Development Planning: A Strategic Approach to Future Air Force Capabilities

ISBN
978-0-309-31365-0

74 pages
7 x 10
PAPERBACK (2014)

Committee on Improving the Effectiveness and Efficiency of U.S. Air Force Pre-Acquisition Development Planning; Air Force Studies Board; Division on Engineering and Physical Sciences; National Research Council

Development Planning

A Strategic Approach to Future Air Force Capabilities

Committee on Improving the Effectiveness and Efficiency of U.S. Air Force Pre-Acquisition Development Planning

Air Force Studies Board

Division on Engineering and Physical Sciences

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, NW Washington, DC 20001

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This is a report of work supported by Grant FA9550-14-1-0011 DEF between the U.S. Air Force and the National Academy of Sciences. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the view of the organizations or agencies that provided support for the project.

International Standard Book Number-13: 978-0-309-31365-0
International Standard Book Number-10: 0-309-31365-1

Limited copies of this report are available from:

Air Force Studies Board
National Research Council
500 Fifth Street, NW
Washington, DC 20001
(202) 334-3111

Additional copies of this report are available from the National Academies Press, 500 Fifth Street, NW, Keck 360, Washington, DC 20001; (800) 624-6242 or (202) 334-3313; http://www.nap.edu.

Printed in the United States of America

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. C. D. Mote, Jr., is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Victor J. Dzau is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. C. D. Mote, Jr., are chair and vice chair, respectively, of the National Research Council.

www.national-academies.org

COMMITTEE ON IMPROVING THE EFFECTIVENESS AND EFFICIENCY OF U.S. AIR FORCE PRE-ACQUISITION DEVELOPMENT PLANNING

CLAUDE M. BOLTON, JR., Defense Acquisition University, *Co-Chair*
PAUL G. KAMINSKI, Technovation, Inc., *Co-Chair*
FRANCIS J. BAKER, Wright State University
ROBERT F. BEHLER, Software Engineering Institute
W. PETER CHERRY, Ann Arbor, Michigan
KEITH A. COLEMAN, The Boeing Company
JILL P. DAHLBURG, Naval Research Laboratory
BRENDAN B. GODFREY, University of Maryland at College Park
JOHN M. GRIFFIN, Griffin Consulting
ROBERT J. HERMANN, Bloomfield, Connecticut
LESTER L. LYLES, The Lyles Group
WILLIAM L. MELVIN, Georgia Tech Research Institute
DAVID J. NICHOLLS, Institute for Defense Analyses
THOMAS E. ROMESSER, Northrop Grumman Aerospace Systems (retired)
SONYA F. SEPAHBAN, General Dynamics Land Systems, Inc.
DAVID M. VAN WIE, Johns Hopkins University Applied Physics Laboratory

Staff

TERRY J. JAGGERS, Director, Air Force Studies Board
CARTER W. FORD, Study Director
MARGUERITE E. SCHNEIDER, Administrative Coordinator
DIONNA C. ALI, Research Assistant

AIR FORCE STUDIES BOARD

GREGORY S. MARTIN, GS Martin Consulting, *Chair*
DONALD C. FRASER, Charles Stark Draper Laboratory (retired), *Vice Chair*
BRIAN A. ARNOLD, Peachtree City, Georgia
ALLISON ASTORINO-COURTOIS, National Security Innovations, Inc.
CLAUDE M. BOLTON, JR., Defense Acquisition University
STEVEN R.J. BRUECK, University of New Mexico
THOMAS J. BURNS, Great Falls, Virgina
FRANK J. CAPPUCCIO, Cappuccio and Associates, LLC
BLAISE J. DURANTE, U.S. Air Force (retired)
BRENDAN B. GODFREY, University of Maryland at College Park
MICHAEL A. HAMEL, Lockheed Martin Space Systems Company
DANIEL E. HASTINGS, Massachusetts Institute of Technology
RAYMOND E. JOHNS, FlightSafety International
PAUL G. KAMINSKI, Technovation, Inc.
ROBERT H. LATIFF, R. Latiff Associates
NANCY G. LEVESON, Massachusetts Institute of Technology
MARK J. LEWIS, Institute for Defense Analyses Science and Technology Policy Institute
LESTER L. LYLES, The Lyles Group
ALEX MILLER, University of Tennessee
RICHARD V. REYNOLDS, The VanFleet Group, LLC
STARNES E. WALKER, University of Delaware
DEBORAH WESTPHAL, Toffler Associates
DAVID A. WHELAN, Boeing Defense, Space, and Security
REBECCA WINSTON, Winston Strategic Management Consulting

Staff

JOAN FULLER, Director (from October 20, 2014)
TERRY J. JAGGERS, Director (until October 17, 2014)
ALAN H. SHAW, Deputy Director
DIONNA C. ALI, Research Assistant
GREGORY EYRING, Senior Program Officer
CARTER W. FORD, Program Officer
CHRIS JONES, Financial Manager
MARGUERITE E. SCHNEIDER, Administrative Coordinator

Preface

The Weapon Systems Acquisition Reform Act (WSARA; Public Law 111-23) was enacted in 2009. Among its provisions was the direction to the Department of Defense (DoD) to implement development planning within DoD. Congress was concerned that DoD's ability to properly plan for future capability needs had severely eroded. One of the inputs to this belief on the part of Congress was the 2008 National Research Council (NRC) report *Pre-Milestone A and Early-Phase Systems Engineering: A Retrospective Review and Benefits for Future Air Force Acquisition.*[1] That report concluded that not only was DoD systems engineering in need of re-invigoration, but also development planning. In short, what Congress directed in WSARA was for DoD to regain its expertise in systems engineering, but also to do proper development planning, so that DoD would know what to systems engineer. While this appears to have been the right set of things for Congress to direct, implementation of development planning has been slow to meet the intent of WSARA.

Historically, the Air Force established a development planning process and used it extensively to, as accurately as possible, determine its capability needs throughout the 1970s and 1980s. A significant process within development planning, called Vanguard, was started in 1978 by General Alton Slay, then the Commander of Air Force Systems Command. From 1978 to the demise of development planning within DoD as a whole in the 1990s, development planning, and in particular

[1] National Research Council (NRC), *Pre-Milestone A and Early-Phase Systems Engineering: A Retrospective Review and Benefits for Future Air Force Acquisition,* The National Academies Press, Washington, D.C., 2008.

Vanguard, supported the Air Force's capability needs during both increasing and decreasing budgetary periods. Even though WSARA directed the reinstatement of development planning in DoD, and even though the Air Force has re-established development planning, there is concern that the full potential of development planning is not being realized.[2,3]

TERMS OF REFERENCE AND STUDY APPROACH

In this context, the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering requested that the Air Force Studies Board (AFSB) of the NRC review the Air Force approach to development planning and provide recommendations to improve Air Force development planning.[4] The NRC approved the terms of reference in February 2013 and appointed the Committee on Improving the Effectiveness and Efficiency of U.S. Air Force Pre-Acquisition Development Planning in January 2014.[5] Specifically, the committee was asked to provide recommendations to the Chief of Staff of the Air Force and the Secretary of the Air Force on the following topics:

1. How can development planning be improved to help improve near-term acquisition decisions?[6]

[2] See Section 3.4 of Air Force Instruction (AFI) 63-101/20-101, March 7, 2013, http://static.e-publishing.af.mil/production/1/saf_aq/publication/afi63-101/afi63-101_20-101.pdf.

[3] For this study, it was difficult to find organizations in the Department of Defense (DoD) and industry that did something called "development planning." When the committee did find DoD organizations that indicated they were doing development planning, it found a variety of definitions for development planning. As a result, the committee developed its own definition for the purposes of its report. The Navy (N81) provided a good insight to the Navy's approach to a portion of the committee's definition. For the Army, the Assistant Secretary of the Army for Acquisition, Logistics, and Technology has been trying to institute some form of development planning, but this has been ongoing, and the Army is trying to determine how to codify it, although it was not clear when this would occur.

[4] Appendix A provides the study's terms of reference.

[5] Appendix B provides short biographies of the committee members. The committee reflects extensive expertise in systems engineering (early SE), acquisition planning, capability planning, technology development, modeling and simulation, war gaming, life-cycle cost estimation, military utility assessment, and prototyping/experimentation.

[6] The terms of reference are directed at Air Force development planning. The committee, however, recognizes that the Air Force, as it conducts development planning, needs to participate in Joint planning processes with other military departments and the Office of the Secretary of Defense. However, addressing the entire Department of Defense Joint planning process is beyond the scope of this report. The committee suggests that when the Air Force engages in the development planning process in this Joint environment that the best practices developed and demonstrated by the Air Force be considered by the other military departments and the DoD after demonstration and validation by the Air Force.

2. How can development planning be improved to help concepts not quite ready for acquisition become more mature, perhaps by identifying the need for more engineering analysis, hardware prototyping, etc.?
3. How can development planning be improved to enable the development of corporate strategic plans, such as science and technology investment roadmaps, Major Command capability roadmaps, workforce development plans, etc.?
4. How can development planning be used to develop and train acquisition personnel?

To address these four items, the committee held six meetings to both receive information and write its report.[7] The committee met with senior Pentagon representatives from the Air Force, Army, and Navy, as well as representatives from three Air Force major commands. In addition, the committee visited two Air Force product centers, the Air Force Life Cycle Management Center, and the Space and Missile System Center, where much of the current Air Force development planning occurs. Finally, the committee received valuable input from several industry representatives to gain a perspective on how non-DoD organizations approach long-term strategic planning.

ROLE OF THE AIR FORCE STUDIES BOARD

The AFSB was established in 1996 as a unit of the NRC at the request of the U.S. Air Force. The AFSB brings to bear broad military, industrial, academic, scientific, engineering, and management expertise on Air Force technical challenges and other issues of importance to senior Air Force leaders. The board discusses potential studies of interest, develops and frames study tasks, ensures proper project planning, suggests potential committee members and reviewers for reports produced by fully independent ad hoc study committees, and convenes meetings to examine strategic issues. The board members were not asked to endorse the committee's conclusions or recommendations nor did the board review the final draft of this report before its release, although board members with appropriate expertise may be nominated to serve as formal members of study committees or as report reviewers.

The committee thanks all the people who provided information, including guest speakers listed in Appendix C, their organizations, and supporting staffs. The committee also thanks the sponsor of the study, the U.S. Air Force, and David Walker, Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering, Office of the Assistant Secretary of the Air Force for Acquisition

[7] Appendix C provides a list of meetings and speakers.

and his staff. The committee is especially grateful for the NRC staff that provided superb and professional support throughout the entire study.

Claude M. Bolton, Jr., *Co-Chair*
Paul G. Kaminski, *Co-Chair*
Committee on Improving the Effectiveness and Efficiency of
U.S. Air Force Pre-Acquisition Development Planning

Acknowledgment of Reviewers

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to thank the following individuals for their review of this report:

Edward C. Aldridge, Jr., U.S. Department of Defense (retired),
Melani Austin, Lockheed Martin Aeronautics Company,
R. Stephen Berry, The University of Chicago,
Blaise J. Durante, U.S. Air Force (retired),
Alan H. Epstein, Pratt & Whitney,
Eric T. Forbes, 3M Aerospace and Commercial Transportation Division,
Ramayya Krishnan, Carnegie Mellon University,
R. Noel Longuemare, U.S. Department of Defense (retired), and
Paul A. Schneider. The Chertoff Group.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review

of this report was overseen by John F. Ahearne, Sigma Xi, The Scientific Research Society, and Larry D. Welch, Institute for Defense Analyses. Appointed by the National Research Council, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

Contents

Acronyms

A2/AD	anti-access/area denial
ACC	Air Combat Command
AFLC	Air Force Logistics Command
AFLCMC	Air Force Life Cycle Management Center
AFMC	Air Force Materiel Command
AFNWC	Air Force Nuclear Weapons Center
AFRL	Air Force Research Laboratory
AFSAB	Air Force Scientific Advisory Board
AFSB	Air Force Studies Board
AFSC	Air Force Systems Command
AoA	analysis of alternatives
ATC	Applied Technology Council
CCT	capability collaboration team
CCTD	Concept Characterization and Technical Description
CFL	Core Function Lead
CFSP	Core Function Support Plan
CMT	capability material team
COCOM	combatant command
CONOP	concept of operation
CPT	Chief of Staff of the Air Force planning team

CREATE	Computational Research Engineering Acquisition Tools and Environments
CSAF	Chief of Staff of the Air Force
DCGS	Distributed Common Ground Station
DoD	Department of Defense
DSB	Defense Science Board
DSG	Defense Strategic Guidance
EMD	engineering and manufacturing development
GAO	Government Accountability Office, formerly the General Accounting Office
GHOST	Geurts Hands-On Support Team
GMTI	Ground Moving Target Indication
ICMB	intercontinental ballistic missile
IR&D	independent research and development
ISR	intelligence, surveillance, and reconnaissance
IWSM	Integrated Weapon Systems Management
JCS	Joint Chiefs of Staff
JSTARS	Joint Surveillance Target Attack Radar System
MAJCOM	major command
MDD	materiel development decision
NRC	National Research Council
O&M	operations and maintenance
PE	program element
POM	program objective memorandum
R&D	research and development
RATPAC	Revolutionary Acquisition Techniques Procedures and Collaboration
RDT&E	research, development, test, and evaluation
ROI	return on investment

S&T	science and technology
SAB	Scientific Advisory Board
SAC	Strategic Air Command
SAF/AQ	Assistant Secretary of the Air Force (Acquisition)
SAG	Scientific Advisory Group
SECAF	Secretary of the Air Force
SMC	Space and Missile Systems Center
SOCOM	Special Operations Command
SP3	strategy, planning, and programming process
T&E	test and evaluation
TAC	Tactical Air Command
TRL	technology readiness level
WSARA	Weapon Systems Acquisition Reform Act

Summary

INTRODUCTION

> The beginning of wisdom is the definition of terms.
>
> —Attributed to Socrates

Nowhere is this Socratic wisdom more apparent than in the world of Air Force development planning. In all the months of study, research, and discussions that went into the preparation of this report, it seemed that every source had a different definition of development planning. Indeed, there was not even agreement on the term itself: Some called it "development planning," while others referred to "developmental planning." Yet a third term was "planning for development." These differences may sound trivial, but they are not. The semantic disagreements surrounding the term "development planning" are symptomatic of all the different ways that the act of planning for future Air Force capabilities is perceived, even by those closest to the process.

DEFINITION OF AIR FORCE DEVELOPMENT PLANNING

This definitional ambiguity dates back decades, at least as far back as the former Air Force Systems Command's establishment of Vanguard, the first comprehensive, formal development planning system. Established in 1978, Vanguard was composed of two major aspects that are illustrated in Figure S-1.

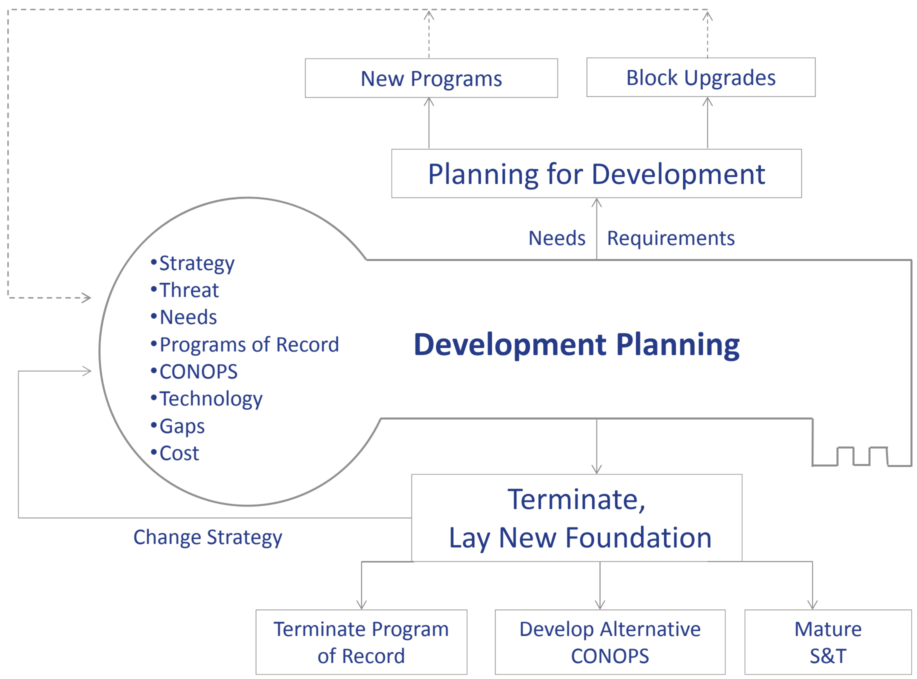

FIGURE S-1 The concepts of "planning for development" and "development planning."

One aspect, called "planning for development," was *acquisition* based and included translating user requirements into the systems, costs, schedules, and plans needed to meet those requirements. The other half of Vanguard was called "development planning," which was *technology* focused, coordinating all research and development in the Air Force. Development planning, in Vanguard's lexicon, focused most directly on Exploratory Development (budget category 6.2) and Advanced Development (budget category 6.3). These investments eventually either transitioned to new programs or were terminated to enable investments in more promising technologies. Vanguard is discussed in detail in Chapter 1. However, it is appropriate to say simply that the terminological differences between "planning for development" and "development planning" were symptomatic of a definitional "haziness" that has survived to this day.[1,2,3] While all of the various development

[1] U.S. Air Force, *Integrated Life Cycle Management*, Air Force Instruction (AFI) 63-101, March 7, 2013, http://static.e-publishing.af.mil/production/1/saf_aq/publication/afi63-101/afi63-101_20-101.pdf.

[2] Office of the Deputy Assistant Secretary of Defense, Systems Engineering, "Initiatives," http://www.acq.osd.mil/se/initiatives/init_devplng.html, accessed July 15, 2014.

[3] Air Force Materiel Command, 2010, *Development Planning (DP) Guide*, June 17, http://www.defenseinnovationmarketplace.mil/resources/DevelopmentPlanningGuide-Jun2010.pdf, p. 2.

planning definitions may make sense individually, the multiple variations combine to lead to a loss of clarity, in terms of what is and what is not included within the boundaries of development planning. As a result, the committee added what it believes to be the appropriate definition (see Recommendation 1).

Development planning was practiced in the Air Force and throughout the Department of Defense (DoD) until the program element was zeroed by Congress in the late 1990s. At its height, development planning was a primary planning process focused on answering key capability questions of the Air Force. It was codified in 1978 in a process called "Vanguard" that was initiated and promulgated by General Alton D. Slay, the Air Force Systems Command commander. The process answered a critical and basic question for the Air Force and the Air Force's leadership: Over the next 20 years in 5-year increments, what capability gaps will the Air Force have that must be filled? Under Vanguard, a group was assembled to answer this question. The group consisted of representatives from the intelligence community, warfighters, acquisition professionals, the science and technology community, industry and independent research and development, cost estimators, logisticians, and some of the nation's best analysts 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. The Vanguard product was briefed to all the Air Force four-star generals, briefed to the Chief of Staff of the Air Force, approved by the Secretary of the Air Force, and was used to justify the annual Air Force budget submitted to Congress.[4]

Given how development planning was viewed and used in the past, and given what the committee learned during this study of development planning, the committee is able to recommend an organizational construct, which is fully described in Chapter 3 and shown in Figure S-2.[5] The process begins with strategic inputs from the national, Office of the Secretary of Defense, and Air Force level. The Air Force published its new Strategic Plan in July 2014 that will play an important part in "setting the stage" for the work to be done in the process shown in Figure S-2.[6] A key proposed construct is the establishment of a Chief of Staff of the Air Force planning team to provide the development planning needed across the Air Force core functions.

