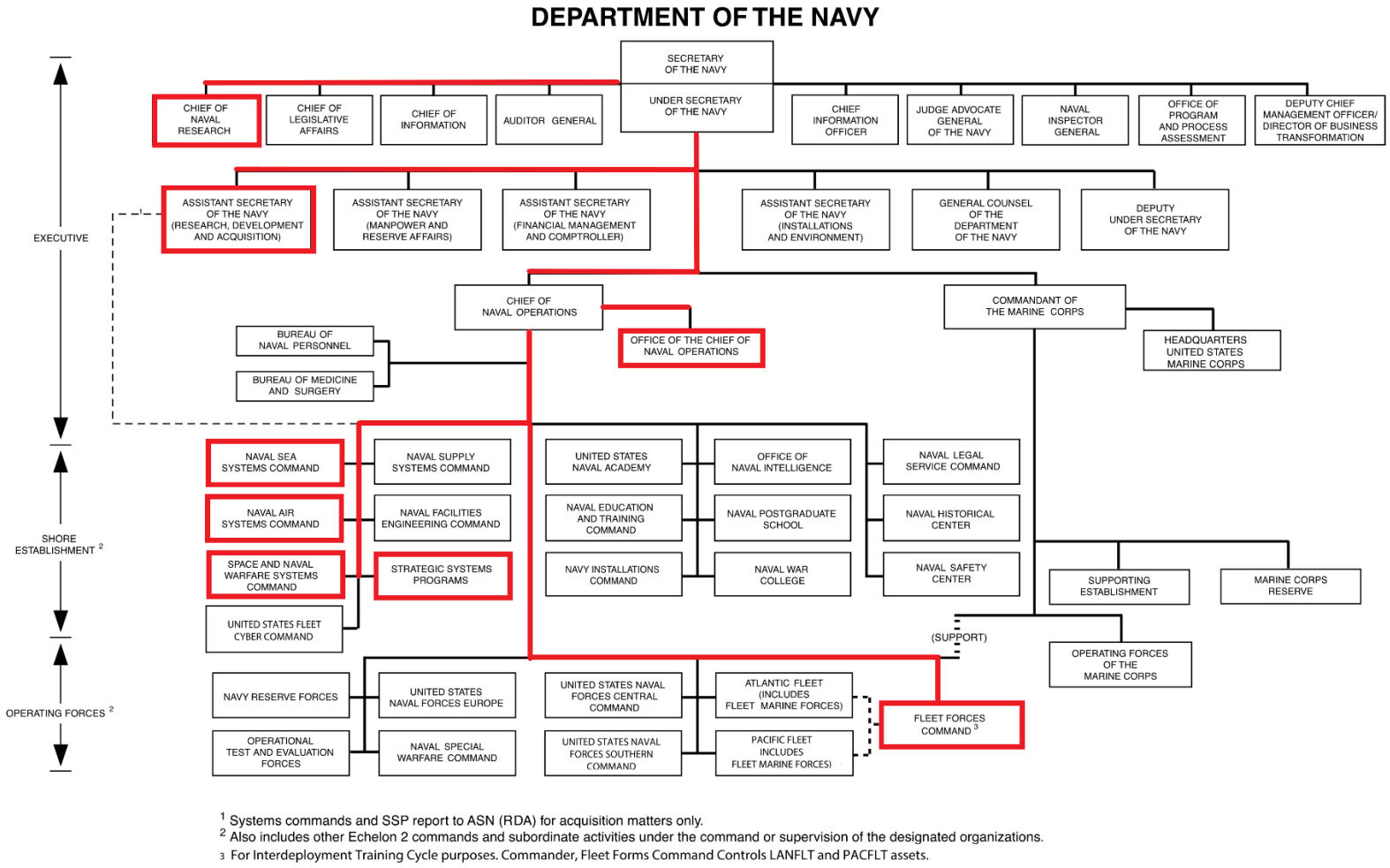

Figure 7. Naval Shore Establishment and Operating Forces (“United States Government Manual,” 2017:Department of the Navy)

Four of the Systems Commands of the Navy's Shore Establishment provide and manage significant capabilities pertaining to: Naval Sea Systems, Naval Air Systems, Space and Naval Warfare Systems, and Strategic Systems ("United States Government Manual," 2017:Department of the Navy). Also, the Naval Warfare Development Command and Navy Warfighting Development Centers directly support the Operating Forces (Department of the Navy, 2018), as seen in Figure 8.

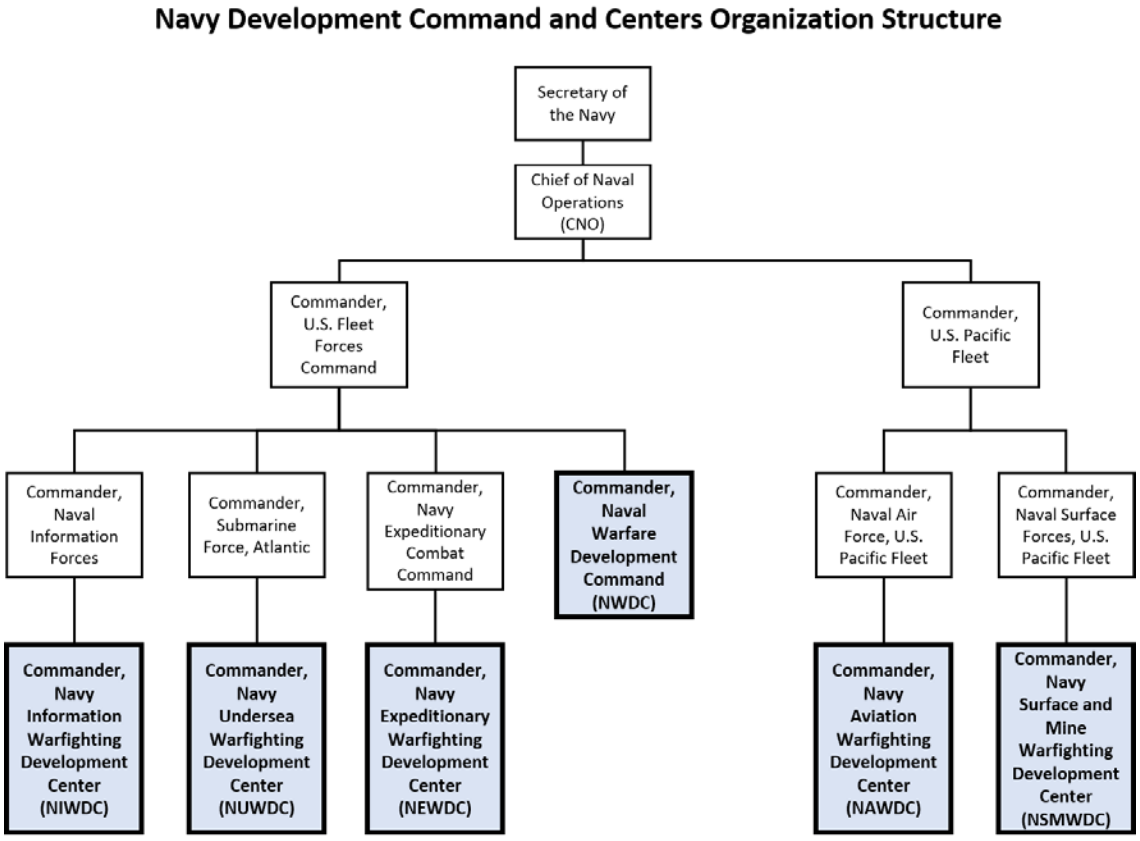

Figure 8. Navy Development Command and Centers

The Navy Warfighting Development Centers (WDC) were established within the last five years at the direction of the Chief of Naval Operations (Deboer, 2017:par. 9; "Wanted," 2017:6). They support the Navy Fleet by integrating their individual warfighting Focus