---

[4] General Alton Slay, Sr. (USAF, Ret.), "Historical Perspectives," presentation to the committee on January 30, 2014; Frank Campanile, U.S. Air Force (retired), Joe Lusczek, Jr., Technical Director of Air Force Aerospace Systems Design and Analysis (Ret.), Jim Mattice, SES (Ret.), Former SAF/AQ, Former DAS for Research and Engineering, and Former ASC/XR, panel discussion with the committee on February 26, 2014.

[5] A complete description of the recommended process for Air Force development planning is provided in Chapter 3.

[6] U.S. Air Force, *America's Air Force: A Call to the Future,* July 2014, http://airman.dodlive.mil/files/2014/07/AF_30_Year_Strategy_2.pdf.

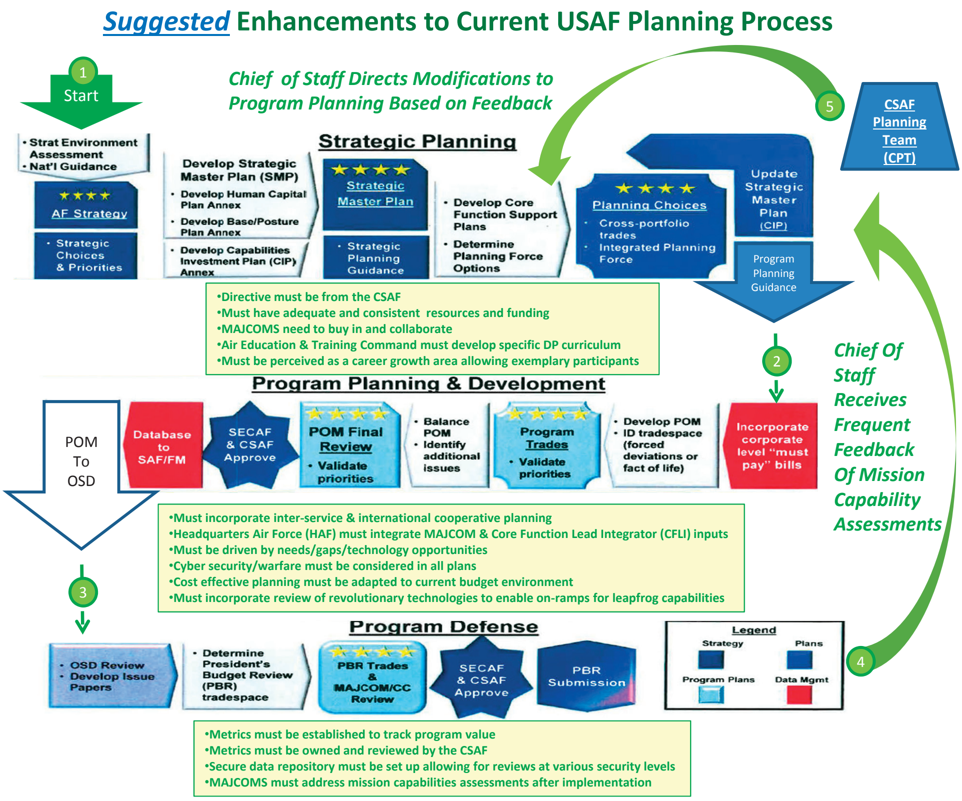

FIGURE S-2 Suggested enhancements (shown in green) to current Air Force Strategy, Planning, and Programming Process (SP3), indicated with green arrows and text.

This report is comprised of three chapters. Chapter 1 discusses the history of development planning: what it was and why it was abandoned in the Air Force. Chapter 2 describes the status of development planning today in the Air Force, other military services, and industry. Chapter 3 describes what development planning could be and should be for the Air Force. The findings, which support the recommendations immediately following and those in Chapter 3, are provided in Chapter 2.

RECOMMENDATIONS

Recommendation 1. The Air Force should redefine development planning as "a key process to support the Secretary of the Air Force and the 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."

Recommendation 2. The Chief of Staff of the Air Force and the Secretary of the Air Force should claim ownership of development planning in the Air Force and provide top-level guidance and leadership to all Air Force organizations responsible for carrying out development planning. This leadership should encourage and facilitate interaction among these organizations.

Recommendation 3. The Air Force should enhance its strategic planning and programming process with a Chief of Staff of the Air Force planning team function that reports to the Chief of Staff of the Air Force with the primary responsibility for integrating development planning across Air Force core functions and coordinating it with Core Function Leads.

The Chief of Staff of the Air Force planning team will advise, in particular, on areas that fall between or span functional areas and support trade-offs between core functions. This should include (1) assessing the potential impact of current and evolving threats on Air Force mission capability needs and defining corresponding responses, (2) identifying new concepts utilizing emerging technologies with the purpose of informing operational concepts, and (3) assessing feedback from the Air Force major commands and the Air Force enterprise on program changes that impact warfighter effectiveness.

Recommendation 4. The Air Force should develop and standardize the use of capability collaboration teams across all Service core functions as a means to facilitate development planning.

As originally established by Air Combat Command, capability collaboration teams are formed as needed to explore potential solutions paths for filling known gaps.[7] These capability collaboration teams bring together representatives of major commands and the acquisition and science and technology communities to complete development planning activities associated with identified capability gaps. The use of capability collaboration teams should be standardized as a best practice across all Air Force Service core functions. The decision to start a new capability

[7] The capability collaboration team concept was a product of the science and technology Tiger Team, which included participation by all major commands, the Product Centers, Air Force Research Laboratory, and Headquarters Air Force representatives, that developed the current science and technology planning process and governance structure, which was subsequently codified in Air Force Instruction 61-101. Air Combat Command was the first major command to formally establish capability collaboration teams and the major command that most enthusiastically incorporated the capability collaboration team concept into their planning process (Stephen Munday, Office of the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering, personal communication to National Research Council staff member Carter Ford, September 29, 2014).

collaboration team should be made following a formal selection process to focus attention on the most pressing challenges and should be chartered and resourced to address the needed development planning activities to include warfighting capability analyses, advanced technology development and demonstration, early prototyping, and warfighter concept refinement. Capability collaboration team activities should become an integral part of the generation of Air Force Core Function Support Plans regarding advancement of new concepts and capabilities.

Recommendation 5. The Air Force should align adequate resources to ensure the success of the Chief of Staff of the Air Force planning team and its interactions with the capability collaboration teams to enhance Air Force development planning. The key element of the development planning process provided by the Deputy Chief of Staff for Operations, Plans and Requirements is the targeted Core Function Support Plan, which starts with the 12 Core Function Leads identifying and prioritizing capability gaps. The resources needed should provide focused support from the Core Function Leads, the necessary analytical and technical capabilities of the personnel comprising and supporting the Chief of Staff of the Air Force planning teams and the capability collaboration teams, and the financial means to achieve the desired planning analysis and recommendations.

Workforce development is essential to provide the human resources necessary for robust development planning, and senior Air Force leaders need to instill a corporate commitment to this career field that, in turn, attracts personnel with high potential.

Recommendation 6. The Secretary of the Air Force and the Chief of Staff of the Air Force should emphasize development planning as a key workforce development tool for Air Force science and technology, acquisition, and operational personnel. In emphasizing this development, lessons learned from initiatives such as the U.S. Special Operations Command GHOST (Geurts Hands-On Support Team) initiative and its related "Revolutionary Acquisition Techniques Procedure and Collaboration" forum should be captured and examined for application to the broader development planning tool set. In this sustained emphasis on development planning, analytical skills, technical innovation, concept development, systems engineering rigor, and excellence become part of the broader Air Force culture.

Recommendation 7. The Air Force should periodically assess how well development planning is meeting its overall objective of providing the necessary support for the strategic decisions that guide the Air Force toward mission success, within available funds and with acceptable risk. A systematic approach would include identifying weaknesses, shortcomings, and failures; the causes of these; and ways to address them in the next stages.

BOTTOM LINE

Development planning, properly used by experienced practitioners, can provide the Air Force leadership with a tool to answer the critical question, Over the next 20 years in 5-year increments, what capability gaps will the Air Force have that must be filled? Development planning will also provide for development of the workforce skills needed to think strategically and to effectively define and close the capability gap.

1

Historical Context Regarding Planning for Future Air Force Capabilities

INTRODUCTION

> The men in charge of the future Air Forces should always remember that problems never have final or universal solutions, and only a constant inquisitive attitude toward science and a ceaseless and swift adaptation to new developments can maintain the security of this nation through world air supremacy.
>
> —Theodore von Kármán, 1945[1]

In the spring of 1911, the young Lieutenant Henry H. "Hap" Arnold was sent to Dayton, Ohio, to learn about aviation from the Wright brothers, on what is now the site of Wright-Patterson Air Force Base.[2] From that date on, the development and application of technology has been an essential part of U.S. airpower, leading to a century of air supremacy. But that developmental path has rarely been straight, and it has never been smooth. Only the extraordinary efforts of exceptional leadership—in the Air Forces and the wider Department of Defense (DoD) in science and in industry—have made the triumphs of military airpower possible.

PLANNING FOR AIRPOWER

The earliest years of the U.S. Army Air Service were marked by mere halting steps in technological development, as the United States fell far behind the powers

[1] Dik A. Daso, *Architects of American Air Supremacy: Gen. Hap Arnold and Dr. Theodore von Kármán,* Air University Press, Maxwell Air Force Base, Ala., 1997, p. 322.

[2] H.H. Arnold, *Global Mission*, Harper, New York, 1949, pp. 15-29.

of Europe. Of all the factors that led to the defeat of Germany in World War I, U.S. aviation technology was clearly *not* one of them.

> By the time the Armistice came, we did have 2,768 completely trained pilots and observers on the Western Front. Out of 20,000 officers and 149,000 enlisted men of the Army Air Service at home and abroad, almost 40 percent of the officers and 50 percent of the enlisted men were in France or at advanced training bases in England. Many more would have been there if there were airplanes for them. . . . No American-designed combat planes flew in France or Italy during the entire war.[3]

General Arnold was the first—and thankfully not the last—in a tradition of visionary airpower leaders who understood that U.S. air forces would always need to rely on technological advances rather than superiority in numbers. He also understood that those technology breakthroughs were not likely to come solely from within the Air Corps, but also from partners in academia, science, engineering, and business. He made his views on the matter clear in a 1937 speech, shortly before he became the U.S. Army Air Corps Chief.

> Remember that the seed comes first: if you are to reap a harvest of aeronautical development, you must plant the seed called experimental research. Install aeronautical branches in your universities; encourage your young men to take up aeronautical engineering. . . . Spend all the funds you can possibly make available on experimentation and research. Next, do not visualize aviation merely as a collection of airplanes. It is broad and far-reaching. It combines manufacture, schools, transportation, airdrome building and management, air munitions and armaments, metallurgy, mills and mines, finance and banking, and finally, public security—national defense.[4]

To General Arnold, this emphasis on partnership was an essential part of planning for future airpower capabilities. He reached out to an unprecedented consortium of strategic thinkers at leading universities, as well as to inventors, aviators, aeronautical designers, automotive manufacturers, and financiers. He always recognized the need for these partnerships, because he believed that the degree of specialized genius required to plan for future Air Force capabilities was unlikely to be found solely within the ranks of the Air Force. Under the auspices of the National Academy of Sciences, he held meetings of top experts, meetings at which the military and scientific cultures did not always mix well.

> Few high ranking Army officers seemed aware of the close relationship developing between these specialists and the little Air Corps—a relationship that was to grow to such importance in World War II that civilian scientists would work side-by-side with staff officers in our overseas operational commands, frequently flying on combat missions to increase their data. Once, after George Marshall became Chief of Staff, I asked him to come to lunch with

[3] Ibid., pp. 61-64.
[4] Daso, *Architects of American Air Supremacy,* 1997, p. 57.

> a group of these men. He was amazed that I knew them. "What on earth are you doing with people like that!" he exclaimed. "Using them," I replied. "Using their brains to help us develop gadgets and devices for our airplanes—gadgets and devices that are far too difficult for the Air Force engineers to develop themselves."[5]

THE RISE OF DEVELOPMENT PLANNING

In the years following World War II, planning for future Air Force capabilities waxed and waned. General Curtis E. LeMay was a brilliant combat leader, but perhaps not the best choice to lead Air Force research and development (R&D) activities in 1946. His thinking tended to be short term—"Lemay's responsibilities were largely tied to here-and-now requirements."[6] His short stint leading all Air Force R&D—he was off to command U.S. Air Forces in Europe within a year—was not exactly a highlight of his career.

> I certainly hadn't been screeching with enthusiasm about my new duties, but it didn't take me long to become mighty interested. It was strictly a management job. I didn't know much about Research and Development. . . . I still could never forget that I essentially considered myself a field commander.[7]

At the other end of the spectrum were leaders who exemplified General Arnold's ideas about fresh thinking, close partnerships, and long-term vision. No better example exists than the development of intercontinental ballistic missiles (ICBMs), led by General Bernard Schriever. Through the 1950s, while operational field commanders like General LeMay focused on improving current systems like the B-52, visionaries like General Schriever used alliances among scientists, technologists, manufacturers, and acquisition leaders to create a series of powerful missile systems—Navajo, Bomarc, Thor, Atlas, Titan, Minuteman—at an almost unimaginable pace. (For a long time, General LeMay, by then Commander in Chief of the Strategic Air Command, was notably unimpressed, referring to ICBMs and their thermonuclear warheads as Schriever's "firecrackers."[8])

Many of the challenges arising in today's acquisition environment are reminiscent of those that have come before. But organizational memory can be fleeting, and lessons learned today may be forgotten tomorrow. Changing threats, shifting requirements, ineffectual processes, chronic funding issues, and excessive oversight

---

[5] Arnold, *Global Mission*, 1949, p. 165.

[6] Daso, *Architects of American Air Supremacy,* 1997, p. 160.

[7] Curtis E. LeMay and MacKinlay Kantor, *Mission With LeMay; My Story,* Doubleday, Garden City, N.Y., 1965, p. 400.

[8] To see how the perspective of visionaries and operators can clash, see Neil Sheehan, *A Fiery Peace in a Cold War: Bernard Schriever and the Ultimate Weapon,* Random House, New York, 2009.

have existed as long as there has been a U.S. Air Force—and even before. In his 1949 autobiography, General Arnold explained as follows:

> The tough part of aircraft development and securing an air program is to make Congress, the War Department, and the public realize that it is impossible to get a program that means anything unless it covers a period of not less than five years. Any program covering a shorter period is of little value. Normally it takes five years from the time the designer has an idea until the plane is delivered to the combatants. The funds must cover the entire period or there is no continuity of development or procurement. For years, the Army—and the Army Air Forces while a part of it—was hamstrung in its procurement programs by governmental shortsightedness.[9]

Around the time that General Arnold was writing these words, the newly established Air Force was creating the Ridenour Committee to study the Air Force's R&D activities.[10] The Ridenour Committee recommended the creation of a new organization, separate from the Air Materiel Command, to control all of the Air Force's R&D. By the mid-1950s, there was recognition that formal channels were needed to connect combat commands, the science and technology (S&T) community, and acquisition program offices. These ideas resulted in the establishment in 1960 of an organization called the Advanced System Program Office, which was tasked with developing mission requirement analysis and operational assessment tools and using them to focus technology development.[11] Figure 1-1 shows Air Force research, development, test, and evaluation (RDT&E) funding as a part of Air Force total obligation authority over time.

VANGUARD, APPLIED TECHNOLOGY COUNCILS, AND THE AIR FORCE SCIENTIFIC ADVISORY BOARD

The first development planning offices were begun in the 1960s, and their processes and policies were defined over the following years. In 1978, the Commander of Air Force Systems Command (AFSC), General Alton D. Slay, saw the need for a more comprehensive and complex development planning methodology.

Vanguard

In General Slay's view, the development planning activities that did occur were conducted primarily by Pentagon or AFSC elements, with insufficient involvement

[9] Arnold, *Global Mission*, 1949, p. 156.

[10] Kent C. Redmond and Thomas M. Smith, *From Whirlwind to MITRE: The R&D Story of the SAGE Air Defense Computer,* MIT Press, Cambridge, Mass., 2000, p. 23.

[11] John M. Griffin and James J. Mattice, "Development Planning and Capability Planning, 1947 to 1999 and Beyond," unpublished manuscript, 2010, pp. 5-6.

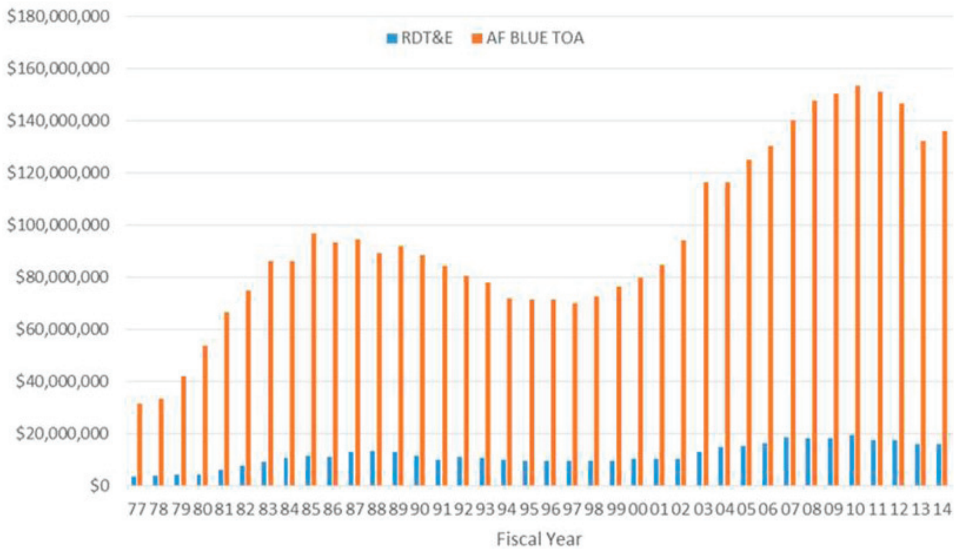

FIGURE 1-1 Air Force research, development, test, and evaluation funding as a part of Air Force total obligation authority over time (in $1,000s and “then-year dollars” versus constant or inflation-adjusted dollars). NOTE: Air Force RDT&E spending (in blue) tends to track with the overall Air Force budget, but with less variation. The funding chart reflects the geopolitical realities of the past 40 years: The post-Vietnam Carter years; The Reagan buildup of the 1980s; the “peace dividend” of the 1990s, and the military commitments in the Middle East and southwest Asia since 9/11.

from the field—the warfighters. As a result, General Slay began a new program to revitalize development planning by making it cohesive, cross-cutting, inclusive, and efficient. This new development planning effort was known as “Vanguard.”

With Vanguard, General Slay split the management of technology into two pieces. The first, what he called “planning for development,” was *acquisition* based; it codified user requirements and determined the systems, costs, schedules, and plans necessary to meet those requirements. The second piece was called “development planning,” and it was *technology* based, coordinating all research and development in the Air Force, focusing on Exploratory Development (budget category 6.2) and Advanced Development (budget category 6.3). Vanguard used advanced computer tools to increase visibility into technology efforts across all fronts, throughout industry, and across the armed services. A channel was established within the AFSC, from the Deputy Chief of Staff for Development Plans down to each individual program office and laboratory, through which Vanguard data were accumulated, sorted, analyzed, and redistributed. Participation was not optional.