Areas (information, undersea, expeditionary, aviation, and surface and mine) "into Naval warfighting" (Deboer, 2017:par. 11). Each WDC engages in four lines of operation: (1) "enhancing advanced level training" (Deboer, 2017:par.6), (2) "development of doctrine" (Deboer, 2017:par. 7), (3) "cultivat[ing] and develop[ing] … subject matter expertise" (Deboer, 2017:par. 8), and (4) assessing the organization's three other lines of operation and its other capabilities for improvement (Deboer, 2017:par. 9).

The Naval Warfare Development Command (NWDC) was established in 1998 (Navy Warfare, 2017b:par. 8) and it is currently responsible for the development and integration of "innovative solutions to complex naval warfare challenges to enhance current and future warfighting capabilities" ("The NWDC Mission," 2018) *across* the Navy, similar to the Air Force's Strategic Development Planning and Experimentation Office's role. It carries out its duties through heading the Navy Capability Generation and Concept Development Program (Department of the Navy, 2014:9) and conducting "a variety of forums including flag level summits, tactical and operational level war games, and fleet experimentation initiatives that bring together all the WDCs in order to get at fully integrated, all-domain solutions" (Navy Warfare, 2017a:par. 3). The seven areas of responsibility for NWDC are: Concepts, Concept of Operations (CONOPS), Experimentation, Doctrine, Lessons Learned, Wargaming, and Modeling & Simulation ("Products and Services," 2018).

One finding from the previous sections of research on Navy structure was that it grouped capability development into significant Focus Areas (Sea Systems, Air Systems, Information Warfighting, Expeditionary Warfighting, etc.) and then assigned organizations to each Focus Area. Then, some of the organizations were held responsible

for managing capability development through an inner office, center, or structure. For example, the “Air Systems” Focus Area is led by the Naval Air Systems Command (NAVAIR), which has assigned two noticeable capability development management branches, namely, *Research & Engineering* and *Test & Evaluation* (“NAVAIR Overview," 2017), as shown in Figure 9.

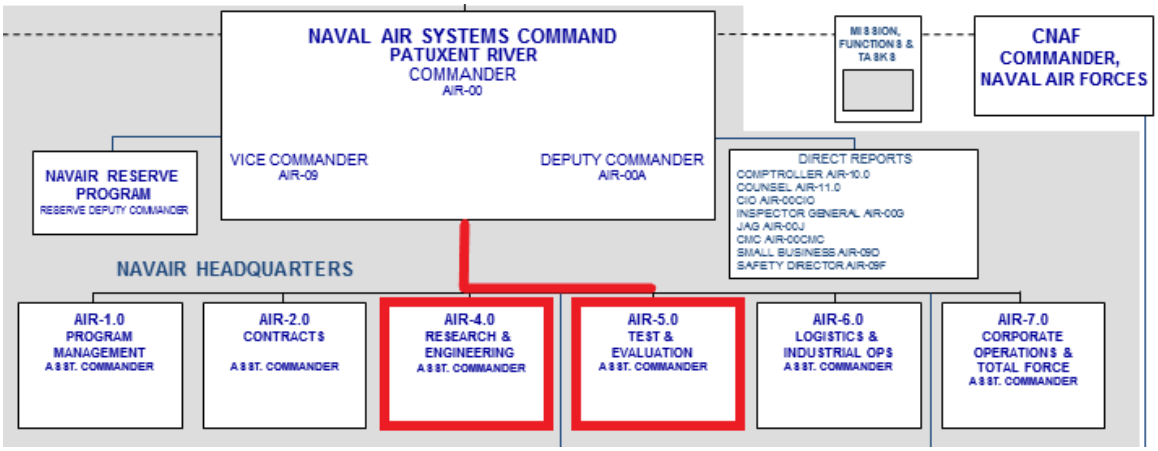

Figure 9. Naval Air Systems Command Structure (“NAVAIR Overview," 2017)

Another way that the Navy manages capability development is through senior level review boards. In 2008, the Department of the Navy established two authoritative Capability Boards: the Resources and Requirements Review Board (R3B) and the Naval Capabilities Board (NCB). The 3-Star General level R3B is the ultimate decision authority on “Navy capability requirements” (Department of the Navy, 2008b:1), while the NCB manages capability development one level below the Resources and Requirements Review Board “by reviewing and making decisions on Navy requirement and resource issues” (Department of the Navy, 2008a:1). Two key members of the Resources and Requirements Review Board who have capability development management responsibilities are the Deputy Chief of Naval Operations for Integration of

Capabilities and Resources (CNO N8) and the Principal Deputy Assisant Secretary of the Navy (Research, Development, and Acquisition) (PDASN (RD&A)) (Department of the Navy, 2008b:2). These two individuals play an important role in the Naval Capability Development Process and their positions provide more understanding of how the Navy structures capability development.

Capability development "decision making authorit[y]" (Department of the Navy, 2008b:Encl. 1) is divided between the two Boards based off of DoD Program Acquisition Categories (ACATs) and other classifications. As a brief introduction to ACATs, an Acquisition Program is defined as "a directed, funded effort that provides a new, improved, or continuing materiel, weapon or information system, or service capability in response to an approved need" (Department of Defense, 2007:2). The DoD organizes Acquisition Programs into categories (ACATs) that are primarily designated by Research, Development, Test, and Evaluation (RDT&E) thresholds and Total Procurement thresholds, as seen in Table 2.

Table 2. ACAT Categories and Thresholds (adapted from DoDI 5000.02, Table 1)

Acquisition Category (ACAT)	**RDT&E** (FY) 2014 Constant Dollars	**Total Procurement** (FY) 2014 Constant Dollars
ACAT I	> $480 Million	> $2.79 Billion
ACAT II	> $185 Million	> $835 Million
ACAT III	< ACAT II	< ACAT II

In the Navy, the Resources and Requirements Review Board is assigned as the "decision making authorit[y]" (Department of the Navy, 2008a:Encl 1) for ACAT I programs that

have the Joint Requirement Oversight Council's (JROC) special attention, while the Naval Capabilities Board is responsible for ACAT II programs with "non JROC interest" (Department of the Navy, 2008a:Encl 1). Both the R3B and NCB being involved in the Capability Development Process of the Navy, supports evidence of more of the Navy's structure for managing capability development and integration.