Vanguard's success hinged on a tool known as "hooks and strings," which provided the linkages between the combat commands, the S&T world, and the acquisition centers. In connecting the three worlds, hooks and strings answered critical questions that are as important today as they were 35 years ago (see Box 1-1). Vanguard included the following three core planning areas: (1) mission plans, (2) major force elements, and (3) functional plans. Mission-level plans addressed specific tasks that must be completed, whereas major force elements included larger and more general categories of systems that would garner interest across the board. Functional plans

BOX 1-1
The Objectives of Vanguard

The Vanguard "hooks and strings" tool provided answers to the following questions:

- 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?
- Do all advanced development (budget category 6.3) projects have a clear and recognized trace forward to some on-going, planned or projected engineering, or manufacturing development program or project?
- Do all advanced development (budget category 6.3) project funding profiles and schedules take into account the schedules of engineering and manufacturing development (EMD) programs or projects which they support?
- Do all Air Force exploratory development (budget category 6.2) projects have a clear trace to some existing or projected and officially recognized technology shortfall?
- Do all Air Force exploratory development (budget category 6.2) projects have a clear and officially recognized "path" to advanced development or to some other exploitation of the generated technology?
- Do all defense industry independent research and development (IR&D) projects supported directly by Air Force funds have a clear trace directly to some existing and officially recognized technology shortfall which, if filled, would enhance the ability of the Air Force to perform its mission?
- 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?
- Can assurance be provided that each Air Force EMD program office fully recognizes and exploits the technology accomplishments and advances made by the Air Force laboratories which are applicable to the EMD program or project?
- Can each Air Force EMD program office be provided access to "entry level" information from all sources (Air Force laboratories, other Air Force programs or projects, other Services, defense industry) which identifies all available technology specifically related to their program or project?

SOURCE: Derived from an undated talking paper by General Alton D. Slay (USAF, Ret.) entitled "Vanguard."

addressed those activities that spanned several mission areas. All these plans were supported by a wealth of information, such as applicable citations from the Air Force's out-year development plan, relevant regulations, pertinent organizational dependencies, and proposed schedules, milestones, and requirements.

Key parts of Vanguard were frequent, regular, face-to-face meetings at the four-star level, to facilitate coordination among all parties. In the words of General Slay,

> I hosted separate meetings each quarter at HQ AFSC with the operational commanders (e.g., SAC, MAC, TAC) and selected members of their staffs. Vanguard briefings described the Vanguard "hooks and strings" trace to all projects/ programs underway or planned in response to their requirements. Project funding levels and schedules were discussed in detail and comments solicited thereon.[12]

The results of Vanguard were mixed, according to its creator. Asked about his own level of satisfaction with the Vanguard implementation as of his retirement in 1981, General Slay said,

> On the whole, I would rate my degree of satisfaction with its implementation as something just north of lukewarm. Maybe if I had been able to stick with it another year. . . .[13]

This loss of momentum described by General Slay is an important feature of this story. From General Arnold to General Slay to today's Air Force leadership, a common thread emerges again and again: A strong leader sees the need for a better system to integrate the warfighter, S&T, and acquisition worlds and creates a new management system to fill that need. With the powerful support of the senior leadership, the new management system is developed and implemented. But it is not long before the new system itself comes under fire. Perhaps the sponsoring leader moves on, or priorities change, or the system comes under attack from the outside.

Such was the case with Vanguard. The details of its demise are neither well documented nor well remembered, but it certainly faded away after General Slay's 1981 retirement and subsequent criticism by watchdog agencies within government.[14]

[12] Arnold, *Global Mission*, 1949, p. 4. Note: SAC, Strategic Air Command; MAC, Mobility Air Command; TAC, Tactical Air Command.

[13] Ibid., p. 6.

[14] For a deeper look at Vanguard, its successes and its shortfalls, a good source is an Air Force Institute of Technology master's degree thesis, "An Evaluation of the Top-Level Air Force Long Range Planning Model Based on a Set of Planning Factors To Determine the Feasibility for Implementation," by Captain Fredric J. Weishoff, September 1990, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio.

Applied Technology Councils

After the end of Vanguard, when it became clear that the need for coordination between the worlds of warfighters, S&T, and acquisition commands still existed, a new concept evolved at the product center level. Applied Technology Councils (ATCs) were instituted by product center and laboratory commanders to carry on the old Vanguard mission of integrating warfighter requirements with acquisition priorities and laboratory efforts (see Figure 1-2).

The major mission of the ATCs was to address the issue of the "valley of death," a term used to describe the gap between funds allocated to develop a technology and the funds needed to support acquisition and testing to transform the technology into an operational capability. By the late 1990s and early 2000s, the Air Force had evolved to the point where final funding support in the budget came primarily from the using commands, the warfighters. If the warfighters did not understand a specific technology or how it related to their own operational needs, they tended to not support funds to carry the system through the valley of death. The ATCs were an attempt to ensure that warfighters clearly understood what was being developed

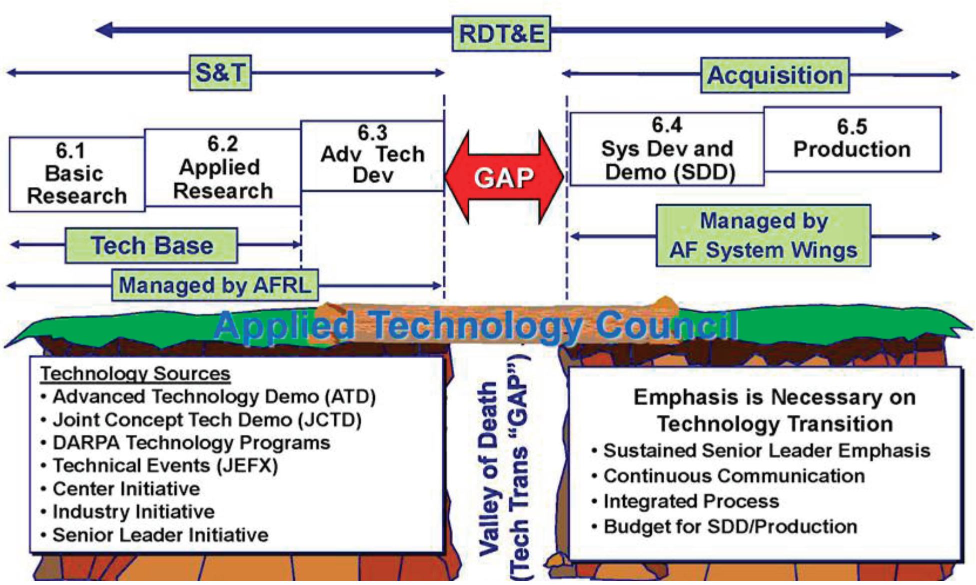

FIGURE 1-2 Applied Technology Councils (ATCs) serve to bridge the "valley of death" technology transition gap between budget category 6.3 and 6.4. SOURCE: Colonel Arthur Huber, Vice Commander, Aeronautical Systems Center, and Gerald Freisthler, Executive Director, Aeronautical Systems Center, presentation to the Committee on Evaluation of Air Force Pre-Acquisition Technology Development, June 1, 2010.

in laboratories and product centers and, consequently, better understood their role in funding that critical bridge across the valley of death.

ATCs were thus instituted by product center and laboratory commanders to carry on the old Vanguard mission of integrating warfighter requirements with acquisition priorities and laboratory efforts. As with the Vanguard meetings, ATCs were scheduled quarterly and attended by senior-level warfighters, top laboratory management, and high-level acquisition leaders. Warfighters clarified their combat requirements, S&T leaders explained what was feasible technologically, and the acquisition community laid out programmatic plans for matching requirements with new systems or subsystems. Priorities were established, funding was committed, and plans were made to transition technologies from the S&T world, over the valley of death, to operational success—all as in the days of General Slay's Vanguard.

As with Vanguard, however, the ATCs were eventually allowed to erode past the point of usefulness, in at least some instances. The causes were many: Different commands had different assessments of the value of the ATC process. New commanders—whether warfighters, laboratory leaders, or top acquisition management—at times had other priorities. Sometimes, overtaxed leadership let the intervals between ATCs increase—from quarterly to semiannual, then to annual, and sometimes beyond that. The staffs of participating organizations began to require multiple pre-briefings, adding bureaucracy to the process and arguably watering down the frank dialog on what systems engineering is needed and why. Eventually, the rank—and the perspective and the power—of ATC attendees declined: What had at one time been meetings of lieutenant generals eventually became meetings of lieutenant colonels who generally lacked the required strategic view.

Vanguard and ATCs were both aimed at integrating the needs and capabilities of operational commands, S&T organizations, and acquisition centers. Both enjoyed some success, and both eventually declined in importance. As with the demise of Vanguard, the erosion of ATCs in some areas represents a significant setback in the pursuit of a fully integrated technology development and systems acquisition mission.

The Role of the Air Force Scientific Advisory Board

The U.S. Army Air Force's Scientific Advisory Group (SAG) (later known as the Air Force Scientific Advisory Board, AFSAB) was formally commissioned by General Arnold in 1944 to advise him and to guide the technological strategies of the Army Air Forces. Led by General Arnold's trusted colleague and advisor Theodore von Kármán, the SAG provided the foundation and blueprint for General Arnold's vision of Air Force technological supremacy. Its prescient 1945 report, *Toward New Horizons*, foresaw many of the scientific developments that would come to fruition over the next seven decades, which are taken for granted today.[15,16]

The AFSAB, like so many other activities related to development planning, has gone through good times and bad in the past 70 years, but it continues today.[17] While not directly involved in the development planning process, the AFSAB has played an important role in the management of technology and innovation through its summer studies and its annual assessment of S&T activities in the laboratories. In those reviews, the AFSAB assessed laboratory programs for both technology excellence—that is, how laboratory activities rate in relationship to "best-of-class" R&D and how they rank in accordance with relevance to warfighter needs. It was understood among the Air Force research laboratories, the AFSAB, and warfighters that the warfighter would be unlikely to support further funding for a technology research effort that was either technically deficient or failed to meet standards of relevance that spanned from near-term requirements to longer-term envisioned needs that would enable operational dominance and avoid technology surprise. Thus, the AFSAB had an influence on what technologies ultimately were developed.

A CRITICAL GAO REPORT IN 1986

Vanguard and development planning cost money, of course, and that money had to come from somewhere. In 1986, the General Accounting Office (GAO; now the Government Accountability Office), released a review of AFSC's Aeronautical Systems Division's assessment of authorized programs to fund and account for certain development planning activities titled *Appropriated Funds: Air Force Needs to Change Process for Funding Some Activities* (see Figure 1-3).[18] Beginning in fiscal year (FY) 1981, Congress slashed funding for the Air Force's development planning work.[19] But, despite the reduction of congressionally appropriated funds, AFSC's spending on development planning climbed from less than $1 million in 1982 to more than $20 million in 1984.[20] To support development planning efforts, includ-

[15] U.S. Army Air Force Scientific Advisory Group, *Toward New Horizons,* multi-volume report to General of the Army H.H. Arnold, 1945.

[16] The scanning of scientific innovation was part of the role of the SAG/SAB. *Toward New Horizons* was a textbook example, addressing all sorts of scientific breakthroughs that could be capitalized upon by the Air Force. Some of the topics in *Toward New Horizons* presage such modern developments as unmanned aerial vehicles, automatic target recognition, and precision "fire and forget" weaponry, among other things.

[17] General LeMay in particular had some skepticism about it; see Daso, *Architects of American Air Supremacy*, 1997, pp. 160-162.

[18] GAO, *Appropriated Funds: Air Force Needs to Change Process For Funding Some Activities*, GAO 86-24, Washington, D.C., January 1986.

[19] Ibid.

[20] Ibid., p. 8.

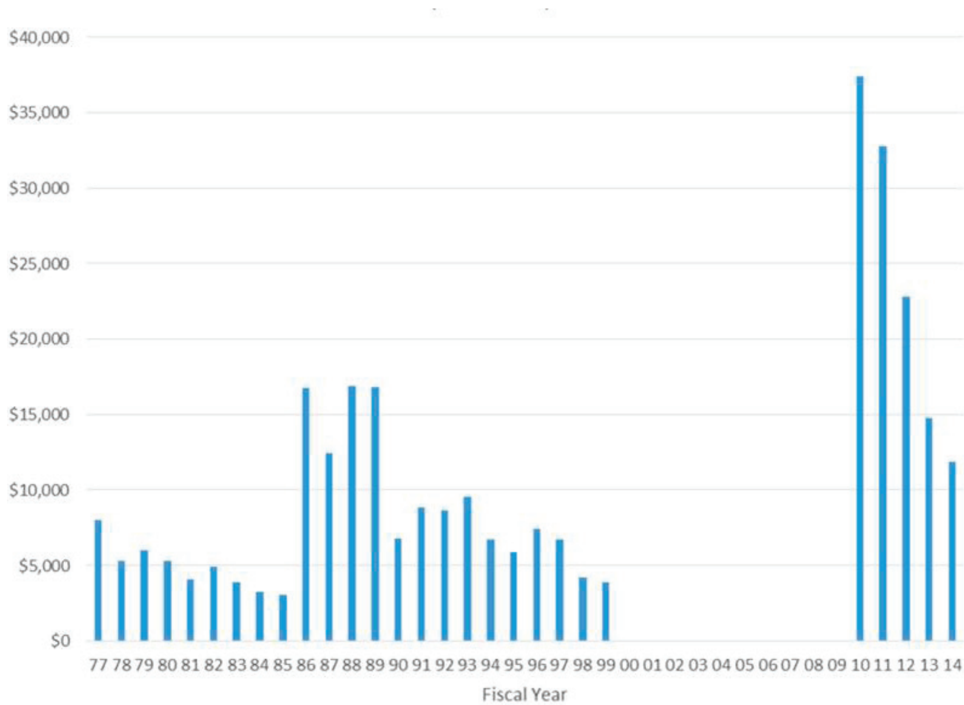

FIGURE 1-3 Air Force spending for development planning from fiscal year (FY) 1977 to FY 2014 (in $1,000s and "then-year dollars" versus constant or inflation-adjusted dollars). NOTE: Stability of funding for development planning has been inconsistent at best, and was actually zeroed from FY 2000 through 2009. In periods where funding plummeted, Air Force leaders were forced to adapt and innovate, in attempts to keep development planning alive. The committee's research revealed that there were at times major differences between development planning funding, and actual spending on development planning. SOURCE: Jerry Lautenschlager, Development Planning Program Element Monitor, Office of the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering.

ing Vanguard, the Air Force began to "tax" existing programs of record to support development planning, even for unrelated systems. For one example, beginning in 1982, just after General Slay's retirement, existing aircraft programs, including the B-52 and B-1, were assessed $1.7 million to support development of *space* vehicles.

Not surprisingly, the GAO took some exception to this. In its response to the criticisms in the GAO's 1986 report, DoD agreed that the Air Force's accounting was indeed a bit too creative, and DoD agreed to direct the Air Force to cease its practice of taxes and assessments to support development planning. But this would not be the last time that development planning would face a loss of funding, nor would it be the last time that Air Force leaders would try to find ways to keep it alive.

Whenever appropriated funding for development planning withered, leaders throughout AFSC (and its successor, the newly formed Air Force Materiel Command) were forced to adapt to the new and dangerous financial reality. Continuing to recognize that the need to plan for the future is essential, the acquisition and development communities tried various ways to substitute for the lack of institutional funding. As seen previously, centralized "taxation" of programs was prohibited as a result of the 1986 GAO report. However, some product center commanders urged program directors under their command to carve out a portion of their appropriated funds to look at future capability modifications that could enhance their individual programs in the future. For example, the F-16 System Program Office had the authority and funding to look into the future for technologies and architectures to keep the F-16 platform relevant into the 21st century. That project, begun in 1982 and called "Falcon Century," was a mini-development planning process, focused on that one platform.[21]

THE DECLINE OF DEVELOPMENT PLANNING

Contributing to the decline in development planning within the Air Force was what some have described as the "perfect storm" of circumstances. During the early 1990s, the Air Force began a series of actions to both downsize and reorganize after the collapse of the Soviet Union and to right-size the Service for the future. These actions were a recognition that resources for the military would probably decline in the new post-Soviet Union era. The Air Force leadership decided to combine major commands with common or complementary missions as the primary focus of its reorganizations. Therefore, the former Strategic Air Command (SAC), with its strategic bomber force, was combined with Tactical Air Command (TAC), with its fighter aircraft forces, to create Air Combat Command (ACC). Similarly, AFSC, whose mission was the research, development, and acquisition of new weapon systems, was combined with Air Force Logistics Command (AFLC), whose mission was the maintenance and sustainment of weapon systems, to create Air Force Materiel Command (AFMC).

One of the primary objectives for creating AFMC was to eliminate the perceived problem of developing weapon systems in one command (AFSC) without adequately considering the long-term implications and costs of how to sustain that same weapon system for years, or even generations, in the future in another command (AFLC). AFMC was envisioned to provide the Air Force with a single command that looked at weapons development from cradle-to-grave and planned

[21] Frank Camm, *The F-16 Multinational Staged Improvement Program: A Case Study of Risk Assessment and Risk Management*, Rand Report N-3619-AF, 1993, available at http://www.dtic.mil/dtic/tr/fulltext/u2/a281706.pdf.

their designs and capabilities up front with maintenance as a forethought, not an afterthought.

Development planning was a major process in AFSC. As part of the perfect storm mentioned earlier, the funding for development planning was also being reduced significantly around the same time as the Air Force began its reorganization to create ACC and AFMC. The operational pull and requirements strengths of SAC and TAC, which informed the front-end of the development planning process, suffered as the new ACC was being formed. Simultaneously, the objectives and mission of AFMC led to a renewed emphasis on the transition between the development of a new system and its maintenance/sustainment. Initially, AFMC even created an Integrated Weapon Systems Management (IWSM) process as the hallmark of the new command. IWSM's key focus was on the smooth transition between development and sustainment, not the front-end development of a system that was the primary focus of development planning. As AFMC was being established and IWSM was maturing, the commander of AFMC stated that the decision to locate the new command at Wright-Patterson Air Force Base was made to counter the perception that sustainment, maintenance, and logistics were being de-emphasized in the Air Force at the expense of R&D. AFMC's commander also stated that he would probably have to spend most of his time working sustainment issues for the corporate Air Force because of their long-term implications and costs, instead of S&T or R&D and acquisition issues.

Finally, the location of AFMC at Wright-Patterson Air Force Base had the secondary effect of removing a "four-star" champion for development planning from the crucial, time-critical decision-making apparatus of the Pentagon and Congress. All of these factors helped define a perfect storm of circumstances that contributed to the decline of development planning within the Air Force.

CONCLUDING REMARKS

In reviewing the history of what has become known as development planning, one thing stands out, not for its historical presence, but for its *absence*: In none of the Air Force histories reviewed by the committee did leaders perform, or cite, what today would be called a formal cost-benefit analysis. General Arnold never once wrote of modern corporate concepts like return on investment or internal rates of return. Surely, this is at least partly due to the impossibility of reducing issues of war and peace, and the relevance therein of revolutionary technologies, to mere financial or quantitative terms. But it also reflects another reality: For the people who built the Air Force, keeping that Air Force at the cutting edge technologically was instinctive. They did not need to hear fiscal arguments about payback on current investment and future rates of return. They knew and accepted a much more important relationship—that technological progress leads to victory in war.

This is important to understand: In the research for this report, the committee heard more than once that the funding turbulence and fiscal shortfalls plaguing development planning were a result of no one making the case for development planning to senior leadership. As intuitively appealing as that argument seems, it is also disingenuous. No subordinate made the argument for technology to those Air Force pioneers, because it was unnecessary. They already understood the importance, and they knew that an effective process for supporting technological development was *their* responsibility, as the top leadership. From a 1945 letter from General Arnold to his successor, General Spaatz,

> In connection with programs for scientific research . . . it is of the utmost importance that there be no administrative obstructions between the officer in charge of these research problems and programs and the Commanding General of the Army Air Forces. As I visualize it, in time of peace the one man who should have time to think more than anyone else in the whole Air Forces organization . . . is the Commanding General, Army Air Forces. He should be able to project himself farther into the future than any of the staff.[22]

Planning for future Air Force capabilities has followed an inconsistent path for much of the past century. Whether in the hands of legendary giants of aviation—Arnold, von Kármán, LeMay, Schriever, and Slay—or leaders less well known but no less knowledgeable, capitalizing on technological innovation has always been a priority for the Air Force. But countervailing pressures have also always existed—the immediate demands of wartime operations, financial constraints driven by domestic economic conditions, or changing political powers and priorities are just some examples. The results of all this—a variety of attempts by subordinate commanders to keep development planning alive and a fragmented development planning system that is well intentioned but lacking in clarity, consistency, and coherence—will be described in Chapter 2.

[22] Letter from General Arnold to his successor, General Spaatz, 1945.

2

Development Planning Today

INTRODUCTION

The need to reinvigorate early development planning was recognized as part of the Weapon Systems Acquisition Reform Act of 2009 (WSARA). The policy was initially documented in Directive-Type Memorandum 10-017, "Development Planning (DP) to Inform Materiel Development Decision (MDD) Reviews and Support Analyses of Alternatives (AoA)" and later incorporated in the Department of Defense (DoD) Instruction 5000.02 update. This chapter describes and examines development planning as it is implemented today by the Air Force, including the overall development planning process and implementation, key development planning interfaces and linkages, development planning assessment measures, and development planning for Air Force workforce development.

OVERALL PROCESS AND IMPLEMENTATION

Process Description and Organizational Responsibilities

The process flow provided by the Office of the Deputy Chief of Staff for Operations, Plans, and Requirements (HAF A3/5), shown in Figure 2-1, indicates where the current development planning process in the Air Force occurs. The key element of the development planning process is the targeted Core Function Support Plans (CFSPs), which start with the 12 Core Function Leads (CFLs) identifying and

FIGURE 2-1 Air Force Strategy, Planning, and Programming Process (SP3). SOURCE: Harry Disbrow, Senior Executive Service, Associate Deputy Chief of Staff for Operations, Plans and Requirements, Headquarters U.S. Air Force.

prioritizing capability gaps.[1] The CFL-led capability collaboration teams perform early systems engineering to inform requirements, develop concepts, and identify technology risks and science and technology (S&T) needs, hence bridging the S&T and System Program Office worlds.

Although the framework above allows for planning at all levels, in its current implementation, most of the planning effort is focused at the individual

[1] In 2010, the Secretary of the Air Force and Chief of Staff of the Air Force decided that each of the Air Force's 12 Service Core Functions would have an annual Core Function Master Plan (CFMP) developed under the guidance of an Air Force MAJCOM commander acting as a Core Function Lead Integrator (CFLI). In this work, the CFLIs align strategy, operating concepts, and capability development with requirements and programmatic decisions about the Service Core Function over a 20-year period (National Research Council, *Capability Planning and Analysis to Optimize Air Force Intelligence, Surveillance, and Reconnaissance Investments*, The National Academies Press, Washington, D.C., 2012). NOTE: Under the new Strategy, Planning, and Programming Process (SP3), the Air Force dropped "Integrator" from CFLI because the integration across core functions will take place at Headquarters, Air Force (Stephen Munday, Office of the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering, personal communication to National Research Council staff member Carter Ford, September 29, 2014).

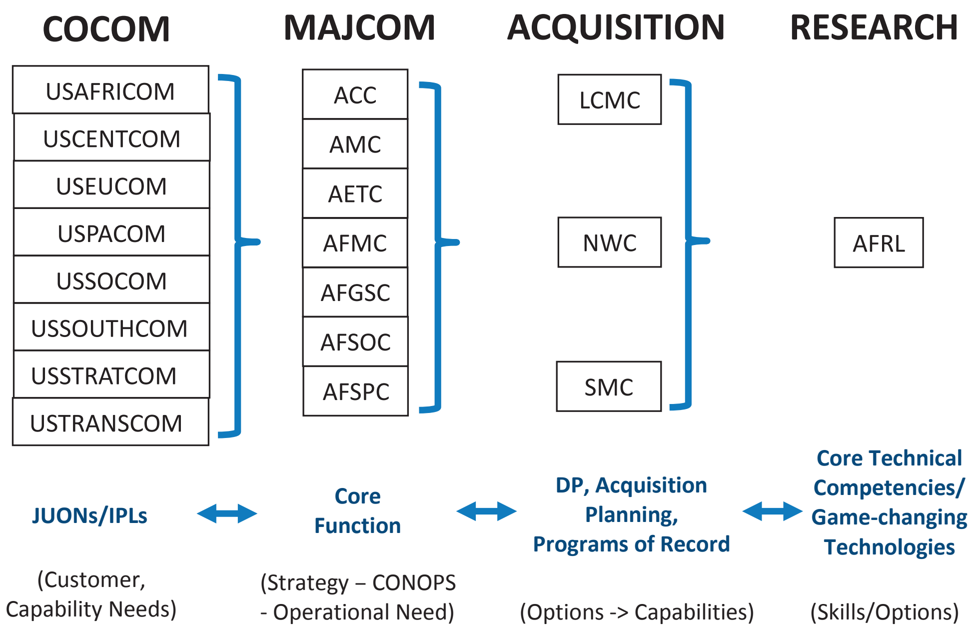

FIGURE 2-2 Key players and coordination in the development planning process.

CFL level, with little evidence of consistent cross-CFL planning effort occurring. Furthermore, the detailed implementation of the development planning process as defined above has significant variability across the Air Force, depending on the organizational leadership and specific CFL's needs and focus. Implementation of development planning appears to work best in cases where close linkages exist between the major commands (MAJCOMs) and the development centers. Examples include Air Force Space Command and Space and Missile Systems Center, Global Strike Command and Nuclear Weapon Center, and Air Force Materiel Command and Air Force Life Cycle Management Center. Figure 2-2 depicts all the key players and their interactions in the development planning process. Good collaboration is noted across the key players from combatant commands (COCOMs) to MAJCOMs to the acquisition and S&T communities, as needed.

It is not clear how coordination and collaboration occurs vertically during implementation to balance needs across the CFSPs. Significant inconsistencies exist in leveraging development planning to support needed program trade-offs. The planning horizon also appears to vary across CFLs. The longest planning span identified during the study is related to the *Technology Horizons*[2] and the *Global Horizons*[3] studies led by the Air Force Chief Scientist, covering 10 to 20 years in the future.

Budget Trends

In 1986, the General Accounting Office (GAO; now the General Accountability Office) report discussed in Chapter 1 ended the Air Force's system of taxing programs of record to support unrelated development planning efforts.[4] At the same time, Congress restored funding for development planning in Program Element (PE) 65808, thereby allowing development planning spending to return and remain relatively stable through the remainder of the 1980s (see Figure 2-3).

Despite Air Force Systems Command leadership support of development planning, PE 65808 experienced reductions in the early 1990s and was eliminated as a program element by the year 2000 due to a number of factors described in Chapter 1.

With the reinvigoration of development planning as part of WSARA, the program element has been reinstated, but once again appears to be experiencing reductions and variability. However, there appears to be several other means of funding development planning-type efforts when it is deemed necessary. Although in some cases, the appropriate funding may be ultimately made available for development planning, there are no consistent and traceable means of estimating the total funding applied to development planning across the Air Force today. Nor was the committee able to identify an entity or source of information for the total amount of funding that may be going to various development planning efforts or ascertain the adequacy and efficiency of the funding amount and mechanisms. Moreover, it seems clear that the level of funding in the program element today would not be sufficient to support all needed cross-cutting development planning efforts.

Finding 2-1. Lack of focused responsibility, capability, and funding for cross-core function analysis and trade-offs has limited the effectiveness of Air Force development planning.

[2] Office of the U.S. Air Force Chief Scientist, *Technology Horizons: A Vision for Air Force Science and Technology 2010-2030*, Washington, D.C., May 15, 2010, available at http://www.defenseinnovationmarketplace.mil/resources/AF_TechnologyHorizons2010-2030.pdf.

[3] Office of the U.S. Air Force Chief Scientist, *Global Horizons Final Report: United States Air Force Global Science and Technology Vision*, June 21, 2013, available at http://www.defenseinnovationmarketplace.mil/resources/GlobalHorizonsFINALREPORT6-26-13.pdf.

[4] General Accounting Office, *Appropriated Funds: Air Force Needs to Change Process For Funding Some Activities*, GAO 86-24, Washington, D.C., January 1986.

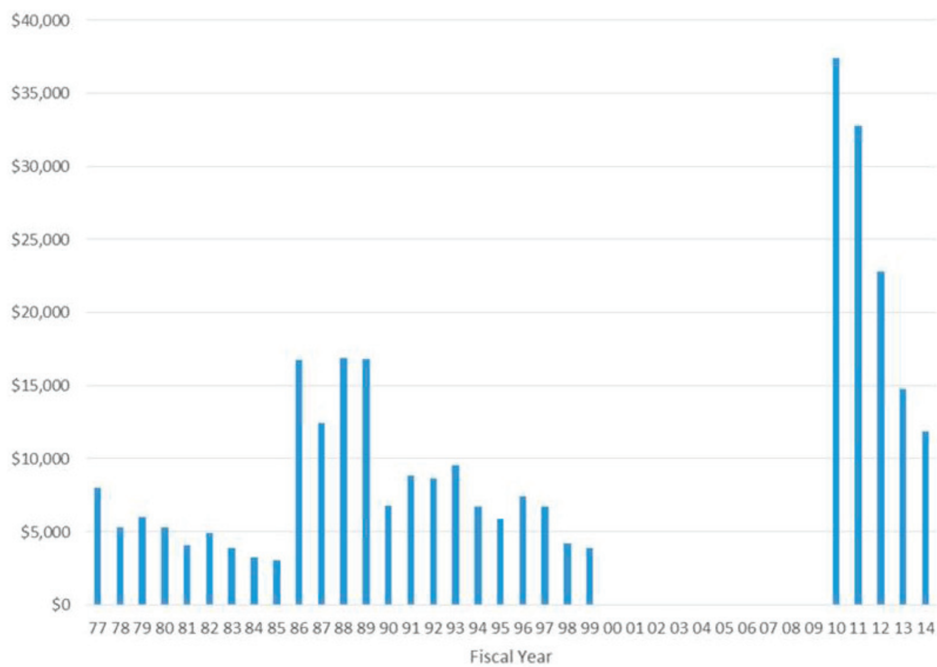

FIGURE 2-3 Funding trends for development planning (in $1,000s and "then-year dollars" versus constant or inflation-adjusted dollars). NOTE: WSARA (Weapons System Acquisition Reform Act) was established in 2009.

> **Finding 2-2.** The amount of program element funding for development planning is insufficient to perform effective development planning. The current allocation process of the funding is ineffectual.

KEY INTERFACES AND LINKAGES

Defense Strategic Guidance and Air Force 2023 Strategic Planning

Guidance for determining the development and sustainment of the Air Force's required capabilities comes from a series of documents that start with the National Security Strategy[5] issued by the White House and required by the Goldwater-Nichols Act of 1986. DoD uses the National Security Strategy as a basis for draft-

[5] White House, *National Security Strategy*, Washington, D.C., May 2010, http://www.whitehouse.gov/sites/default/files/rss_viewer/national_security_strategy.pdf.

ing and issuing the Defense Strategic Guidance (DSG),[6] which adds content and sets a strategic direction for the department and services as a whole. The National Defense Strategic Guidance further defines the environment and threats that need to be addressed on behalf of the nation. The Joint Chiefs of Staff (JCS) uses the Defense Strategic Guidance as a basis for drafting the National Military Strategy,[7] which provides "strategic direction for the Armed Forces" and is prepared by the chairman of the JCS, who is responsible under the Goldwater-Nichols Act for "assisting the President and Secretary of Defense" in providing strategic direction.

These and other supporting documents provide the input to the Air Force to determine the capabilities that need to be sustained, those that can be phased out or retired, and new capabilities that are needed for the future. The current fiscal environment creates an imperative to perform this assessment correctly. WSARA identified development planning and early-phase systems engineering as critical needs that need to be strengthened. At the current time, implementation of the National Military Strategy appears to be done at the Air Force Service Core Function level via the CFSPs.[8] Figure 2-4 shows the Air Combat Command (ACC) approach for developing its CFSP.

Development planning activities, as implemented, are focused along supporting each CFSP independently. The committee did not see evidence of development planning utilizing the national planning documents or providing data and information for Air Force-wide consideration that looked at either the integration across Service core functions to achieve the desired objectives or potential reallocation across core function boundaries. These cross-functional trades and reallocation across core functions (or even across service elements) should be an outcome of the national planning documents. In the current Air Force construct, each core function area would be expected to advocate for the mission and capability represented within its area. Development of the analytic capability and supporting data for cross-core-function trade-offs would need to be done with strong senior leadership direction and guidance. There appear to be only a few isolated areas where senior leadership support resulted in high-quality development planning products for that area.[9]

The committee was briefed on the development planning approach by multiple organizations across the Air Force. In most cases, the development planning efforts

---

[6] DoD, *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense,* January 2012, http://www.defense.gov/news/defense_strategic_guidance.pdf.

[7] DoD, *The National Military Strategy of the United States of America 2011: Redefining America's Military Leadership,* February 8, 2011, http://www.army.mil/info/references/docs/NMS%20FEB%202011.pdf.

[8] Robert "Blaze" Burgess, Chief, Planning, Programming and Requirements Division (A8X), HQ Air Combat Command, "ACC Viewpoint on DP," presentation to the committee on April 29, 2014.

[9] SMC and AFNWC both demonstrated a much broader and integrated development planning approach.

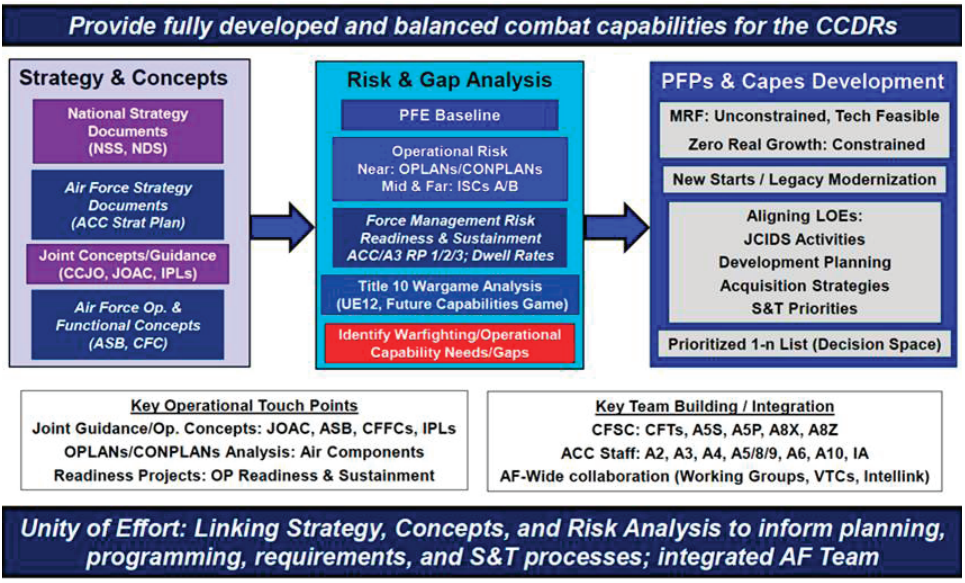

FIGURE 2-4 Air Combat Command methodology for developing Core Function Support Plans. SOURCE: Robert "Blaze" Burgess, Chief, Planning, Programming and Requirements Division (A8X), HQ Air Combat Command, "ACC Viewpoint on DP," presentation to the committee on April 29, 2014.

were aligned with supporting specific acquisition or pre-acquisition activities. As a general rule, the organizational responsibility and reporting was quite low in the organization, with significant variability in the products and engagement of the development planning organization. In limited cases (i.e., Space and Missile Systems Center [SMC] and Air Force Nuclear Weapons Center [AFNWC]), there was evidence of strong executive insight and overview within these organizations that lead to a better development planning process and products.

The senior leadership and guidance for development planning that the committee observed at SMC resulted in an exemplar integrated space portfolio. One measure of the quality or effectiveness of this work is the recent success in the defense of budget submissions. While SMC was and is excellent in working with Air Force Space Command to develop an integrated space portfolio, it is necessary to extend this to cross-portfolio, cross-core function analysis and trade-offs—for example, airborne communication nodes versus space versus non-Air Force space programs. Because this analysis could potentially impact force structure, the need for a higher-level Air Force-wide organizational structure with broad capability and strong endorsement and engagement from Air Force senior leadership, with independence from the core function organizations, is required to an even greater degree. As an example, the leadership-driven, centralized organization with responsibility, capability, and funding for the space portfolio demonstrates the value that an Air Force-wide development planning function could provide.

> **Finding 2-3.** The implementation of development planning as currently practiced is local, fragmented, and inconsistent and lacks Air Force senior leadership demand for the required analysis to address cross-core function trade-offs.

> **Finding 2-4.** The flow down from the Defense Planning Guidance and Air Force Strategic Planning processes and products to development planning is not evident.

Science and Technology Community, Including Alignment with Industry

The Air Force has a robust S&T effort, primarily executed in the Air Force Research Laboratory (AFRL). Continuation of this S&T base is required to assure that the Air Force has capability and insight into emerging technologies that can be evaluated for applicability to known Air Force needs and to also identify game-changing technologies that offer potential for new capabilities not previously under consideration. The maturation of these technologies to a technology readiness level (TRL) acceptable for an advanced technology demonstration provides the path for acceptance by a systems program. The S&T base addressable by the Air Force includes Air Force and DoD-wide S&T efforts as well as the significant independent research and development (IR&D) efforts in industry and research ideas and products from academia. A mature, well-performing development planning process would effectively tap into and influence these investments and assure that the portfolio has maximum impact for future Air Force capability needs. This section examines the current processes and identifies best practices and deficiencies. The Air Force S&T planning process, shown in Figure 2-5, is initiated from many of the strategic drivers that are inputs to the overall development planning process but is augmented by the CFSPs, *Technology Horizons*,[10] and wargaming.[11]

The planning process and governance structure provides oversight and review by the MAJCOM structure and the Air Force Requirements Oversight Council. The inclusion of MAJCOM input to the Air Force S&T plan is a major advance over

[10] Office of the U.S. Air Force Chief Scientist, *Technology Horizons*, 2010.

[11] Col Ralph Sandfry, Chief, Science and Technology Division, SAF/AQRT, U.S. Air Force, "Aligning Science and Technology (S&T) and Development Planning (DP) to Support Air Force Capability Development Priorities," presentation at the NDIA DPWG Workshop on S&T/IR&D, June 21, 2012, http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Pages/Past_Projects.aspx#2010.

FIGURE 2-5 Air Force science and technology planning process—identifying the highest-priority capability needs. NOTE: It may be appropriate to increase COCOM insight and impact on the S&T planning process, but that is beyond the scope of this report. SOURCE: Colonel Ralph Sandfry, Chief, Science and Technology Division, SAF/AQRT, U.S. Air Force, "Aligning Science and Technology (S&T) and Development Planning (DP) to Support Air Force Capability Development Priorities," presentation at the NDIA DPWG Workshop on S&T/IR&D, June 21, 2012, http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Pages/Past_Projects.aspx#2010.

prior efforts, and AFRL is to be commended for ensuring MAJCOM involvement in the process. Outputs of the S&T process include the following:

- *Innovation push*—Leveraging existing technologies ("tech push") to create new and better capabilities for tomorrow's warfighter.
- *More advanced technology demos, higher TRL levels, "tech push"*—Not all demos need to come from a defined demand signal or requirement.
- *Affordability*—"Baked in" to what the Air Force does across its entire S&T portfolio.
- *Engagement and partnership*—Focusing the nation's economic engine on Air Force S&T problems.