The Naval Capabilities Development Process (NCDP) capitalizes on Capabilities Based Assessments (Department of the Navy, 2011:page 1-5) and is summarized in Figure 10.

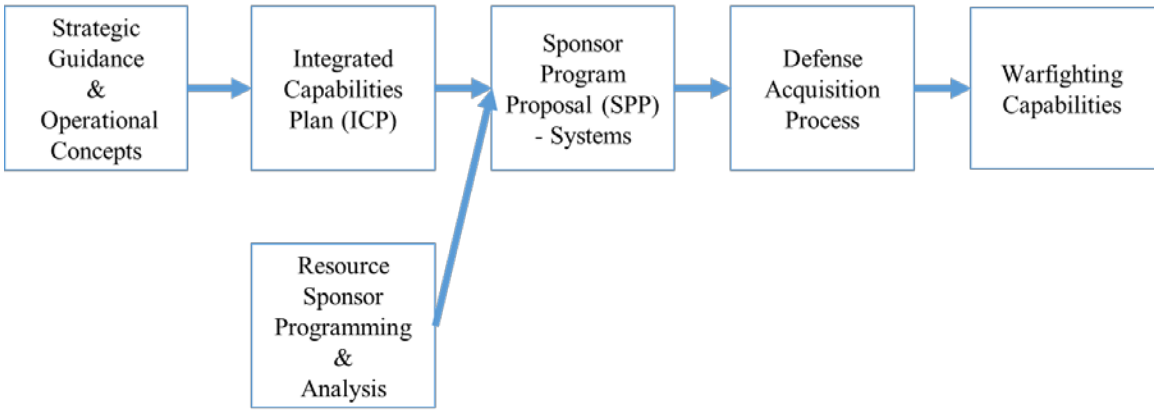

Figure 10. NCDP (adapted from SECNAVINST 5000.2, page 1-5)

The Naval Capabilities Development Process takes guidance from strategy and warfighter concepts to produce the Integrated Capabilities Plan (ICP) (Department of the Navy, 2011:page 1-5). The ICP is a portfolio of all of the Navy's capability investments and "serves as the Navy's 'warfare investment strategy' for programming operational capabilities" (Department of the Navy, 2011:page 1-5). While the Integrated Capabilities Plan is being formed, organizations who will be sponsoring resources for a capability are managing finances through "programming and analysis" (Department of the Navy,

2011:page 1-5). Both the Integrated Capabilities Plan and the resource sponsor's Planning, Programming, Budgeting, and Execution activities are used to form the Sponsor Program Proposal (SPP). The SPP delineates the Systems that corresponding operational capabilities (listed in the ICP) are contingent upon for functionality. For clarification, an example of the dependent relationship between a *System* and a *capability* can be seen with the "Duplexer" Naval Radar System. Before this System was made available, an individual antenna was capable of either only transmitting or only receiving data. The "Duplexer" System activated the capability of both "transmitting and receiving" ("Naval Radar Systems," 2018) data through one antenna. Moving back to the Naval Capabilities Development Process, after a System is validated through the Sponsor Program Proposal, it is acquired through the DoD Acquisition Process, ultimately resulting in a capability being put into the hands of the warfighter (Department of the Navy, 2011:page 1-5). The next section reviews how a few civilian sector organizations and foreign militaries approached capability development management.

2.4 Civilian R&D and Foreign Military Capability Development Management

The primary motivations to develop capabilities, found in the literature for this section, were national defense (Lee and Yoon, 2015:1309-1310), market competition (Kolk and Rungi, 2012:6), and organization/personal improvement (Matheson and Matheson, 2016; Covey, 2004). For the national defense motivation, Lee and Yoon compare the development of three foreign military aircraft industries. Each aircraft industry development process involved four key factors: (1) "international technology transfer agreements" (Lee and Yoon, 2015:1296), (2) the "technology acquisition mode"

(Lee and Yoon, 2015:1297), which referred to the initial emphasis of either making or buying aircraft at the start of the industry, (3) the "role of foreign partners" (Lee and Yoon, 2015:1296) either actively or passively engaging with the respective developing aircraft industry, and (4) government "industrial policy initiatives" (Lee and Yoon, 2015:1299) in support of Research and Development. An aircraft industry gained further development as factors one, three, and four improved. Currently, South Korea, China and Brazil have an improved military capability of national defense due to the development of each respective aircraft industry.

For the market competition motivation, Kolk and Rungi studied and assessed how four major "information and communication technology (ICT)" (Kolk and Rungi, 2012:6) companies developed capabilities in relation to market partnerships. They categorized ICT capabilities into four areas: Transformative, Intrinsic, Directions, and Combinative (Kolk and Rungi, 2012:12-13). Transformative and Intrinsic Capabilities sided on "exploitive" (Kolk and Rungi, 2012:5) activities, while Directions and Combinative Capabilities sided on "explorative" (Kolk and Rungi, 2012:7) activities. In organizational learning theory, *exploitation* deals with "practicing activities" (Kolk and Rungi, 2012:7) while *exploration* deals with "learning activities" (Kolk and Rungi, 2012:7). After analyzing market evolvement information on each ICT company, Kolk and Rungi found that overall, the majority of capability focus was on exploitive activities (Kolk and Rungi, 2012:15-16). They also confirmed that all of the companies exhibited "open" partnerships (Kolk and Rungi, 2012:12). "Open" partnerships meant a company displayed a minimal number of repeated alliances with other firms and more alliances with firms outside of their Standard Industrial Classification (SIC) business fields (Kolk

and Rungi, 2012:10). Kolk and Rungi's organization of Google, Ericcson, Microsoft, and Nokia's capabilities, to study the development in respect to "market emergence, market take-off, and market growth" (Kolk and Rungi, 2012:14), provide "best practices in capability development that other companies could follow to achieve similar results and benefits" (Kolk and Rungi, 2012:6). Their conclusion that "exploitation prevails over exploration" (Kolk and Rungi, 2012:18) conflicts with the Department of Defense's emphasis on the need for innovation and exploration in the Services.

For the organization/personal improvement motivation, Covey focuses on improving an individual's personal effectiveness based on "universal, timeless, self-evident *principles* common to every enduring, prospering society throughout history" (Covey, 2004:7), and Matheson and Matheson argue that enhancing decision making brings improvement and success to an organization. In order to develop the capability of being personally effective, Covey expounds on seven achievable habits, each based on a "principle or natural law that governs the results you seek" (Covey, 2004:7). These habits and corresponding principles are organized in Figure 11.

HABIT	Be Proactive	Begin with the End in Mind	Put First Things First	Think Win/ Win	Seek First to Understand, Then to be Understood	Synergize	Sharpen the Saw
PRINCIPLE	Principles of Personal Vision	Principles of Personal Leadership	Principles of Personal Management	Principles of Interpersonal Leadership	Principles of Empathetic Communication	Principles of Creative Cooperation	Principles of Balanced Self-Renewal

Figure 11. Covey's Seven Habits and Principles (Covey, 2004)

Understanding and instilling "realities" (Covey, 2004:24) and principles and working to develop and achieve the seven habits, brings personal improvement and effectiveness.