The development planning briefings received by the committee were largely focused on specific systems, and the ties to the Air Force and industry S&T developments were extremely limited. In addition, insight and understanding of both evolutionary and revolutionary technology advances were not evident. A robust, mature development planning effort would understand the art of the possible relative to system extensions and provide justification for increasing the maturity of specific high-pay-off technology and performing significant demonstrations, such as was done in the development of stealth technologies. Recognition of the role of advanced technology demonstrations has not been evident in the development planning presentations the committee has seen.

> **Finding 2-5.** Development planning, as currently implemented, is not effective at leveraging promising low-TRL laboratory-developed technology—including manufacturing readiness level and integration readiness level. In addition, recognition of and inclusion of the outputs of Advanced Technology Demonstrations has been limited.

One of the inputs to the current Air Force S&T planning process, as shown in Figure 2-5, is *Technology Horizons*, which was a study requested by the Chief of Staff of the Air Force (CSAF) and was led by the Air Force Chief Scientist. *Technology Horizons* was followed in 2013 by *Global Horizons*, also led by the Air Force Chief Scientist.[12,13] Both of these studies provide valuable insights and useful ways of considering the impact of technology. *Technology Horizons* looked 10 years into the future to anticipate S&T advances and then another 10 years to anticipate both U.S. and adversary capabilities.[14] The process (see Figure 2-6) then marches back in time to look at the needed S&T investments to allow realization of the future options. The S&T planning process is strongly aligned with the CFSP construct. This is both a strength of the process and a limitation. As Finding 2-3 indicates, the lack of Air Force-wide development planning in the CFSP process is a current development planning weakness. An S&T plan aligned with the CFSP will have this same weakness embedded within it.

Technology Horizons represents a less constrained look at the future, allowing insight into what might be possible capabilities, in a way that addresses defined needs without suppressing technological innovation. While AFRL conducts a planning process to define its S&T portfolio, it does not appear to be connected to an Air Force-wide evaluation, selection, and nurturing of these future capabilities. As part of the development planning presentations, there were occasional technology roadmaps presented demonstrating the alignment of portions of the AFRL portfolio with that specific presentation. There was no overall indication of the S&T portfolio alignment with Air Force needs or acceptance of that alignment by the

[12] Office of the U.S. Air Force Chief Scientist, *Technology Horizons*, 2010.
[13] Office of the U.S. Air Force Chief Scientist, *Global Horizons*, 2013.
[14] Office of the U.S. Air Force Chief Scientist, *Technology Horizons*, 2010.

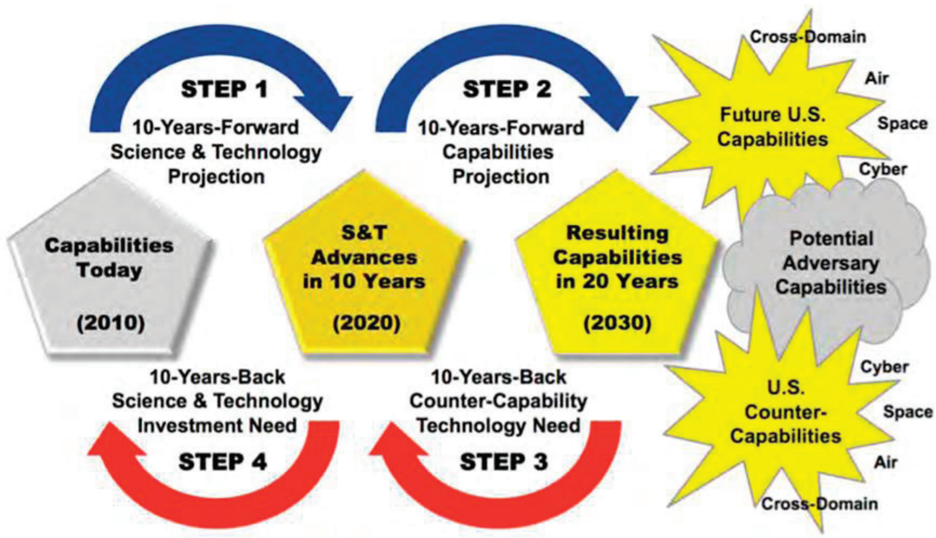

FIGURE 2-6 Schematic of the 10+10 Technology-to-Capability process used in *Technology Horizons*. SOURCE: Office of the U.S. Air Force Chief Scientist, *Technology Horizons: A Vision for Air Force Science and Technology 2010-2030,* Washington, D.C., May 15, 2010, available at http://www.defenseinnovationmarketplace.mil/resources/AF_TechnologyHorizons2010-2030.pdf.

development planning and system programs. In the early Vanguard activity, this was characterized as the "hooks and strings" that assured two-way acknowledgment of the investments and potential insertion or upgrade opportunities.[15,16]

Finding 2-6. While the newly established Air Force S&T planning process is promising, it is insufficiently mature to demonstrate how S&T investments should best be linked to prioritized Air Force needs.

Industry serves as another significant source of S&T funding via IR&D. In the past, communications of and influence on the industry portfolio occurred via the annual IR&D review process. During this process, each corporation's IR&D portfolio was reviewed, and each project was graded by the government. This provided communication that was necessary in the pre-information technology

[15] General Alton Slay, Sr. (USAF, Ret.), "Historical Perspectives," presentation to the committee on January 30, 2014.

[16] A core issue within the Air Force is that the Air Force capability analysis teams do not report to a sufficiently high Service level to properly motivate Air Force actions directed toward 6.3/6.4 capability developments in analogy with Navy. This realization resulted in Recommendation 2.

era, and the grading served to align the investments with service limitations on allowable expenditures. These processes degraded over time as constraints were removed. A limited set of these elements have begun to be reinstituted, as will be described below.

The Defense Innovation Marketplace currently serves as the information portal supporting service and DoD-wide engagement with industry on IR&D.[17] It serves as a repository of service information for industry-wide access and provides many links to acquisition activities. Air Force planning documents are available on the website for industry to study future Air Force needs and investment trends. It also serves as a secure portal for companies to submit proprietary IR&D reports. Mandatory report submission for reimbursable IR&D programs was reinstated in 2012. This controlled database can be accessed by Air Force personnel to determine corporate investments and technology maturation activities being pursued by industry. This leads to exchange meetings where the Air Force identifies IR&D programs it would like to receive briefings regarding the content and output. While this process provides some information to the Air Force on selected IR&D activities, it provides no insight on the total investment of a company. While the Defense Innovation Marketplace serves as a source of information, its effectiveness at influencing either industrial IR&D investments or AFRL investments is not clear. At best, the influence may be indirect and occur because of improved knowledge and communication. However, in areas that are isolated and not widely implemented, the Air Force has demonstrated an ability to strongly influence both the content and the quality of industrial IR&D projects.

As an example, participation in the Versatile Affordable Advanced Turbine Engines program (see Figure 2-7) requires industry to identify and report on IR&D activities as part of the Advanced Turbo-Propulsion Program. The Air Force reviews the IR&D programs at each participant company on a regular basis and provides a report card to that company on both the topics being pursued by that company and their standing relative to the industry as a whole (leading, ahead of, at, or behind the state of the art). These reports strongly influence both the IR&D topics and drive quality into the work. This approach represents a best-in-class practice. The Air Force (and DoD as a whole) could benefit from expanding this practice.

> **Finding 2-7.** Development planning, as currently implemented, is not effective at leveraging industry IR&D investments.

---

[17] For additional information, see the Defense Innovation Marketplace website at http://www.defenseinnovationmarketplace.mil/, accessed July 8, 2014.

FIGURE 2-7 Aligning science and technology and development planning to support Air Force capability development priorities. SOURCE: Col Ralph Sandfry, Chief, Science and Technology Division, SAF/AQRT, U.S. Air Force, "Aligning Science and Technology (S&T) and Development Planning (DP) to Support Air Force Capability Development Priorities," presentation at the NDIA DPWG Workshop on S&T/IR&D, June 21, 2012, http://www.ndia.org/Divisions/Divisions/SystemsEngineering/Pages/Past_Projects.aspx#2010.

Transition to Programming

The Air Force Strategy, Planning, and Programming Process (SP3) (see Figure 2-1) provides a context for understanding the potential value of development planning and where the outputs of development planning could provide information to allow the Air Force to make better-informed decisions. Development planning should support via analysis and trade-offs, indicated by the major portions of the top and middle lines of Figure 2-1. The senior leadership of SMC and their guidance for development planning resulted in an integrated space portfolio that was implemented in programming. One measure of the quality or effectiveness of this work is the recent success in maintaining the requested budget. The leadership-driven centralized organization with responsibility, capability, and funding for the space portfolio programming was key in maintaining the requested budget.

As the Air Force aggressively pursues cyberspace as a warfighting domain alongside all others, it needs to just as aggressively pursue the changes necessary to comprehensively address software and cybersecurity issues in its weapon systems acquisition and development practices. The ability of the Air Force to produce and evolve software is central to its ability to achieve integration and maintain mission agility. For example, studies by Defense Science Board (DSB)[18] and the National Research Council[19] over the past 30 years have established and confirmed the critical importance of software to fulfilling DoD mission objectives.

The DSB report *Resilient Military Systems and the Advanced Cyber Threat* adds another element for consideration in the Air Force software environment: cyber resiliency. The report states,

> Based in part on the complexity of modern software and microelectronic systems, very small and difficult to detect defects or subversive modifications introduced at some point in the life cycle of the systems can create debilitating effects. As a result of the great and growing complexity of DoD systems, cyber resiliency is an extremely broad and difficult attribute to guarantee.[20]

Today, the original pillars of "hooks and strings" require a shared understanding of the cyber threats in the expected mission environment. Software and cyber considerations are at the heart of the needed cross-core function analysis and trade-offs and the resulting gains in efficiencies, cost effectiveness, and mission agility. However, the concerns outlined in Findings 2-1 and 2-3 are further exacerbated by a lack of knowledge and awareness of cyber threats and risks among senior Air Force leadership, combatant commands, S&T entities, and the acquisition community; a lack of cybersecurity expertise available to support development planning; and a lack of clear prioritization of cyber risk management as both an element of development planning and as a technical requirement in acquisitions.

Finding 2-8. The Air Force operates in a networked and integrated fashion, yet there is little or no evidence that development planning today addresses networked, integrated, and cyberspace operations.

---

[18] See, for example, the Defense Science Board reports *Report of the Defense Science Board Task Force on Acquiring Defense Software Commercially* (1994), *Defense Software* (2000), *Mission Impact of Foreign Influence on DoD Software* (2007), and *Resilient Military Systems and the Advanced Cyber Threat* (2012), published by the Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics in Washington, D.C.

[19] See, for example, the National Research Council reports *Innovations in Software Engineering for Defense Systems* (2003), *Summary of a Workshop for Software-Intensive Systems and Uncertainty at Scale* (2007), *Preliminary Observations on DoD Software Research Needs and Priorities: A Letter Report* (2008), *Achieving Effective Acquisition of Information Technology in the Department of Defense* (2010), *Critical Code: Software Producibility for Defense* (2010), and *Proceedings of a Workshop on Deterring Cyberattacks: Informing Strategies and Developing Options for U.S. Policy* (2010), published by the National Academies Press in Washington, D.C.

[20] Defense Science Board, *Resilient Military Systems and the Advanced Cyber Threat,* 2012.

Development planning is intended to support the guidance embedded in the Strategic Master Plan and Strategic Planning Guidance, but current development planning capabilities appear inadequate. Tools available to the development planning community for cross-core function trade-offs and integrated force planning—with the capability to analyze, assess, simulate, and trade performance of the Air Force against a range of realistic and stressing scenarios utilizing a set of validated common models across the Air Force-wide portfolio—were not apparent. This analytical effort requires modern tools and knowledgeable analysts to perform the multivariate analysis needed to enable definition of the required force that meets Air Force needs, assures robustness, and maintains flexibility while operating in the fiscal constraints facing the nation and the Air Force today. The Air Force appears to lack these tools and the analyst cadre to use them. As the process moves forward from program planning guidance to a balanced program objective memorandum (POM), it will be crucial to identify issues and validate the performance of the Air Force in successfully executing the missions required and allow optimization across Service core functions—collecting critical data as the Secretary of the Air Force and CSAF approve future budget submissions.

The need for an independent analysis of the core function is enhanced by the integrated, networked, and cyber-enabled way the Air Force will fight in the future. As the Air Force transitions from the "alone and unafraid" doctrine, which is best encapsulated in the B-2 bomber, to the integrated systems-of-systems constructs of the future, the need for fidelity in the analysis at the Air Force-wide-level increases. Decisions can no longer be left to a core function but need to be evaluated for their impact on other elements of the Air Force and on the performance of the Air Force as a whole. The emergence of not just cyber-enabled but also cyber-threatened systems further enhances the need for this analysis.

Test and Operations Influence

The test and evaluation (T&E) community is currently embedded in the development planning process, as documented in AFMC's *Development Planning (DP) Guide*.[21] The T&E community is included as part of the governance structure and also provides members for the capability material teams (CMTs) that address the detailed material implementations for a capability gap. The CMT is defined in the planning guide and is a multi-disciplinary team tasked to execute a development planning effort. In addition, "the CMT works directly with the operational MAJCOM representatives to ensure a thorough understanding of

[21] Air Force Materiel Command, *Development Planning (DP) Guide,* Directorate of Intelligence and Requirements (AFMC A2/5), Wright-Patterson Air Force Base, 2010, http://www.defenseinnovationmarketplace.mil/resources/DevelopmentPlanningGuide-Jun2010.pdf.

operational requirements and concepts of operations (CONOPS)."[22] Inclusion of the T&E community is essential for at least two reasons. First, as members of the development planning activity, they will have an improved understanding of the integrated warfighting capability desired, resulting in improved perceptiveness of the testing. Second, as new capability emerges and enters the force structure, testing will be a key element in assuring that adequate understanding of this capability is developed. Of particular note here are cyber- and directed-energy weapons. Neither of these has established a validated effects manual, but both offer potential game-changing capabilities that will likely cut across multiple Service core functions, which may require changes to experiments-based testing. Significant systems testing of under-realistic conditions will be needed to allow validation of models and the confidence to include non-kinetic weapons to be used and trusted.

Cyberspace is essential to all Air Force missions. All future Air Force weapon systems will be software reliant. This dependency on software is increasing systems' functionality and performance tremendously, but the associated connectivity and complexity is also expanding systems' vulnerability to attack. Disruptive cyberattacks on software-reliant systems are well known, adaptable, and increasing in intensity. Cybersecurity risks could potentially interfere with the Air Force's ability to successfully plan, prepare, and execute assigned missions.[23]

Finding 2-9. Air Force development planners recognize the increasing importance of the cyber domain, but lack the priority, policies, flexibility, and procedures in the development planning and end-to-end acquisition processes to address the cyber security topic effectively. The cyber domain includes cybersecurity, cyber warfare and cyber impact on knowledge confidence. Further effort is required to address capability assessment; gap identification; early system engineering; design, test, and evaluation; fielding; and sustainment to avoid degrading systems' advanced functionality and performance.

ASSESSMENT MEASURES

The committee received briefings on current metrics used from the Air Force Life Cycle Management Center (AFLCMC) and from the Air Force Nuclear Weapons Center (AFNWC). These briefings included a description of the metrics used as well as the purpose of those metrics. Additional information was also obtained from

[22] Ibid.

[23] The breadth of the cyber questions can best be answered in a study that is focused on the topic and conducted at the appropriate classification level.

AFLCMC's *Standard Process for Development Planning.*[24] This section will describe the metrics which the Air Force is currently using. AFLCMC has categorized the metrics they use to assess the development planning process as "process metrics" and "health metrics." Process metrics are primarily intended to provide data on the efficiency of operations and to facilitate lessons learned in order to further streamline the process. AFLCMC's current process metrics are as follows:

- The number of development planning requests processed on time,
- The number of development planning proposals developed on time,
- The number of Concept Characterization and Technical Descriptions (CCTDs) completed on time and approved within 6 calendar weeks, and
- The total time from development planning request to a signed development planning proposal.

In addition, AFLCMC has three health metrics intended to assess the effectiveness of the development planning process. In one metric, the quality of the delivered development planning project to the customer (MAJCOM, Headquarters Air Force, or program manager) is assessed by that customer. In a second metric, the adequacy of the development planning effort to support a Materiel Development Decision (MDD) is assessed by recording the percentage of development planning projects that successfully pass MDD without significant rework. In the third health metric, AFLCMC quantitatively estimates a return on investment (ROI) for their development planning efforts. This ROI is computed by dividing the estimated cost avoidance due to the development planning effort by the cost of the development planning effort. The cost of the development planning effort is known. The cost-avoidance computation attempts to quantify the role of development planning in avoiding a false start and in reducing acquisition cost growth. Historical data is used to estimate the average cost of cancelled programs and the average amount of cost overrun. It is then assumed that development planning reduces the historical cancellation rate by 50 percent and the average overrun by 20 percent. A further qualitative multiplicative adjustment factor is based on a qualitative assessment of the scope and quality of the development planning effort, which ranges from 0 to 1. Figure 2-8 provides a sample calculation.

Overall, development planning needs to be evaluated on its ability to motivate organizational interventions that improve the probability of program success. While not explicitly discussed this way, the framework proposed by AFNWC is compatible with this evaluation. The framework also permits a phased plan for the continued

[24] Air Force Life Cycle Management Center, *Standard Process for Development Planning,* September 20, 2013, http://www.defenseinnovationmarketplace.mil/resources/20131122_AFLCMC-DPStandProcess.pdf.

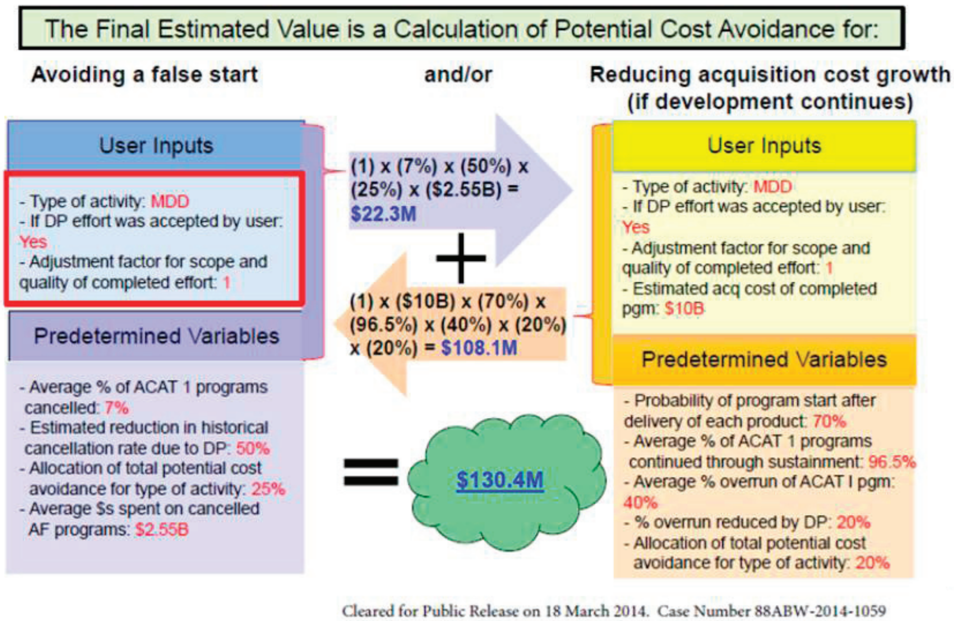

FIGURE 2-8 Air Force Life Cycle Management Center metrics. SOURCE: Captain Erica Anderson, “Development Planning (DP) Metrics Overview,” presentation to the committee on February 25, 2014.

assessment of progress as the technological capabilities mature, threats evolve, and organizational constructs are developed. An additional advantage of AFNWC’s approach is that it permits the tailoring of specific metrics to assess the overall desired outcome of launching high-confidence programs. A major reason that such tailoring would be required is that the metrics for game-changing capabilities typically differ substantially from those for sustaining capabilities. Game-changing capabilities usually have large explicit or implicit framing assumptions that are critical to assess early in the development process. Development planning can provide a critical role in identifying those assumptions and the corresponding metrics.

AFNWC reviewed AFLCMC’s development planning metrics and delayed their concurrence on the development planning ROI, pending a yet-to-be-scheduled verification and validation of the metric’s underlying equation. Additionally, they have proposed a development planning metric approach to assess the degree to which AFNWC is postured for success in launching high-confidence programs.

Both AFLCMC and AFNWC focus their metrics on development planning projects that are funded under the Air Force’s program element for development planning. In the examples of development planning activity that were briefed to the committee, a minority appeared to be funded under the development planning line. Additionally, what is funded by a program and what is funded by the development planning program element seemed to be partly determined by what type of funding the program could spend. An assessment of development planning value, where the development planning activities not funded by the development planning program element are not included, will significantly understate that value.

The Air Force's effort to use metrics to assess value of development planning is laudable but, as yet, less effective than it could be. In particular, the return in the ROI approach depends primarily on estimated value of the program. The other factors, such as the historical cost growth, are invariant; that is, these inputs are the same for all computations of ROI. As a result, the computed ROI effort has no direct linkage to the impact that the development planning effort actually had on the program, instead leading to the contradictory outcome that the most effective way to improve the ROI for a development planning effort is to reduce the denominator of the ROI—that is, the amount of money spent on the development planning program itself. This puts the entire usefulness of this metric into question, in part because it cannot be used to improve the development planning process.

AFNWC's approach to characterizing value is significantly different and offers significant promise, although they have not yet defined specific metrics. As mentioned above, AFNWC defines an outcome for development planning as the degree to which AFNWC is postured for success in launching high-confidence programs. This overall assessment is then divided into three key categories: external factors, center factors, and end-user factors. AFNWC highlights the need to define responsibility so that accountability for results can be tracked. This division assists with the identification of that accountability. AFNWC then divides each of these factor categories into several supporting factors, as shown in Figure 2-9.

While AFNWC has not yet completed the development of the metrics, it is in the process of developing templates for each of the supporting factors. These consist of evaluation areas or questions that will be used to assess the given supporting factor. The templates are planned to contain line items phrased as statements of fact. The intent is for each line item to elicit a brief summary of effort status rather than a "yes" or "no" response and for there to be an emphasis on "what needs to be done" versus "how to do it." Significantly, a single lead office of primary responsibility will be identified for each line item to increase accountability for results.

AFLCMC's process metrics focus entirely on the time taken to complete various development planning activities. Additionally, two of the health metrics address product quality. While these are process characteristics that should be assessed, they are not the only process characteristics worth measuring. Examples of characteristics not addressed include the funding and personnel consumed, the adequacy of the tools available for analysis, the adequacy of the training of personnel, and the adequacy of funding. The AFNWC approach appears better in this regard because it has identified funding and resources as important factors that metrics can help

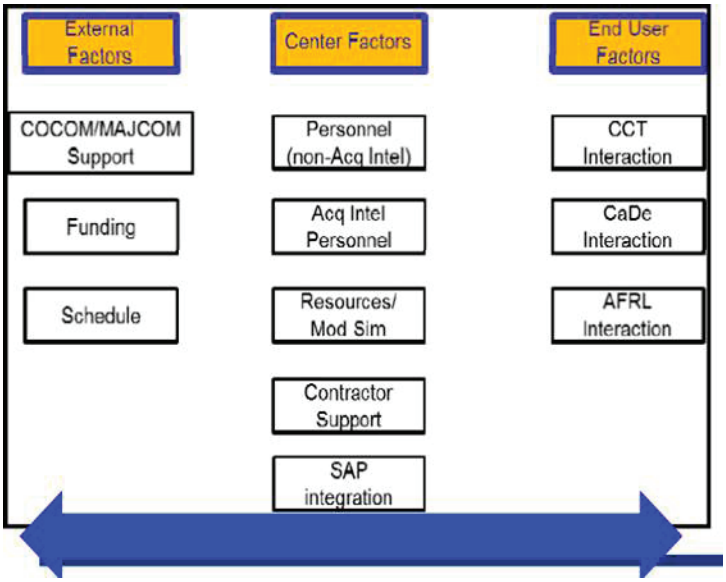

FIGURE 2-9 Metric key factors. SOURCE: Air Force Nuclear Weapons Center, AFNWC/XZ, "AFNWC DP Posture Metric," June 19, 2014.

assess, although they have not yet defined specific metrics that would assess these factors.

> **Finding 2-10.** Development planning metrics do not currently provide an objective and actionable assessment of the effectiveness and efficiency of development planning.

AFLCMC has three health metrics intended to assess the effectiveness of the development planning process. Two of these characterize quality (one as a qualitative customer assessment and the other as a percentage of development planning projects that successfully pass MDD without significant rework). Neither of these metrics address the impact of the development planning effort on the program, which is the crucial assessment for effectiveness. On the surface, AFLCMC's ROI metric appears more promising. But the only quantitative factor that varies between applications of development planning to various programs is the estimated value of the program. This is not the same as, or even necessarily related to, the value of the development planning effort to the program. There is also a multiplicative adjustment factor that varies between programs. But this is based on a qualitative assessment of the scope and quality of the development planning effort and is, therefore, not objective because judgment is used. It is also not actionable because the cause of a given assessment is not apparent. Moreover, an ROI computation is susceptible to manipulation if the metric can be "improved" by simply reducing the cost of the development planning effort. AFNWC's approach is conceptually sound because it emphasizes metrics to support an assessment of how well AFNWC is postured for success in launching high-confidence programs. But, its development of metrics was incomplete at the time of the writing of this report.

AFLCMC also had "process" metrics intended to provide data on the efficiency of development planning. These metrics included whether various processes (e.g., development planning processes/proposals and CCTDs) were completed on time and the total time from development planning request to a signed development planning proposal. There were no metrics that illuminated efficiency with respect to consumption of resources (people or money) and no way of assessing whether the time allocated was efficient, even if schedules were met.

None of the current metrics assessed whether the development planning processes are enduring—that is, whether adequate and stable resources are being supplied or whether the processes themselves are properly designed to integrate all the functional skills (e.g., manufacturing, test, contracting, etc.) required for successful acquisition.

IMPLEMENTATION OF DEVELOPMENT PLANNING ON RECENT AIR FORCE PROGRAMS

The purpose of this section is to briefly discuss the perceived role of development planning in recent Air Force program acquisitions. Three examples are considered: Next-Generation Radar (a.k.a., JSTARS [Joint Surveillance Target Attack Radar System] Recap), a currently planned program to replace the E-8 JSTARS platform; Distributed Common Ground Station (DCGS), which focuses on a weapon system with significant history; and AFRL's Layered Sensing Program, a recent laboratory program involving the networking of a plethora of sensor assets distributed in space and time to provide intelligence, surveillance, and reconnaissance (ISR) across a broad range of threats.

JSTARS Recapitalization

Broadly identifying technical solutions to meet Air Force needs in ground threat surveillance and targeting served as the objective of the Ground Moving Target Indication (GMTI) Analysis of Alternatives (AoA) conducted several years ago.[25] The

[25] Much of the consideration was limited to overcoming the constraints of reducing costs associated with the Boeing 707 airframe by going to a business class jet. Operations in future conflicts will likely benefit from a more comprehensive perspective, to include the use of drones.

E-8 JSTARS and Global Hawk platforms presently perform this mission. Both employ X-band radar systems to detect, locate, and track ground moving targets day or night and under all weather conditions. Two prototype JSTARS were deployed in January 1991 to the Gulf War as part of an advanced capabilities technology demonstration, with famous results: JSTARS detected the Iraqi Army's movements in the "mother of all retreats."[26] The system had proven its ability as a ground surveillance system supporting target engagement. The prototype systems evolved from two programs conducted in the 1970s: Stand Off Target Acquisition System and Pave Mover.[27]

A primary motivation for JSTARS development was driven by the evident threat posed by the former Soviet Union. JSTARS was focused on Soviet troop movements in the Fulda Gap, a critical requirement at the time to ensure adequate response by North Atlantic Treaty Organization forces. The original threat was replaced by the post-1990 challenge of finding Iraqi troop movements, especially in the vicinity of Scud missile launchers. Further deployments enhanced the admiration for GMTI capability, leading to additional developments, such as the Multi-Platform Radar Technology Improvement Program GMTI capability deployed on Global Hawk.

The need for better and more comprehensive GMTI emerged during the Global War on Terror (GWOT). But the threats in the GWOT were no longer columns of mechanized infantry. Rather, a premium was placed on detecting time-critical targets, such as single vehicle events and dismounted combatants. Electronic warfare threats, such as coherent jammers leveraging digital radio-frequency memory, became another key concern. The deployed JSTARS design did not include, or anticipate, the changing threat landscape.

To address perceived JSTARS deficiencies, including not only sensor capability but also the high maintenance costs associated with the Boeing 707 airframe, the Air Force conducted an AoA, in essence a development planning activity. The original intent of the AoA was to develop an advanced GMTI capability.[28] In this scenario, a cost-effective, technically superior approach to the warfighter's GMTI requirements was to serve as the objective.

While GMTI has a number of technical challenges, deploying a JSTARS capability on a business-class jet became a centerpiece of the study, rather than broadly focusing on the technical requirements to enable assured Air Force domination of ground targets. This AoA focus subsequently drew the conclusion that integrating existing capability on a business-class jet in the form of a "JSTARS recapitalization" is the Air Force's next-step in GMTI. The high costs of maintaining the Boeing 707 platform comprising the JSTARS fleet appear to have made this a foregone con-

[26] J.N. Entzminger, C.A. Fowler, and W.J. Kenneally, JointSTARS and GMTI: Past, present and future, *IEEE Trans. AES* 35(2):748-761, 1999.

[27] Ibid.

[28] Personal communication with Lt Gen (R) David Deptula, April 2014.

clusion. However, as previously noted, the threat has changed substantially from the Fulda Gap scenarios of the Cold War that led to the creation of JSTARS to a more sophisticated threat set complicated by advanced jamming and surface-to-air missile systems. Some aspects of development planning, in the form of the GMTI AoA, provided an opportunity to consider the broad class of solutions to detect and engage dismounts and time-critical targets in increasingly challenging settings, provide anti-jam capability against digital radio frequency memory, and develop multiplatform solutions to address anti-access/area-denial (A2/AD) scenarios.[29]

Congressional House Report 112-705 recommended limiting funds to the Air Force to proceed to a Milestone A decision as a result of the inadequacy of the findings from the AoA.[30] The conferees noted the conflict between addressing the maintenance costs of the Boeing 707 and the need for a detailed sensor and communications architecture leveraging rapidly changing technology and addressing emerging threats in a flexible manner.

> Nevertheless, the Air Force needs to develop a plan to provide an updated GMTI capability meeting joint warfighting requirements. The capability must include the flexibility to incorporate current and future sensor and communications architectures that can be integrated as they evolve in the future. The conferees are concerned that, absent such a modernization plan, the Air Force may lose its ability to provide this capability to the joint force in the future.[31]

The lack of rigorous development planning in advanced GMTI is evident in 2012 statements by former Air Force Chief General Norton Schwartz, where statements indicated available resources as the factor driving the AoA outcome toward a business-class jet solution.[32] Concern over the technical depth of GMTI development planning was recently expressed by the Assistant Secretary of the Air Force (Acquisition).[33] The AoA might have been better informed by a more complete development planning process that assessed GMTI requirements and sensor performance issues.

---

[29] Major C.J. McCarthy, Anti-access/area denial: The evolution of modern warfare, China Anti-Access/Area Denial, */Luce.nt/—A Journal of National Security Studies*, 2010. https://www.usnwc.edu/Lucent/OpenPdf.aspx?id=95&Title=The%20Global%20System%20in%20Transition.

[30] 112th Congress (2011-2012), House Report 112-705, National Defense Authorization Act for Fiscal Year 2013, http://thomas.loc.gov/cgi-bin/cpquery/?&sid=cp1120zsNS&r_n=hr705.112&dbname=cp112&&sel=TOC_3112329&.

[31] Ibid.

[32] Marcus Weisgerber, JSTARS to remain primary USAF ground tracker for now, *Defense News*, March 27, 2012, http://www.defensenews.com/article/20120327/DEFREG02/303270008/JSTARS-Remain-Primary-USAF-Ground-Tracker-Now.

[33] Hon. William LaPlante, Senior Executive Service, Assistant Secretary of the Air Force (Acquisition), presentation to the committee, January 30, 2014.

In this particular case, the findings suggest that critical issues around the Air Force's desired capability were more or less replaced by a less rigorous approach to address operations and maintenance (O&M) challenges with the aging Boeing 707 platform; yet, the threat continues to evolve, and further GMTI development needs to consider performance potential in non-permissive airspace. Development planning's role should be a more comprehensive evaluation of all elements of the system design, leading to much more focused recommendations approaching a pre-Milestone A plan. Involvement of the breadth of acquisition community resources during the GMTI AoA is questionable and likely limited the technical detail of the effort.

Distributed Common Ground Station

DCGS originally started as a ground station for the U2 platform. It has since grown to accept data from a number of sensors, including GMTI and synthetic aperture radar data from the E-8 and RQ-4, as well as data from the U2, MQ-9, and MQ-1. All told, DCGS is projected to receive data from more than 40 sources. A small fraction of the data received by DCGS is used by the warfighter to assess the threat environment, analysts sift through data manually, and there has been a strong dependence on the use of full-motion video to the exclusion of other critical sensor modes.[34] DCGS has struggled to evolve from its original role as the U2 ground station to a pivotal element in the Air Force ISR enterprise. A strategic plan to migrate DCGS from its current state to a preferred state as a comprehensive, open architected system able to automatically exploit reams of sensor data and provide tasking to the broader enterprise is lacking. As a result, DCGS is among the Air Force's most costly systems to maintain, and incorporating new and desired technology is proving challenging, because development planning applied to this existing weapons system, to lay out a more effective future, is sorely lacking.

DCGS is an operational weapons system. So, a fundamental question arises: Why is development planning needed? Because DCGS is largely viewed as an information technology (IT) capability, its transformation to a new, improved, and increasingly relevant weapon system suffers from cultural bias. Rather than invest in a new DCGS architecture with increased performance and lower cost, the current acquisition approach is predominantly focused on incremental modifications under the guise of O&M (Air Force 3400 funding); research, development, test, and evaluation funds (Air Force 3600 funding) are scarce for DCGS.

Meeting Air Force ISR requirements in a ground station capability is presently (and unfortunately) tantamount to ingesting and storing data. A significant burden

[34] David A. Deptula and James R. Marrs, "Global distributed ISR operations: the changing face of warfare," JFQ, issue 54, 3rd quarter, 2009.

is then placed on the intelligence analyst to understand the sensor data product. Because this is the ISR community's equivalent to big data analysis, a manual approach is doomed to failure. Development planning is needed to develop a new capability that maximally exploits all sensor data using advanced algorithms, computing technology, and networking and to field this new capability to DCGS users.[35] Moreover, DCGS should incorporate sensor tasking authority to collect the right data needed to answer critical questions. In addition to the pervasive view that DCGS is merely an IT capability, the system also suffers from the myopia of an Air Force view centered on a single platform; an enterprise-wide ISR vision is presently absent, but it is precisely such a view that is needed to tackle challenges in near-peer, A2/AD environments.

Under Project Liberty, the DCGS acquisition team developed and deployed a limited-scope, multi-intelligence capability. Having the flexibility to work outside of current DCGS constraints, the team was able to deploy a working system at 20 percent of the proposed cost and in a short time period. This was possible because the government stepped in to the lead system-integration role, working with diverse contractor teams and organic, government software development teams. The Project Liberty success provides a better path. While not a paradigm example of development planning, the actions of the government team—assessing available technology, evaluating alternatives, and effectively developing a pre-Milestone A solution—led to a rapidly fielded, cost-effective, technically superior solution. Although this approach is unlikely to scale to DCGS, it is a promising example and demonstrates that the in-house capabilities of the government to perform the required systems engineering and technology integration, working alongside a small, agile contractor team, can lead to highly beneficial systems-integration outcomes. Extending the Project Liberty success to address a rapidly evolving threat environment will require the use of open standard architectures combined with an increasingly agile, innovative, and responsive team of government and contractor personnel.[36]

Air Force Research Laboratory Layered Sensing

The premise of AFRL's Layered Sensing Program is that data can be holistically exploited as a result of concurrent or recent collections from ISR assets, such as radar, signals intelligence, and optical sensors. The resulting product is an improved ISR perspective corresponding to the spatially and temporally distributed

[35] Jeff McKaughan, "Q&A: Lieutenant General Larry D. James," *Tactical ISR Technology*, Volume 2, Issue 4 (July/August), KMI Media Group, 2012.

[36] Jennifer Ricklin, "Air Force C4ISR S&T vision," presentation to NDIA C4ISR breakfast, Air Force Research Laboratory, December 2011.

collection and exploitation of multi-waveband data. Layered sensing addresses an important issue: With the vast number of DoD sensors collecting data, can additional and important threat information be derived at the cost of additional computing power? Effectively, AFRL sought to develop an enterprise-wide vision for ISR.

Layered sensing, although not a specific program, served as a framework for sensor systems research at AFRL. From the broader Air Force perspective, the framework is vastly appealing.[37] Achieving the complete, layered sensing vision has been elusive, as the concept is complicated to analyze and requires the emerging discipline of systems engineering. There are many considerations in such an approach, such as the cost of data links, the exploitation approach, control of the sensors, and the framework architecture to ingest and then exploit massive quantities of data. Inherently, layered sensing provides robustness and potential utility in an A2/AD environment. Yet, AFRL has moved away from the layered sensing concept that was a critical element of its focused long-term challenges just a few years ago as other priorities emerged.

The layered sensing example raises questions about how the Air Force supports and integrates development planning across the acquisition and S&T communities. A robust development planning capability would provide a forum for evaluation of new concepts based on integration of systems, such as that envisioned by the layered sensing concept. A technology push from AFRL will prove less successful without the pull from the operational users that should be manifest in a strong development planning approach. The Air Force and DoD-wide highly skilled scientific and engineering workforce can play a valuable role in the early stages of development planning and help fill technology gaps required for effective prototypes. The roles and responsibilities of in-house organizations like AFRL in the development planning process require clarification.

Recently, AFRL stood up the Engineering and Technical Management Office (AFRL/EN). AFRL has taken the initiative to close the gap between its research projects and transition to programs of record through the use of systems engineering to better guide their research portfolio. The explicit goal of systems engineering is to ensure that research projects are defined within the bounds of acceptable system integration concepts. Delineating how AFRL activities can be leveraged to support wider Air Force development planning will continue to be important.

The prior three examples highlight a need for enhanced, rigorous, and coordinated development planning to better serve the warfighter. Development planning needs to look broadly at available technology, specific objectives, and realistic

[37] Lt Gen David Deptula (USAF, Ret.), Combat cloud is new face of long range strike, *Armed Forces Journal*, September 18, 2013, http://www.armedforcesjournal.com/deptula-combat-cloud-is-new-face-of-long-range-strike/.

constraints. The JSTARS recapitalization example indicates a lack of broad, multidisciplinary involvement during development planning activities, leading to a narrowly focused solution. Similarly, the DCGS example underscores the need for a comprehensive perspective that effective development planning provides. The layered sensing example exposes a need for increased coordination among all stakeholders in the acquisition community to make the most effective use of limited resources and emerging technology.

Finding 2-11. Development planning implementation today does not always help improve near-term acquisition decisions.