Matheson and Matheson agree that “smart” decision making will both orient and keep an organization on the path to success. In the 1990s, they conducted a study of how hundreds of companies (ranging from industrial chemicals and petroleum products to electronic equipment and aerospace/defense) managed research and development (R&D) decision making (Matheson and Matheson, 2016:65-6). After interviews and questionnaire exchanges with the companies, Matheson’s Strategic Decision Group compiled, identified, and developed a list of best practices for decision making (enumerated in Section 3.2.1) (Matheson and Matheson, 2016:70-73). By working to make these best practices a reality, an organization improves its R&D decision making, which in turn, improves the organization itself.

Although the motivation for developing capabilities was different for all of the studies in this section of the research, evidence of structure and management being necessary for each capability development process was the same. This necessity prompts the search for practices that would benefit the SDPE Office’s management of responsibilities.

III. Analysis and Results

3.1 Introduction

This section explores the tools and techniques that were chosen to be applied to the Strategic Development Planning and Experimentation Office's scenario of managing their responsibilities and capability development. It also examines trends and differences found among the Air Force, Army, and Navy.

3.2 Applicable Tools, Techniques

The following sections describe tools and techniques found in the literature that have applicable use for the SDPE Office. First, their original application and setting are described. Second, the application to the SDPE Office is described for future adaptation or consideration.

3.2.1 Span of Control diagram with Best practices

In *The 7 Habits of Highly Effective People*, Covey categorizes problems of life into three encompassing areas: Circle of Influence, Circle of Concern, and then No Concern. The Circle of Influence is inside the Circle of Concern, while No Concern is placed outside the Circles. He specifies these Circles further into four areas: Direct Control, Indirect Control, No Control, and No Concern (Covey, 2004:85-86). An example of an area in which one has direct control over is one's own behavior. Those problems that we have influence over but do not directly control, often "[involve] other people's behavior" (Covey, 2004:85). The areas of Concern in our lives that we have no control over, cover issues "we can do nothing about, such as our past or situational realities" (Covey, 2004:85). Finally, there are problems in life that do not concern us at

all. As one works in the area of Direct Control, one's Circle of Influence expands in the Circle of Concern. Covey's organizational structure of life problems for personal use, can be used to organize the SDPE Office's responsibilities for managing capability development. For this research, Covey's areas are slightly adapted into the categories of Control, Direct Influence, and Indirect Influence, as shown in the SDPE Office Span of Control Figure 12.

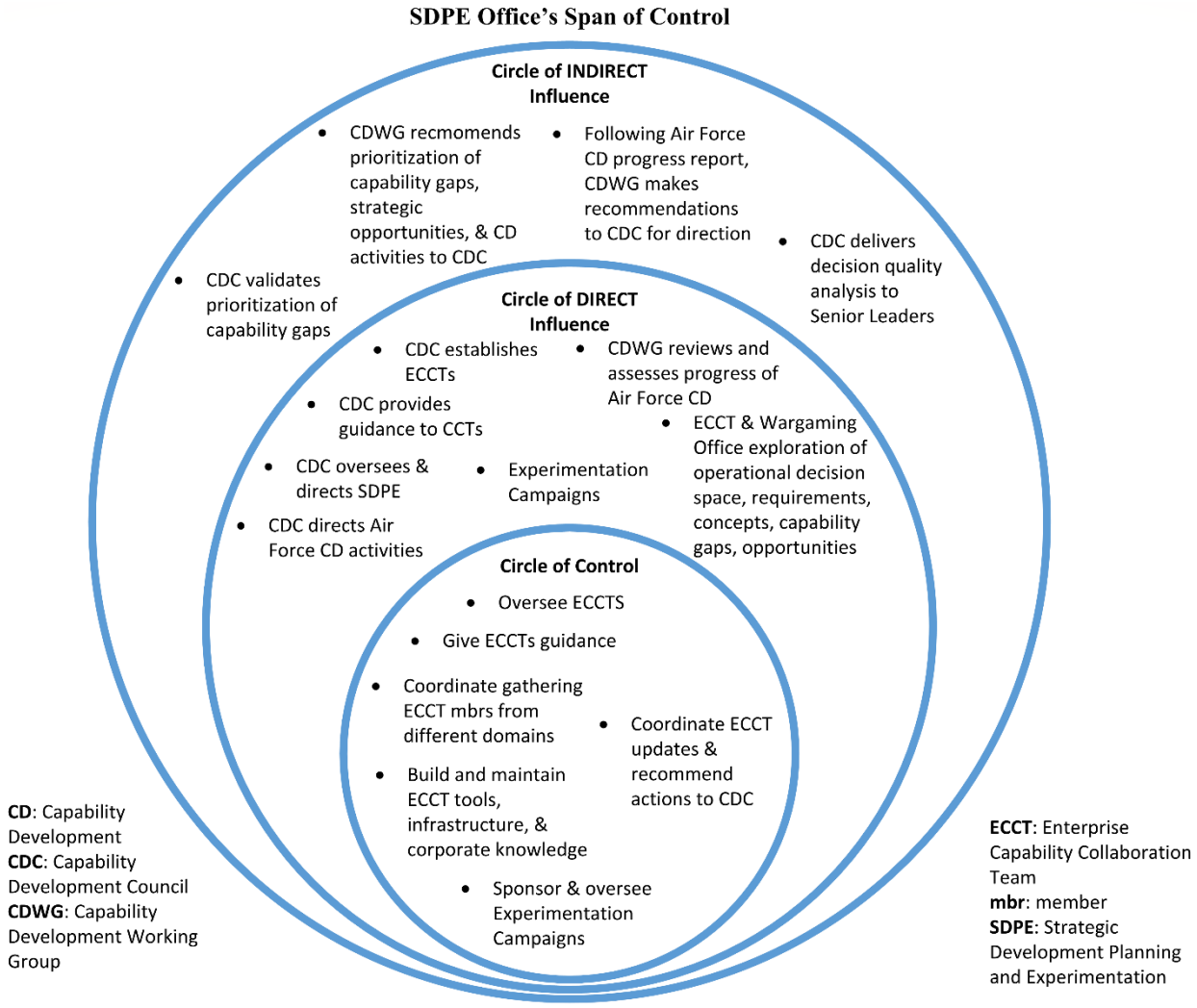

Figure 12. SDPE Office Span of Control (adapted from Covey's Circles of Concern and Influence using material from AFGM 2016-90-1101)

The first category under the SDPE Office's span of control is the Circle of Control. The SDPE Office has primary responsibility of the major tasks listed in its Circle of Control. The second category is the Circle of Direct Influence. In this category, the SDPE Office's responsibilities have a straightforward impact on how an outside organization does its job. For example, the SDPE Office's responsibility of *coordinating ECCT updates and recommending actions to Senior Leadership* (Department of the Air Force, 2016:6; Air Force Studies Board, 2016:94) directly affects the *CDC's responsibility of establishing ECCTs* (Air Force Studies Board, 2016:93). The final category under the SDPE's span of control is the Circle of Indirect Influence. The SDPE has indirect influence, and vice versa, on responsibilities listed in this last category. For example, when one responsibility has a direct influence on another responsibility, that has a direct influence on a third responsibility, then, the first responsibility has an indirect influence on the third responsibility. This can be seen with the SDPE's responsibility of *Sponsoring and overseeing experimentation* (Air Force Studies Board, 2016:93) having an indirect impact on the *CDWG's responsibility of recommending the prioritization of capability gaps, strategic opportunities, and CD activities to the CDC* (Air Force Studies Board, 2016:94). In this example, the link between the two responsibilities is the *CDWG's responsibility of reviewing and assessing the progress of Air Force CD* (Air Force Studies Board, 2016:94). The only way that the Capability Development Working Group ensures credibility of its prioritized recommendations to the CDC is by *reviewing and assessing the progress of CD across the Air Force* (Air Force Studies Board, 2016:94) (a responsibility that the SDPE Office has direct influence over through involvement with ECCTs, wargaming and Experimentation Campaigns). If the SDPE

Office uses and adds to this Span of Control diagram, it will maintain situational awareness. Also, if it keeps track of the progress of all of the responsibilities placed in each of the circles of control, it will be able to adjust and improve its responsibilities (1) as a response to outside changing factors and (2) as a motivation to influence outside organizations for efficiency and improvement.

Integrating high quality decision making into capability development management will undoubtedly enhance the SDPE Office's effectiveness in implementing their responsibilities. This research proposes integrating high quality decision making through applying a select number of best practices compiled by Matheson and Matheson to the Strategic Development Planning and Experimentation Office. Matheson and Matheson compiled a set of 45 best practices for "diagnosing and managing R&D decision making" (Matheson and Matheson, 2016:68). These best practices were grouped into nine component areas: 1. Decision basis, 2. Technology Strategy, 3. Portfolio Management, 4. Project Strategy, 5. Organization and Process, 6. Relationship with internal customer, 7. Relationship with external customer, 8. R&D culture and values, and 9. Improving decision quality, which were further combined into three emphasis areas: Making quality decisions, Organizing for decision quality and Improving decision quality, as shown in Figure 13 (The "Improving decision quality" area is included as both a component and emphasis area).

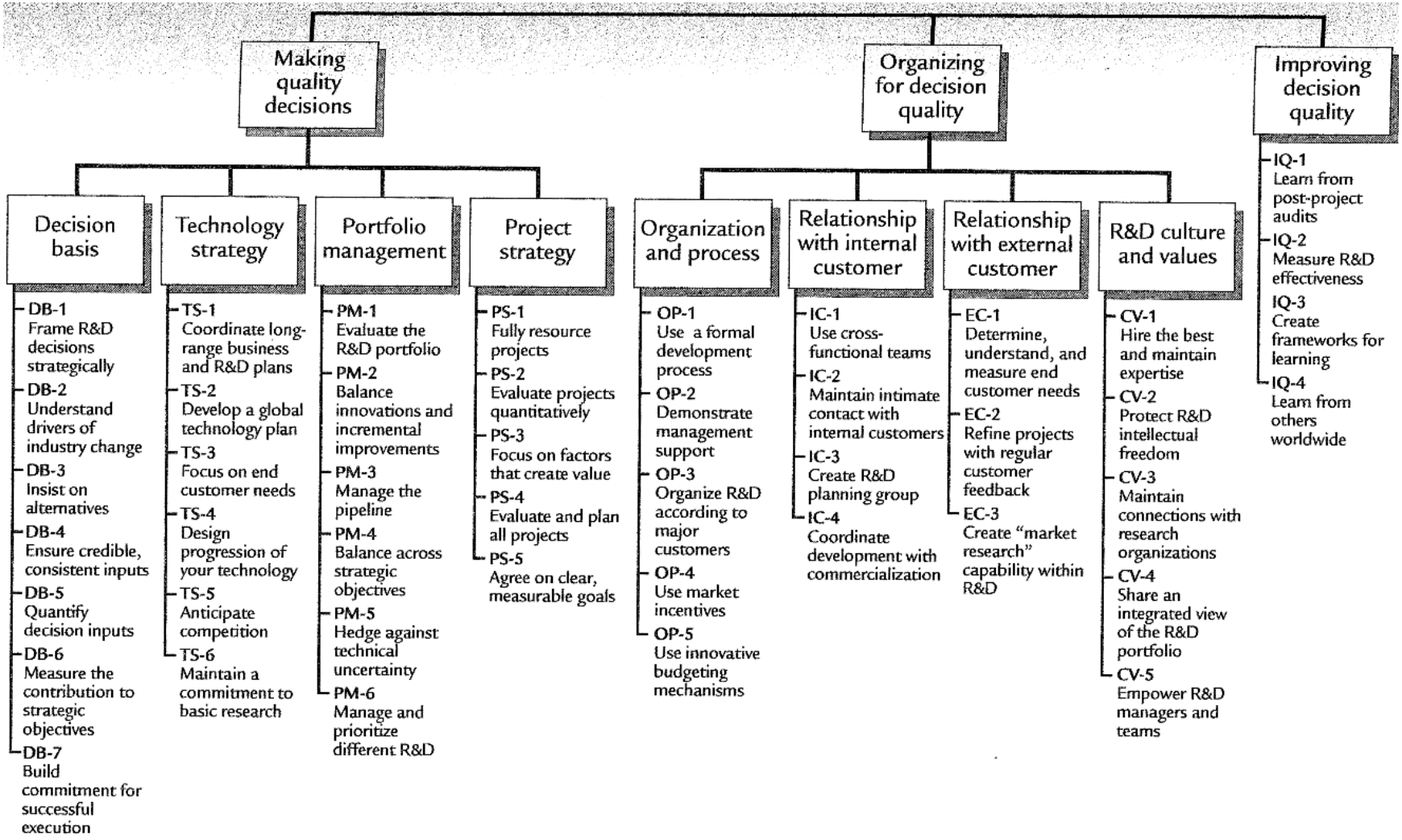

Figure 13. Best Practices for R&D Decision-Making (Matheson and Matheson, 1998:71 (Fig. 4-5))

After considering the Circles of Control for the SDPE Office, seven of the 45 practices were chosen for the Strategic Development Planning and Experimentation Office to adapt for enhanced decision making, and are listed in Table 3.

Table 3. Applicable Decision-making Practices for SDPE Office

Decision basis	Project strategy	Improving decision quality
DB-4 Ensure credible, consistent inputs	**PS-3** Focus on factors that create value	**IQ-1** Learn from post-project audits
DB-5 Quantify decision inputs	**PS-5** Agree on clear, measurable goals	**IQ-3** Create frameworks for learning
		IQ-4 Learn from others worldwide

By working on the practices listed under the components Decision basis and Project strategy, the SDPE Office will reinforce “making quality decisions” (Matheson and Matheson, 2016:68). Similarly, developing and regularly implementing those practices listed in the third column of Table 3 will aid the SDPE Office in improving future decision making quality (Matheson and Matheson, 2016:70).