In the JSTARS recapitalization effort, development planning activities appeared focused on solving near-term O&M issues with the Boeing 707, rather than taking a comprehensive look at the warfighter's needs for advanced GMTI. Even the resulting name of the activity, "JSTARS recapitalization," provides a limiting perspective. DCGS is viewed as a current weapons system; research and development in multi-intelligence and information technology is not adequately leveraged into development planning activities to transform this critical Air Force asset.

Finding 2-12. Development planning implementation today does not always help mature pre-acquisition concepts by identifying specific needs for more engineering analyses, prototyping, and technology development, among other factors.

Layered sensing is a brilliant, enterprise-wide concept for ISR, but this vision does not appear to be adequately connected to, or leveraged by, a broader development planning construct. The role of the laboratories in supporting development planning should be strengthened. AFRL/EN is a positive step in this direction.

DEVELOPMENT PLANNING FOR AIR FORCE WORKFORCE DEVELOPMENT

Hard metrics on human factors are difficult to quantify. Having said this, however, there does not appear to be clear or consistent evidence that development of the Air Force's enduring deterrent, its cadre of world-leading scientists and engineers, is a specific objective or even a consideration in making assignments to the development planning function. At times, it also seems unclear to Air Force personnel themselves as to why they were assigned to the development planning function. To ensure a healthy and successful Air Force today and into the future, strategic thinkers are needed in key leadership positions. These leaders are called on to make challenging trade-offs to ensure solutions that will support the diverse needs of the community and to make difficult choices regarding future scenarios and needs. It appears that the potential for development planning to act as a training ground for future leaders of Air Force S&T, operations, and acquisition is not currently leveraged.

> **Finding 2-13**. Development planning in its current implementation is not adequately influencing S&T, acquisition, and operational workforce development.

3

Improving Development Planning Support to U.S. Air Force Strategic Decision Making

INTRODUCTION

Chapter 1 discussed the history of development planning, what it was, and why it was abandoned in the Air Force. Chapter 2 described the status of development planning today in the military technology development complex. This chapter describes what development planning could be and should be for the Air Force and recommends specific steps the Air Force should take to strengthen, revitalize, and make development planning an ongoing and enduring Air Force process. Table 3-1 describes the specific objectives of the terms of reference and the committee's corresponding findings and recommendations.

Chapter 1 identified the definitional ambiguity associated with the term "development planning." In addition, Finding 2-4 identified the lack of cross-core function considerations. Clarity of the meaning, content, and definition of development planning is required to assure a common view throughout the Air Force. This report retains use of the term development planning, but the definition given in Recommendation 1 (below) has significantly broader scope than that in Air Force Instruction 63-101.

REDEFINE AIR FORCE DEVELOPMENT PLANNING

Recommendation 1. The Air Force should redefine development planning as "a key process to support the Secretary of the Air Force and the Chief of Staff

TABLE 3-1 Terms of Reference and Corresponding Findings and Recommendations

		Findings	Recommendations
1	How can development planning be improved to help improve near-term acquisition decisions?	2-1, 2-2, 2-3, 2-8, 2-9, 2-10, 2-11	R-1, R-2, R-3, R-4, R-5, R-7
2	How can development planning be improved to help concepts not quite ready for acquisition become more mature, perhaps by identifying the need for more engineering analysis, hardware prototyping, etc.?	2-1, 2-2, 2-3, 2-5, 2-8, 2-9, 2-10, 2-12, 2-13	R-1, R-2, R-3, R-4, R-5, R-6, R-7
3	How can development planning be improved to enable the development of corporate strategic plans, such as science and technology investment roadmaps, Major Command capability roadmaps, workforce development plans, etc.?	2-1, 2-2, 2-3, 2-4, 2-5, 2-6, 2-7, 2-10	R-1, R-2, R-3, R-4, R-5, R-7
4	How can development planning be used to develop and train acquisition personnel?	2-2, 2-10	R-5, R-7

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."

The overall rhythm of the process will be dictated by the annual program objective memorandum and budget process. The seniority and experience of the personnel is key and needs to be developed as the process proceeds. Given the importance of development planning in providing data to allow strategic decisions to be made, it is essential that ownership of the direction and guidance originate from the Chief of Staff of the Air Force (CSAF) and the Secretary of the Air Force (SECAF), and their strong leadership engagement is required throughout the process.

AIR FORCE CO-CHAMPIONS FOR DEVELOPMENT PLANNING

Recommendation 2. The Chief of Staff of the Air Force and the Secretary of the Air Force should claim ownership of development planning in the Air Force and provide top-level guidance and leadership to all Air Force organizations responsible for carrying out development planning. This leadership should encourage and facilitate interaction among these organizations.

For development planning to be effective, it should be institutionalized as part of the existing Air Force strategic planning process, as shown in Figure 3-1. This current overall strategic planning process takes national strategies and joint capabilities assessment and distills them into various programs that are then submitted as part of the Air Force budget request. Within this process, development

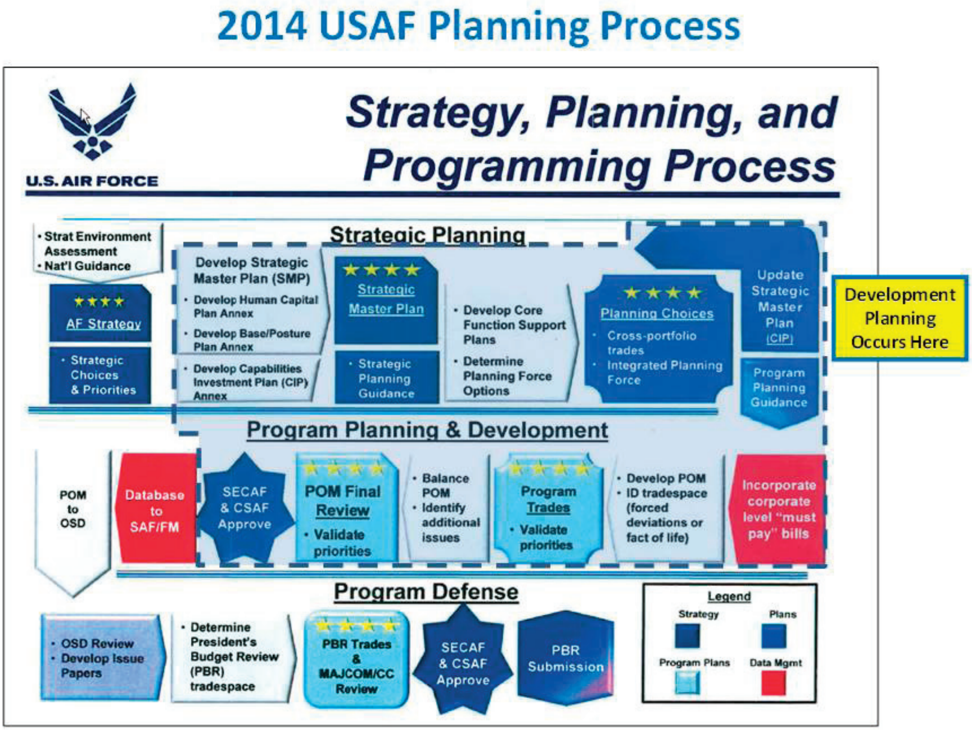

FIGURE 3-1 Current Air Force Strategy, Planning, and Programming Process (SP3). SOURCE: Harry Disbrow, Senior Executive Service, Associate Deputy Chief of Staff for Operations, Plans and Requirements, Headquarters U.S. Air Force.

planning provides data supporting fundamental program trades being performed across the Air Force core functions to determine what is needed to support the Air Force Strategic Master Plan. These trades, in turn, support Core Function Support Plans and planning choices to provide program guidance, recommendations, and updates to the Air Force Strategic Master Plan. In particular, development planning should affect the areas in the box identified in Figure 3-1.

ORGANIZATION FOR DEVELOPMENT PLANNING

Chief of Staff of the Air Force Planning Team

Recommendation 3. The Air Force should enhance its strategic planning and programming process with a Chief of Staff of the Air Force planning team function that reports to the Chief of Staff of the Air Force with the primary responsibility for integrating development planning across Air Force core functions and coordinating it with Core Function Leads.

Overall, the CSAF planning team (CPT) will advise, in particular, on areas that fall between or span functional areas and support trade-offs between core functions. The CPT's primary responsibilities are envisioned to include the following:

- *Assessing the potential impact of current and evolving threats on Air Force mission capability needs and defining corresponding responses.* This should be done particularly with respect to understanding threats that cut across functional areas (e.g., cyberspace). This should leverage both the intelligence and operational communities so that the impacts across Air Force capabilities are identified and placed in a relevant operational context.
- *Identifying new concepts utilizing emerging technologies with the purpose of informing operational concepts.* There should be particular focus on cross-cutting technologies, and there should be collaboration with the Air Force Research Laboratory (AFRL) and other Service laboratories, the Defense Advanced Research Projects Agency, industry, federally funded research and development centers, and university applied research centers and academia.
- *Assessing feedback from the Air Force major commands and the greater Air Force enterprise on program changes that impact warfighter effectiveness.* The CPT should provide regular planning updates/revisions to the CSAF based on feedback received primarily from the major commands (MAJCOMs) with inputs from Headquarters Air Force, System Program Offices, and CFLs. This feedback should consist of assessments (metrics-based where possible) that need to be established and maintained by the MAJCOMs to address mission capabilities assessments after implementation. The CPT analyses should particularly emphasize interactions between programs.

Capability Collaboration Teams

Recommendation 4. The Air Force should develop and standardize the use of capability collaboration teams across all Service core functions as a means to facilitate development planning.

As originally established by Air Combat Command (ACC), capability collaboration teams (CCTs) are formed as needed to explore potential solutions paths for filling known gaps.[1] These CCTs bring together representatives of the MAJCOM,

[1] The CCT concept was a product of the science and technology (S&T) Tiger Team, which included participation by all MAJCOMs, the Product Centers, Air Force Research Laboratory, and

acquisition, and science and technology (S&T) communities to complete development planning activities associated with identified capability gaps. The use of CCTs should be standardized as a best practice across all Service core functions. The decision to start a new CCT should be made following a formal selection process to focus attention on the most pressing challenges and should be chartered and resourced to address the needed development planning activities to include warfighting capability analyses, advanced technology development and demonstration, early prototyping, and warfighter concept refinement. CCT's activities should become an integral part of the generation of Core Function Support Plans (CFSPs) regarding advancement of new concepts and capabilities.

The CCTs provide a focused forum for studying potential solutions to identified gaps and, as such, represent a logical path for consideration of emerging S&T, including the issues of cost and integration into the larger warfighting system. Thus, since a key component of the CCTs is the tie to the scientists and engineers in the Department of Defense community, representation of AFRL on CCTs is essential to ensure consideration of emerging new capabilities that are sufficiently matured for transition consideration. CCTs should also be used as a mechanism for consideration of game-changing technologies. As such, AFRL should identify potentially game-changing technologies and work within the core functions to establish CCTs addressing these technologies. By bringing together warfighter, acquisition expertise, and technologists, issues associated with introduction of a new technology can be addressed in a comprehensive manner.

Because the needed lifetime of a CCT may vary depending on the capability-development timeline and coordination issues across the CFSP, each CCT should be formally reviewed periodically by the CFL to assess whether or not the CCT activity should continue. A CCT activity may be terminated for a number of reasons, including the following: (1) the capability has sufficiently matured to advance the capability development in the acquisition process to a Milestone A decision, (2) the capability being addressed by the CCT is no longer needed due to changes in the environment, or (3) the determination is made that the capability being pursued by the CCT is based on an immature but promising technology that needs further early-stage research. While the CCTs may often operate at the early stages of development planning, the CCTs may also serve to support the CPT with needed analyses and concept definition as the CPT executes its responsibility to balance development planning across the Air Force.

Headquarters Air Force representatives, that developed the current science and technology planning process and governance structure, which was subsequently codified in Air Force Instruction 61-101. ACC was the first MAJCOM to formerly establish CCTs and the MAJCOM to most enthusiastically incorporate the CCT concept into their planning process (Stephen Munday, Office of the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering, personal communication to National Research Council staff member Carter Ford, September 29, 2014).

The CPT and CCT development planning process supports the Air Force overall planning process in several locations, as illustrated in Figure 3-2. At the strategic level, CCTs are an integral component to the development of the CFSPs, and the CPTs are integral to providing the supporting analysis for the planning choices to be made across the core functions. Further, information developed through either the CCTs or CPT should be used to feed future variants of the Air Force Strategic Master Plan.

At the program planning and development level, the CCTs are used support program trade-offs, develop new capabilities, and assess technology readiness. Properly executed, the CCTs should provide key inputs to the program objective memorandum development. Finally, the CCTs and CPT efforts are key to the process of defending program decisions. By thoroughly considering new capability development through analyses, experimentation, and demonstration,

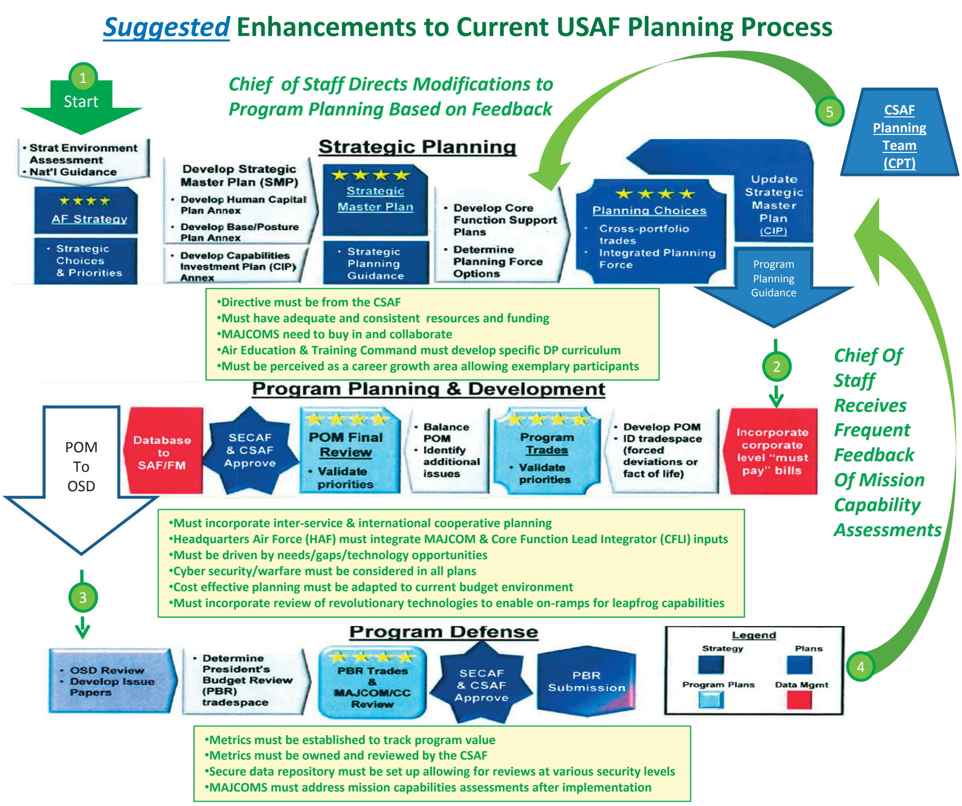

FIGURE 3-2 Suggested enhancements (shown in green) to current Air Force Strategy, Planning, and Programming Process (SP3), indicated with green arrows and text.

recommendations regarding programs will be based on a solid foundation of supporting information.

RESOURCES FOR DEVELOPMENT PLANNING

Finding 2-2 indicates that the current level of funding is inadequate to ensure effective influence of the development planning process. Moreover, Finding 2-12 states the studies that were funded could not be completed with sufficient analysis and assessment to confidently advise the leadership of the viability of the solutions. Of particular note, the strategy for funding cross-cutting areas common to several Service core functions, such as cyber operations, appears to be insufficient (see Finding 2-8). The lack of stable and dedicated funding, highlighted in Chapter 2, makes it difficult to operate the development planning process from year to year.

Defining an oversight role for the CPT, where it reports to the CSAF and SECAF, ensures timely and accurate assessment of adequacy of funding for development planning. This assessment should include the adequacy of funding for individual projects as well as funding availability to address the following: (1) gaps identified from the current threat base, (2) technical analysis capability, (3) multidisciplinary concepts, and (4) maturation of innovative S&T concepts. This assessment would be provided regularly to the CSAF and SECAF in support of the decision-making process.

The Navy's development planning approach, led by N81, possesses a number of desirable traits. It has many of the features of a sound planning process and appears funded at a stable and appropriate level to accomplish the mission at hand. N81 holds significant influence with the Chief of Naval Operations. For these reasons, N81 plays a pivotal role in Navy's equivalent process. Air Force consideration of an entity that couples long-range strategic planning with resources could prove useful to the Air Force.

> **Recommendation 5.** The Air Force should align adequate resources to ensure the success of the Chief of Staff of the Air Force planning team and its interactions with the capability collaboration teams to enhance Air Force development planning. The key element of the development planning process provided by the Deputy Chief of Staff for Operations, Plans and Requirements is the targeted Core Function Support Plan, which starts with the 13 Core Function Leads identifying and prioritizing capability gaps. The resources needed should provide focused support from the Core Function Leads, the necessary analytical and technical capabilities of the personnel comprising and supporting the Chief of Staff of the Air Force planning teams and the capability collaboration teams, and the financial means to achieve the desired planning analysis and recommendations.

Workforce development is essential to ensure robust development planning. Senior Air Force leaders need to instill a corporate commitment to this career field that, in turn, attracts and retains personnel with high potential. This will lead to future Air Force leaders who are strategic thinkers that understand how to use development planning to define the future of the Air Force. This leadership background should include a deep appreciation for innovation, including disruptive innovation, and the ability to solve the complex demands of the current and future Air Force. Following Finding 2-12, prototyping, experimentation, and the familiar use of analysis tools are critical to the acquisition and operation of systems exhibiting the desired performance at an appropriate cost. This important maturation of the acquisition and operational workforce will not take place without the support of senior leadership. Box 3-1 provides a model for Air Force consideration.

There is a strong linkage between development planning and strategic thinking. Formal training in development planning needs to begin early in the career of future Air Force leaders and needs to be incorporated in the curricula of professional military education and advanced education for civilians. It is imperative that the Defense Acquisition University, the Air Force Institute of Technology, and other training organizations make development planning education a priority (see Finding 2-13). Select assignments, on a rotating basis, should be offered to promising future leaders with a strong development planning mindset. Finally, the monitoring

BOX 3-1
U.S. Special Operations Command GHOST Initiative

As a model, the Air Force and U.S. Special Operations Command (SOCOM) has supported a unique initiative that brings together SOCOM operators, their indigenous SOCOM acquisition organization—i.e., Special Operations Research and Development Acquisition Center at McDill Air Force Base, and acquisition specialists from other organizations. The initiative is called GHOST (Geurts Hands-On Support Team, named after Colonel [ret.] James “Hondo” Geurts, the head of the Special Operations Research, Development, and Acquisition Center), and its purpose is to create the equivalent of a “weapons school” for rapid acquisition. The SOCOM commander and SOCOM acquisition executive recently kicked off a “Revolutionary Acquisition Techniques Procedures and Collaboration (RATPAC)” forum to share best practices across the Air Force and SOCOM acquisition community. One direct benefit of the GHOST initiative is the opportunity to allow acquisition professionals to lead rapid-acquisition programs working directly with the end-user operators, and even supporting prototype developments in the field. As a result of a recent CORONA TOP-2014 briefing on the GHOST and RATPAC programs, the Secretary of the Air Force, Chief of Staff of the Air Force, and Air Force acquisition executive have asked how they can be institutionalized and, where appropriate, applied to other acquisition programs.

of career development and assessing the adequacy of training of the development planning workforce should be an ongoing process.