If Best Practices PS-3 and IQ-3 were applied while the SDPE Office built and maintained ECCT tools, infrastructure, and corporate knowledge (Department of the Air Force, 2016:24), the SDPE Office would (1) “create value” (Matheson and Matheson, 2016:71) for the organization and (2) “create frameworks for learning” (Matheson and Matheson, 2016:71). The latter result allows for more steady personnel changeovers, especially since the Armed Forces frequently relocate around the globe. If the SDPE Office “quantif[ied] decision inputs” (Matheson and Matheson, 2016:71) and “agree[d]

on clear, measurable goals" (Matheson and Matheson, 2016:71) while coordinating ECCT updates and recommending actions to the CDC (Department of the Air Force, 2016:6; Air Force Studies Board, 2016:94), it would be able to consistently and quantifiably track those updates and actions. Another responsibility the SDPE Office must take on is deciding on what guidance is appropriate to provide to the ECCTs (Department of the Air Force, 2016:6). If the basis of the SDPE Office's decision "ensures credible, consistent inputs" (Matheson and Matheson, 2016:71), then the guidance is confirmed to be trustworthy and reliable. Finally, after an ECCT is decommissioned, if the SDPE Office "learn[s] from post-project audits" (Matheson and Matheson, 2016:71) and "learn[s] from others worldwide" (Matheson and Matheson, 2016:71), it will improve the quality of its future decision making with respect to "maintain[ing] the expertise needed to support ECCTs, CCTs, and experimentation campaigns" (Department of the Air Force, 2016:24).

Other best practices were not selected for a number of reasons: they were out of the SDPE Office's control, they were another Organization's responsibility, they were not applicable to the SDPE Office, or they were already listed in the SDPE's responsibilities. For instance, the fourth Organization and Process best practice (OP-4) of "us[ing] market incentives" (Matheson and Matheson, 2016:71) was not applicable to the SDPE Office, since being a part of a serving organization contradicts the idea of considering market involvement. A different best practice, namely, "maintain[ing] connections with research organizations" (Matheson and Matheson, 2016:71) is an example of an existent SDPE responsibility (hence the omission from the selected applicable best practices). Finally, an example of a best practice that was not included

because it was another organization's responsibility is "PS-1: Fully resource projects" (Matheson and Matheson, 2016:71). Another applicable tool this research suggests that the SDPE Office implement is Matheson and Matheson's Project Portfolio Matrix.

3.2.2 Capability Portfolio Matrix

Matheson and Matheson developed a Research and Development (R&D) "project portfolio matrix" (Matheson and Matheson, 2016:203) aimed at balancing "risk and return" (Matheson and Matheson, 2016:202). Their R&D portfolio management matrix is reproduced in Figure 14.

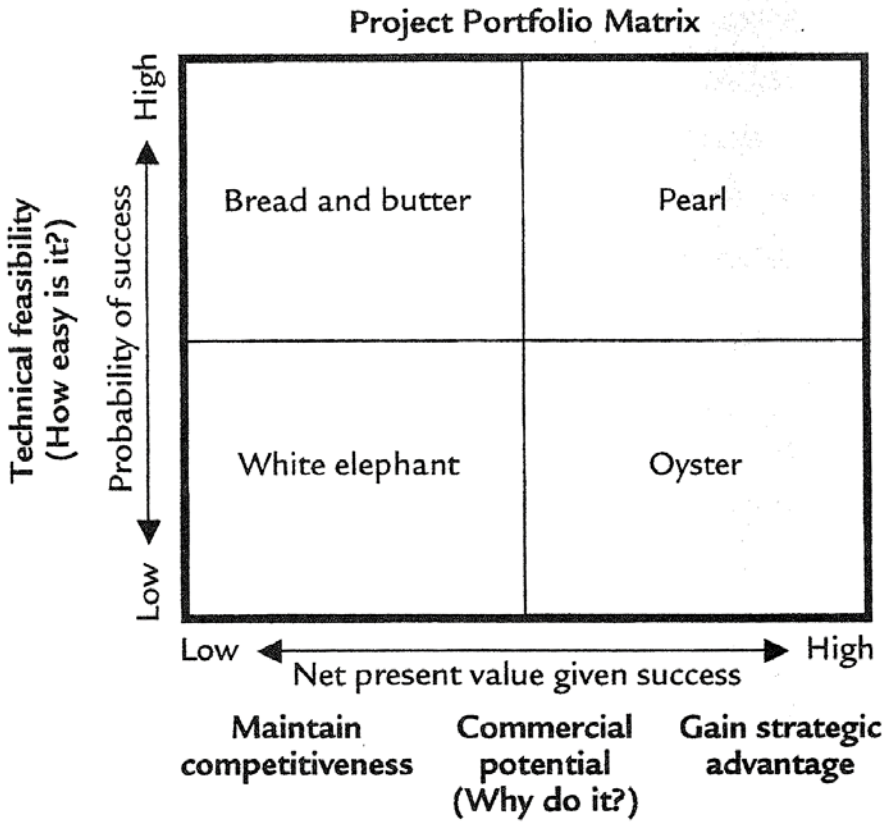

Figure 14. The R&D Grid: Project Portfolio Matrix (Matheson and Matheson, 1998:203 (Fig. 10-2))

The top left quadrant of the Capability Portfolio Matrix contains Bread-and-butter projects, which maintain commercial competitiveness by improving existing projects that are producing “regular results” (Matheson and Matheson, 2016:203). These projects are geared toward gaining incremental, near-term advantage. They have advanced enough to overcome most, if not all, “hurdles (technical, financial, regulatory, etc.)” (Matheson and Matheson, 2016:202). An example of a Bread-and butter project is “upgraded software tools with new features and ease of use” (Matheson and Matheson, 2016:204). This project brings more efficiency to what is already available and in use (existing software). Oysters are highly innovative and “early stage projects” (Matheson and Matheson, 2016:204) that give the organization the potential to gain “strategic advantage” (Matheson and Matheson, 2016:203). These projects are “shifters” that move to other quadrants as uncertainties about “technical feasibility” and “commercial potential” (Matheson and Matheson, 2016:203) decrease. An example of an oyster project that demonstrates the potential for having a major impact in the medical field is a “new approach to pain control” (Matheson and Matheson, 2016:204). Pearls emerge from oysters that have advanced in technical feasibility. To find a pearl, an organization must inspect and investigate numerous oysters (Matheson and Matheson, 2016:204). Finally, White elephant projects provide minimal value to an organization and end up squandering resources that could be used for any other type of project. These projects usually start out as Oyster or Bread-and-butter projects with the potential to bring value to the organization, but because of “technical defects” (Matheson and Matheson, 2016:205) or market environment changes, they end up being more of a burden.

For future work, modifying this portfolio matrix by substituting a “military value” measure for the “commercial value” (Matheson and Matheson, 2016:203) measure, allows it to be used by the SDPE Office for categorizing its capability development projects or responsibilities.

After projects have been categorized into one of the four quadrants of the Project Portfolio Matrix, Matheson and Matheson suggest managing each quadrant separately. White elephant projects that have been identified, must be analyzed as soon as possible to decide whether they can and should be redirected (to Bread-and-butter or Oyster Project) or terminated (Matheson and Matheson, 2016:207). Bread-and-butter projects should be rewarded based on “results and conformance to goals” (Matheson and Matheson, 2016:206), while Oysters should not. Since most Oysters are bound to fail, the organization should focus on investigating whether or not the “technical hurdles” (Matheson and Matheson, 2016:206) are surmountable. If so, the project shifts to become a Pearl; if not, the project is terminated. Pearls are not meant to be measured by “short-term deliverables” (Matheson and Matheson, 2016:206), and should therefore be “managed to encourage entrepreneurship” (Matheson and Matheson, 2016:206) and encourage “value creation” (Matheson and Matheson, 2016:206).

If the SDPE Office categorized their capability development responsibilities according to these Project Portfolio quadrants, it could then obtain insight and a general overview of which areas received more (or less) attention (Matheson and Matheson, 2016:206-207). Afterward, it would need to address each quadrant according to the management methods described in the previous paragraph (Matheson and Matheson, 2016:206-207). Finally, working to achieve an approximate balance of 90% Bread-and-

butter and Pearl Projects with 5-10% Oyster Projects (minimizing White Elephant projects as much as possible) would provide the opportunity to explore innovative projects and balance risk at the same time (Matheson and Matheson, 2016:202).

3.3 Trends and Differences

Each Military Service has designed a structure for managing capability development, as summarized in Table 4.

Table 4. Military Service Capability Development Management Comparison

Service / Level	Air Force	Navy	Army
Division/ Branch	Capability Development Working Group (CDWG)	WDC Divisions	ARCIC CDID Divisions
Directorate	Strategic Development Planning & Experimentation Office (SDPE)		ARCIC Capability Development & Integration Directorate (CDID) CAC Centers of Excellence (CoE)
Center	Air Force Research Laboratory (AFRL)	Warfighting Development Centers (WDC)	Army Capabilities Integration Center (ARCIC) Combined Arms Center (CAC)
Command	Air Force Materiel Command (AFMC) Capability Development Council (CDC)	Naval Warfare Development Command (NWDC)	Training and Doctrine Command (TRADOC)
Headquarters	Chief of Staff of the Air Force Secretary of the Air Force	Chief of Naval Operations (CNO) Secretary of the Navy	Chief of Staff of the Army Secretary of the Army

Every one of the Services have multiple management levels of capability development and integration. In the Air Force, the Strategic Development Planning and Experimentation (SDPE) Office was placed under Air Force Materiel Command, under the Air Force Research Laboratory. The Capability Development Working Group and the SDPE Office have direct access to the Capability Development Council (CDC), which has direct access to Air Force senior leadership. In the Navy, capability development and integration management were distributed to one Warfare Command and several Warfighting Centers. These Warfighting Centers are subordinate organizations placed under the Naval Fleet to directly support the Operating Forces by the different Naval Focus Areas. The Naval Warfare Development Command (NWDC) is responsible for developing and integrating capabilities *across* the Navy enterprise and performs its mission through gathering the Warfighting Development Centers (WDC) and all domains of the Navy for activities such as experimentation campaigns and warfighting games. Both the NWDC and the WDCs have direct access to the Chief of Naval Operations (CNO). In the Army, the Army Capabilities Integration Center (ARCIC) was placed under the Training and Doctrine Command (TRADOC), which has direct access to Army headquarters. The ARCIC Capabilities Development Directorate supports the Centers of Excellence (CoE) found under the Combined Arms Command (CAC). These CoEs were divided by Army Functions such as Mission Command, Intelligence, and Sustainment.

The Army and Navy have multiple mid-level Capability Development and Integration organizations, while the Air Force has one, the SDPE Office. This result makes sense since the Air Force is smaller, in comparison, than each of the other Military Services, but if the Air Force followed either of their structures, it could be beneficial.

Also, both the Army and the Navy have capability development *organizations* that are assigned to key Service-related Functional Areas, while the Air Force has *individuals* (Core Function Leads) as liaisons between the operating environment and leadership. Assigning a team devoted to tackling each Air Force Core Function may prove valuable. Ultimately, the Air Force has a good start for managing capability development and integration, especially with the recent (within the last three years) stand up of related organizations. As it continues to advance in capability development management, the Air Force can find useful guidance from reviewing the other Military Service's methods for managing capability development and integration.

One similarity found among all of the Military Services was the importance of "pre-acquisition" (Air Force Studies Board, 2014:i) strategy development. This importance is apparent through the Navy's Concept Generation and Concept Development (CGCD) Program, the Army Capabilities Integration Center's Concept Development and Learning Directorate, and the Air Force's Development Planning initiatives.

One distinct difference between the Services was how similar words and phrases, such as "capability development" or "capabilities development," had different meanings. For example, the Army expresses "capabilities development" as a synonym for "capabilities determination." Both of these are defined as "the Army's implementation of the JCIDS process used to identify, assess, and document changes in DOTMLPF that collectively produce the force capabilities and attributes prescribed in approved concepts, CONOPS, or other authoritative sources" (Department of the Army, 2013:37). Thus, in some respect, it seems that the Army uses this term specifically for JCIDS activities,

while the Air Force uses it to encompass not only JCIDS activities, but DOTmLP-F activities as well.

An interesting difference between the Army and the Navy is the echelon determination for capability development organizations. The structure for Army capability development from top to bottom is as follows: Army TRADOC Command, Army Capabilities Integration Center, Army Capability Development and Integration Directorate, and ARCIC Divisions (Focus Areas). For the Navy, the capability development chain of commands starts with the Office of Naval Operations and branches out to the *Office of the Deputy Chief of Naval Operations for Integration of Capabilities and Resources (CNO N8),* four major Naval Systems Commands, the Naval Warfare Development Command and five Navy Warfighting Development Centers. Each of the Systems Commands and Navy Warfighting Centers have subdivisions that tackle capability development and integration. The Army's approach to managing capability development emphasizes capability development first, and then spreads that to specific Army Functional Focus Areas, while one of the Navy's approaches starts with Functional Focus Areas and allows each Focus Area (Systems Command, Warfighting Development Centers) to manage capability development and integration individually.

The studies by the civilian sector organizations gave best practices and lessons learned for managing problems, capabilities, and projects. Although each of the categories managed was different, the management methods explored in these studies provided insight and application for the SDPE Office to investigate and possibly adapt these methods.

IV. Conclusion

4.1 Research Questions and Findings

The Research questions and findings are as follows:

Research Question 1:

How do other Military Services approach capability development management?

Research Findings:

The Army organizes capability development through a structural multi-level hierarchy with the Army Capabilities Integration Center (ARCIC) as the head and Capability Development Integration Directorates (CDIDs) as the extensions. The CDIDs work with the Combined Arms Center's Functional Centers of Excellence (CoEs) to address capability development and integration in the Army.

The Navy has three entities that focus on capability development and integration. The Naval Warfare Development Command (NWDC) is responsible for integrating capabilities *across* Navy functions and domains, while the Navy Warfighting Development Centers (WDCs) address capabilities categorized by warfighting functions (for example, Surface and Mine warfighting and Undersea warfighting) in direct support of the Fleet. Finally, the Naval Systems Commands have subdivisions which are responsible for addressing capability development and integration according to the Naval Systems category (i.e. Sea Systems, Air Systems, Space and Naval Warfare Systems, and Strategic Systems).

Research Question 2:

How do organizations from the civilian sector approach R&D portfolio management?

Research Findings:

Matheson and Matheson's Project Portfolio matrix used measures of technical feasibility and commercial potential (Matheson and Matheson, 2016:203) to evaluate Research and Development projects, while Covey's Span of Control chart classified responsibilities into Control and Influence categories that allowed for tracking the status of all tasks for organization efficiency and improvement.

Research Question 3:

Are there any capability development management practices from other Military Services and civilian sector organizations that could be applied to the SDPE Office?

Research Findings:

The Army and Navy's organizational practice of structuring capability development management with a few "lead" commands and multiple operational-level centers and divisions could be adapted in the Strategic Development and Planning Experimentation Office and the Air Force.

Covey's Span of Control chart can be applied to the SDPE Office for categorizing and tracking its capability development management responsibilities.

Matheson and Matheson's Capability Portfolio Matrix can also be useful to the SDPE Office for project categorization and tracking.

4.2 Recommendations

It is recommended that the Air Force considers the Army or Navy's capability development management structure as it continues structuring its own capability development forces. Also, this research recommends that the SDPE Office implement the capability development management tools from Section 3.2 for one year, to figure out which practices and tools produce the best results. Additionally, after one year of using a management tool, documenting an After Action Reports (AAR), evaluation, or lessons learned is suggested for future research. Furthermore, this research seeks to bring the SDPE Office awareness of the trends and differences found in Section 3 of the Results and Analysis Chapter (Chapter 3).

4.3 Future Work/Research

After digging into this research, opportunities for future work emerged. One of these opportunities is conducting a longitudinal study of an Air Force Program that is currently in use by the warfighter in the field. Investigating an Air Force Program from birth to acquisition would provide much insight into the Air Force's capability development and integration process. Working with the Air Force Materiel Command's Air Force Life Cycle Management Center would be beneficial for this longitudinal study.

Another opportunity for future work is creating a Multiple Objective Decision Analysis Value Hierarchy in relation to this research's suggestion, in Section 4.2.2, of modifying Matheson and Matheson's Portfolio Matrix to be relevant to the Strategic Development Planning and Experimentation Office. Figuring out what the SDPE Office

considers “military value” and using those to find evaluation measures might prove useful.

Additionally, after the suggested one year implementation of using the capability development management tools from Section 4.2, the SDPE Office can reevaluate its capability development management responsibilities and ask Academia for an updated Literature Review or additional research for improving management. However, even before the year is up, another Literature Review and Analysis is recommended due to this research’s scope and limitations.

If additional time was available, the research team would attempt to contact the various military organizations for a capability development point of contact for further understanding of how each Service manages capability development and integration.

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Investigating Capability Development Management for the AF SDPE Office

Capt Sarah M. Pak
Advisor: LTC Christopher Smith, Ph.D.
Committee Member: Maj Heidi Tucholski, Ph.D.
Department of Operational Sciences (ENS)
Air Force Institute of Technology

Motivation

- Newness of Air Force (AF) Strategic Development Planning and Experimentation (SDPE) Organization
- Limited time to explore external Capability Development (CD) Management tactics, techniques and procedures
- Sponsor reached out to Academia for assistance

Objectives

- Investigate how certain organizations in other Military Services and Civilian Service Sectors handle Capability Development
- Provide recommendations for managing responsibilities, based on the best practices found among the organizations studied

SDPE Mission

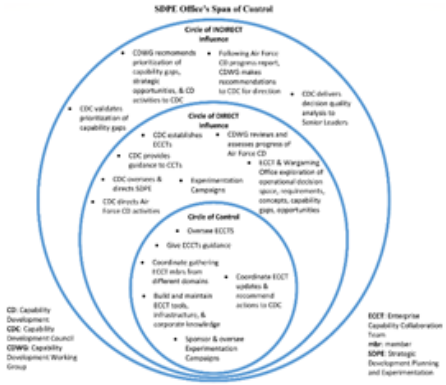
- Support AF Strategic Development Planning
- Sponsor Experimentation Campaigns
- Support Enterprise Capability Collaboration Teams (ECCTs) by managing and maintaining documentation, knowledge, and expertise on non-materiel and materiel capability solutions to challenges spanning multiple domains or service core functions

Project Portfolio Matrix

- Matheson and Matheson's *The Smart Organization* presented a portfolio matrix for categorizing Research & Development projects into four areas: Bread and butter, Pearl, Oyster, and White Elephant; the matrix used two measures: (1) "commercial potential," ranging from maintaining competitiveness (low) to gaining strategic advantage (high) and (2) "technical feasibility," measuring the probability of success.

Applications

SDPE Office's Span of Control



Applicable Best Practices

Decision basis	Project strategy	Improving decision quality
DB-4 Ensure credible, consistent inputs	**PS-3** Focus on factors that create value	**IQ-1** Learn from post-project audits
DB-5 Quantify decision inputs	**PS-5** Agree on clear, measurable goals	**IQ-3** Create frameworks for learning
		IQ-4 Learn from others worldwide

U.S. Military CD Findings

- Air Force focuses on Capabilities
  - AF SDPE Office responsible for managing and coordinating ECCTS to address challenges that span multiple domains & core functions
- Army focuses on Concepts
  - Army Capabilities Integration Center (ARCIC) comparable to AF SDPE Office
- Navy focuses on Systems
  - Naval Warfare Development Command (NWDC) comparable to AF SDPE Office

Recommendations

- Review Army and Navy's CD Management Structure
- Implement Span of Control tool and Applicable Best Practices for one year, then re-evaluate for future research

Future Work

- Multiple Objective Decision Analysis Value Hierarchy for what constitutes "Military Value" in regards to replacing "Commercial potential" from Matheson and Matheson's Portfolio Matrix
- Longitudinal study of Air Force Program currently in the field
- Follow on Literature Review and Research

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14. ABSTRACT

The Air Force provides unique capabilities for the defense of our nation. Capabilities do not come to fruition instantly; they must go through a development process. Managing the development of a capability is a difficult but necessary task. In 2016, a report from the Air Force Studies Board prompted the Air Force to focus on the Capability Development Process and its improvement. In response to the report, the Strategic Development Planning & Experimentation (SDPE) Office was formed. The SDPE Office is tasked to support Enterprise Capability Collaboration Teams (ECCTs), which are, in turn, tasked to research and solve prominent issues articulated by Air Force leadership. To support ECCTs and the Capability Development Council, the SDPE Office must manage capability development. This research investigates how other Military Services and civilian service sectors handle capability development. The results from this analysis will provide the SDPE Office recommendations for managing responsibilities, based on the best practices found among the organizations studied.

15. SUBJECT TERMS

Capability Development, Development Planning, Experimentation, Managing Portfolios, ECCT, Multiple Domain and Service Core Function Challenges

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