Analysis is the basis for much of what occurs in development planning. There are rapid advances occurring in the capabilities of these tools. For example, the CREATE (Computational Research Engineering Acquisition Tools and Environments) program couples complex, multi-physics simulations to high-performance computing capability to enable the assessment of designs and concepts in support of development planning activities.[2] Therefore, the Air Force needs a strategy for investing in and training personnel on the use of these tools.

> **Recommendation 6.** The Secretary of the Air Force and the Chief of Staff of the Air Force should emphasize development planning as a key workforce development tool for Air Force science and technology, acquisition, and operational personnel. In emphasizing this development, lessons learned from initiatives such as the U.S. Special Operations Command GHOST (Geurts Hands-On Support Team) initiative and its related "Revolutionary Acquisition Techniques Procedure and Collaboration" forum should be captured and examined for application to the broader development planning tool set. In this sustained emphasis on development planning, analytical skills, technical innovation, concept development, systems engineering rigor, and excellence become part of the broader Air Force culture.

ASSESSMENTS FOR DEVELOPMENT PLANNING

The recommended definition of development planning and the establishment of the CPT process, along with the enhanced CCT responsibilities, would be implemented and assessed throughout the Air Force strategy, planning, and programing cycle. It is anticipated the process will mature as experience is gained early in the implementation. To facilitate improvements and provide feedback to participants, periodic assessments need to be made. The objective is to assess if development planning is meeting CSAF and SECAF needs and has been communicated, accepted, and acted upon throughout Air Staff, core functions, and MAJCOMs. In addition, it will provide guidance and feedback to execution teams. This assessment process will most likely start as a qualitative assessment by CSAF and SECAF of the value of the development planning process and how it could be improved. Over time, as the maturity of the process increases, a transition to more quantitative measures (e.g., metrics) may be possible.

[2] Douglass Post, Chief Scientist, Department of Defense High Performance Computing Modernization Program, Associate Director for the CREATE Program, "Computational Research and Engineering Acquisition Tools and Environments program," presentation to the committee on June 18, 2014.

Recommendation 7. The Air Force should periodically assess how well development planning is meeting its overall objective of providing the necessary support for the strategic decisions that guide the Air Force toward mission success, within available funds and with acceptable risk. A systematic approach would include identifying weaknesses, shortcomings, and failures; the causes of these; and ways to address them in the next stages.

BOTTOM LINE

Development planning, properly used by experienced practitioners, can provide the Air Force leadership with a tool to answer a critical question, Over the next 20 years in 5-year increments, what capability gaps will the Air Force have that must be filled? Development planning will also provide for development of the workforce skills needed to think strategically and to effectively define and close the capability gap.

Appendixes

A

Terms of Reference

At a minimum, the ad hoc committee will address the following 4 questions and make recommendations to the Chief of Staff of the Air Force (CSAF) and Secretary of the Air Force (SECAF) for improvement;

1. How can development planning be improved to help improve near-term acquisition decisions?
2. How can development planning be improved to help concepts not quite ready for acquisition become more mature, perhaps by identifying the need for more engineering analysis, hardware prototyping, etc.?
3. How can development planning be improved to enable the development of corporate strategic plans, such as science and technology investment roadmaps, Major Command capability roadmaps, workforce development plans, etc.?
4. How can development planning can be used to develop and train acquisition personnel?

In addition to specifically addressing and making recommendations to the four questions above, the committee should consider the following;

- Ensuring a development planning process must be strategic, driven by top-down SECAF/CSAF or corporate Air Force strategic plans and objectives.
- Ensuring a development planning process must be cross-domain and must consider joint capabilities.

- The appropriateness of existing development policies and processes in the Air Force and the Department of Defense.
- Results and impact of development planning activities conducted since the Air Force reinvigorated development planning.
- Appropriate case studies of potential development planning exemplars (e.g., Long Range Strike capability, technology, and acquisition planning).
- How development planning activities and processes should or could fit within Air Force capability planning processes, including Air Force Strategic Planning System and Core Function Master Plans.
- The Air Force's organic capacity, in both manpower and expertise, to conduct development planning, in light of future budgetary constraints.
- The proper role of industry (prime contractors, sub-contractors, support contractors, Federally Funded Research and Development Centers) in conducting development planning during the pre-acquisition phase of the acquisition lifecycle.
- Preferred development planning inputs, activities, and outputs, to include the timing of those activities along the integrated defense acquisition, technology, and logistics life cycle.
- Identification of appropriate Air Force organizations responsible for conducting, funding, evaluating, approving, and utilizing the results of development planning activities.
- Incorporation of technology and the "ilities" to include: test; sustainment/maintenance; affordability; environmental safety and occupational health; security; and human systems, considerations into the development planning process.
- Best practices in government or industry, to include the private sector that could be leveraged by the Air Force and Department of Defense development planning.
- Results of prototypes/pilots in the Air Force or Department of Defense as a result of the recent Air Force Studies Board report on capability planning and analysis for intelligence, surveillance and reconnaissance and make recommendations to incorporate or change as appropriate.
- Interfaces with other Services and Agencies, and any supported/supporting relationships feeds the overarching corporate Joint processes for requirements and Department of Defense processes acquisition, cost and program evaluation, logistics and materiel readiness, and others as appropriate.

B

Biographical Sketches of Committee Members

CLAUDE M. BOLTON, JR., *Co-Chair*, became the executive-in-residence for the Defense Acquisition University (DAU) in January 2008. Mr. Bolton's primary focus is assisting the DAU president achieve the congressional direction to recruit, retain, train, and educate the Department of Defense (DoD) acquisition workforce. Mr. Bolton is also a management consultant to defense and commercial companies and is a board member for several companies. Prior to becoming the DAU executive-in-residence, Mr. Bolton served as the assistant secretary of the Army for Acquisition, Logistics and Technology where he served as the Army acquisition executive, the senior procurement executive, and the science advisor to the secretary. Mr. Bolton oversaw the Elimination of Chemical Weapons Program and had oversight and executive authority over the Project and Contracting Office charged with Iraq reconstruction. Mr. Bolton was responsible for appointing, managing, and evaluating program executive officers as well as managing the Army Acquisition Corps and Army Acquisition Workforce. He retired as a major general in the U.S. Air Force (USAF) following a highly decorated career. Some highlights of Mr. Bolton's Air Force service include serving as the commander, Air Force Security Assistance Center, where he managed foreign military sales programs with totals exceeding $90 billion that supported more than 80 foreign countries; serving as a test pilot for the F-4, F-111, and F-16; program executive officer for the Air Force Fighter and Bomber programs; and the first program manager for the Advance Tactical Fighter Technologies program, which evolved into the F-22 System Program Office. He is an experienced command pilot flying more than 40 different aircraft including Army helicopters; during the Vietnam War he flew 232 combat missions, 40 over North

Vietnam. Mr. Bolton served as commandant of the Defense Systems Management College and as inspector general and director of requirements at Air Force Materiel Command headquarters. Mr. Bolton holds an M.S. in management from Troy State University and an M.A. in national security and strategic studies from the Naval War College. In 2006, he was awarded a D.Sc. (honoris causa) from Cranfield University. In 2007, he was awarded an honorary doctor of science degree from the University of Nebraska, Lincoln, his alma mater. Mr. Bolton is a member of the National Research Council's (NRC's) Air Force Studies Board and is a past member of the NRC Committee on Evaluation of U.S. Air Force Preacquisition Technology Development and Committee on Optimizing U.S. Air Force and Department of Defense Review of Air Force Acquisition Programs.

PAUL G. KAMINSKI, *Co-Chair*, is chairman and CEO of Technovation Inc., a consulting company dedicated to fostering innovation and the development and application of advanced technology. He is a former undersecretary of defense (acquisition and technology) and was responsible for all DoD research, development, and acquisition programs. During his Air Force career, he served as director for low observables technology, with responsibility for overseeing the development, production and fielding of major "stealth" systems (e.g., F-117, B-2). He also led the initial development of a National Reconnaissance Office (NRO) space system and related sensor technology. His government advisory memberships have included the Senate Select Committee on Intelligence Technical Advisory Board, the Defense Science Board (chairman two times), the President's Intelligence Advisory Board, the director of National Intelligence's Senior Advisory Group, and the Federal Bureau of Investigation (FBI) director's Advisory Board. He is a fellow of the Institute for Electrical and Electronics Engineers, an honorary fellow of the American Institute of Aeronautics and Astronautics (AIAA), and a member of the National Academy of Engineering. He has authored publications dealing with inertial and terminal guidance system performance, simulation techniques, and Kalman filtering and numerical techniques applied to estimation problems. He received a bachelor of science from the Air Force Academy, master of science degrees in both aeronautics and astronautics and in electrical engineering from the Massachusetts Institute of Technology, and a Ph.D. in aeronautics and astronautics from Stanford University. Dr. Kaminski has received the following awards: National Medal of Technology, Department of Defense Medal for Distinguished Public Service (four awards), Defense Distinguished Service Medal, Director of Central Intelligence Director's Award, Defense Intelligence Agency Director's Award, Air Force Academy 2002 Distinguished Graduate Award, the Ronald Reagan Award for Missile Defense, the Reed Award for Aeronautics, the International Strategic Studies Association Possony Medal for Outstanding Contributions to Strategic Progress through Science and Technology, the SPIE Lifetime Achievement award, and the Air Force Systems Command Scientific Achievement Award.

FRANCIS J. (BUD) BAKER is professor of management at Wright State University, where he leads Wright State University's M.B.A. in project management. Dr. Baker spent more than two decades as a USAF officer, serving as a navigator, missile crew commander, Strategic Air Command staff officer, and U.S. Air Force Academy professor. His final Air Force assignment was with the B-2 "Stealth Bomber" program at Wright-Patterson Air Force Base (AFB), where he was, at various times, B-2 production program manager, chief of program integration, and executive officer to the program director. Upon retirement from the Air Force in 1991, Dr. Baker became the founding director of the Project Management MBA program at Wright State University, through which the university serves the program management needs of Wright-Patterson AFB. During his tenure at Wright State, he has published more than 100 articles, most dealing with project management and Air Force history, and has received numerous teaching honors, including Wright State's Presidential Award for Excellence in Teaching. Dr. Baker received a Ph.D. and M.A. from the Peter F. Drucker Center of the Claremont Graduate School, Claremont, California, and an MBA from University of North Dakota. Dr. Baker previously served as a member of the NRC Committee on Evaluation of U.S. Air Force Preacquisition Technology Development.

ROBERT F. BEHLER is the chief operating officer and deputy director of the Software Engineering Institute (SEI), a federally funded research and development center operated by Carnegie Mellon University. Before joining SEI, Mr. Behler was president and CEO of SRC, a not-for profit research and development corporation with a for-profit manufacturing subsidiary. Prior to his work with SRC, he was the general manager and senior vice president of the MITRE Corporation where he provided leadership to more than 2,500 technical staff in 65 worldwide locations. He joined MITRE from Johns Hopkins University's Applied Physics Laboratory (JHU/APL) where he supervised more than 350 scientists and engineers as they made significant contributions to critical DoD challenges. During this time, Mr. Behler helped to take new and emerging technologies and turn them into transformational operational capabilities. He retired as a major general from the Air Force in 2003, after 31 years of service. During his military career, he was the principal C2ISR advisor to secretary and chief of staff of the USAF and the deputy commander for Joint Headquarters North, NATO in Norway. He was an experimental test pilot and flew more than 65 aircraft types including the SR-71 Blackbird and U-2. Mr. Behler is an associate fellow of the Society of Experimental Test Pilots and a member of the Armed Forces Communications and Electronics Association and Air Force Association. He is an associate fellow of the AIAA.

W. PETER CHERRY is an independent consultant who retired in 2010 as the chief analyst on the U.S. Army's Future Combat Systems Program at Science Applications International Corporation. He was responsible for analytic support to requirements analysis, performance assessment, and design trades. Previously, Dr. Cherry was leader of the Integrated Simulation and Test Integrated Program Team, focusing on test and evaluation planning, the development of associated models and simulations, and the development of the Future Combat System of Systems Integration Laboratory. He was a participant in the Future Combat Systems program from its inception, leading analysis and evaluation of concepts as a member of the Full Spectrum Team during the contract activities which preceded concept and technology development. Since the completion of his studies at the University of Michigan he has focused on the development and application of operations research in the national security domain, primarily in the field of land combat. He contributed to the development and fielding of many of the major systems employed by the Army, ranging from the Patriot Missile System to the Apache helicopter, as well as command control and intelligence systems such as ASAS and AFATDS. In addition, he contributed to the creation of the Army's Manpower Personnel and Training Program and to the Army's Embedded Training Initiative. His recent research interests include peacekeeping operations and the development of transformational organizations and materiel. Dr. Cherry was a member of the Army Science Board and served as chair of the Board's Logistics Subpanel. In addition he has participated over the past 10 years in independent reviews of the Army's Science and Technology programs and on NRC studies addressing a variety of defense issues. Dr. Cherry received a Ph.D. in industrial engineering from the University of Michigan. He is currently a member of the Board on Army Science and Technology, a fellow of INFORMS, and a member of the National Academy of Engineering.

KEITH A. COLEMAN is currently assigned as the chief engineer for Boeing's Cruise Missile Systems within Boeing Global Strike Systems. This organization has a charter to design, build, and test current and new development cruise missiles and support systems. He has worked in Boeing Military Aircraft production and Phantom Works advanced design organizations for over 28 years working production and prototype fighter aircraft and weapon systems. Mr. Coleman's last assignment was in the Boeing Special Pursuits Cell (SPC) working on special application unmanned aerial vehicle (UAV) designs. Due to his numerous endeavors he is well versed in the latest advanced technologies, including advanced composite, 3D printing, and production, and prototype design and build practices. He has also worked in the Advanced Weapons division working as the Program Manager for the successful Office of the Secretary of Defense Counter Electronics High Powered Microwave Advanced Missile Project (CHAMP) Joint Concept Technology Demonstration resulting in the world's first successful air launched high-power microwave cruise missile in 2012. Before the CHAMP program, Mr. Coleman led the Defense Threat Reduction Agency's UAV-based Beyond-Line-of-Site Biological Combat Assessment System (BCAS) prototype Advanced Technology Demonstration. This shipboard system successfully intercepted a biological cloud, captured it autonomously, and returned it for analysis. Mr. Coleman has led and worked on numerous other aircraft and missile proprietary, competitive design efforts. Mr. Coleman's other efforts were, in chronological order from the latest: the Boeing X-45A DARPA/Air Force efforts on Unmanned Combat Air Vehicle (UCAV); the Boeing X-32 Joint Strike Fighter (JSF); numerous Proprietary aircraft and missile efforts, Northrop/McDonnell Douglas YF-23A Advanced Tactical Fighter, and the Boeing F-15E and F/A-18 programs. Mr. Coleman has worked in new and production configuration design, manufacturing and testing, and management and is well versed in ongoing and past aircraft and missile acquisitions and recent competitive programs. He was a member of the NRC Planning Committee for a Workshop on Assessment to Enhance Air Force and Department of Defense Prototyping for the New Defense Strategy.

JILL P. DAHLBURG has been superintendent of the Space Science Division (SSD) at the Naval Research Laboratory (NRL) and a member of the U.S. Navy Senior Executive Service since December 2007. In this position, Dr. Dahlburg leads conception, planning, and execution of space science research and development programs with instruments to be flown on satellites, sounding rockets, and balloons; ground-based facilities; and mathematical models. She served as NRL senior scientist for science applications from June 2003 to December 2007. Her duties included facilitating/expediting the accomplishments of the scientific missions of organizations within NRL, with emphasis on interdisciplinary areas of opportunity and distributed autonomous systems. From 2001 to mid-2003, Dr. Dahlburg left NRL to work for General Atomics in San Diego as the director of the Division of Inertial Fusion Technology and co-director of the Theory and Computing Center. In 2000, she served as head of the NRL Tactical Electronic Warfare Division's Distributed Sensor Technology Office, where she co-proposed and was co-principal investigator for the first year of development of the small, expendable, unmanned aerial vehicle Dragon Eye, which saw active duty in Iraq. Dr. Dahlburg began her federal career at NRL in 1985 working as a research physicist. As a member of the NRL Nike KrF Laser Program from its inception through 1999, she contributed to laser matter interaction research, implosion and coronal hydrodynamics, and laser beam imprinting. Her work included spearheading the development of the first three-dimensional multi-group radiation transport hydro-code appropriate for laser-plasma modeling. She is chair of the American Physical Society (APS) Mid-Atlantic Section (2014), chair of the Navy Space Experiments Review Board (2007-present), and a member of the Committee for Space Weather (2007-present). Her previous professional service includes serving as 2005 chair of the APS/Division of Plasma Physics, 2011-2012 chair of the APS Panel on Public Affairs, and member of the Lawrence Livermore National Laboratory Defense and Nuclear Technologies Director's Review Committee (2001-2006). Her honors include six NRL Allan Berman Awards for scientific publication excellence and a Department of Energy (DOE) Appreciation Award presented by Under Secretary for Science Raymond L. Orbach for outstanding service as the chair of the DOE Advanced Scientific Computing Advisory Committee. Dr. Dahlburg is a fellow of the APS. She was a member of the NRC Committee on Quality of the Management of S&E at the Department of Energy National Nuclear Security Administration Laboratories (Phase-I and Phase-II) and the NRC Planning Committee for a Workshop on Assessment to Enhance Air Force and DoD Prototyping for the New Defense Strategy. Dr. Dahlburg holds a Ph.D. in theoretical plasma physics from the College of William & Mary.

BRENDAN GODFREY is a visiting senior research scientist at the University of Maryland, where he conducts studies on numerical simulation of plasmas and served as advisor to the U.S. deputy assistant secretary of defense for research. Dr. Godfrey is also an affiliate of the Lawrence Berkeley National Laboratory. Previously, he was director of the Air Force Office of Scientific Research, responsible for its nearly half billion dollar basic research program. He was an Air Force officer at Kirtland AFB from 1970 to 1972, performing plasma research. He began his civilian career at Los Alamos National Laboratory, establishing its intense particle beam research program. Dr. Godfrey then managed and conducted intense microwave and particle beam research at Mission Research Corporation, becoming vice president and regional manager. In 1989, he returned to the Air Force as civilian chief scientist of the Weapons Laboratory. Later responsibilities included service as director of Phillips Laboratory's high-power microwave research; director of the 1,500-person Armstrong Laboratory; director of plans at the Air Force Research Laboratory, and deputy director of Brooks City-Base. Known for his contributions to computational plasma theory and applications, Dr. Godfrey is author of more than 200 publications and reports. He also has served on numerous professional and civic committees and is a fellow of IEEE and of the APS. He received his Ph.D. from Princeton University.

JOHN GRIFFIN is president of Griffin Consulting, providing systems engineering and program management services to large and mid-sized aerospace firms. He provides strategy planning initiatives for corporations, reviews ongoing programs to assess progress and recommend corrective actions, and participates with industry and government in developing program strategy and implementation tactics. During his civilian career with the Air Force, Mr. Griffin served in a diverse spectrum of capacities of assignments and special duties. He served on numerous special panels, two of which formed the structure of Air Force Materiel Command. Mr. Griffin was on the development team for ground-breaking technology revolutions in weapon systems, including stealth, unmanned vehicles, hypersonics, and cruise missiles. He retired from the Air Force in 1997. Mr. Griffin holds a B.S. in aeronautical engineering from the University of Detroit, and an MSEE from the Air Force Institute of Technology.

ROBERT J. HERMANN is a private consultant. Previously he served as a senior partner at Global Technology Partners, LLC. He is a former director of DoD's NRO and a former senior official at the National Security Agency. Dr. Hermann served as a member of the President's Foreign Intelligence Advisory Board during the Clinton Administration (1993-2001). In 1998, he retired from United Technologies Corporation (UTC) where he held the position of senior vice president of science and technology. In this role, he was responsible for assuring the development of technical resources and the full exploitation of science and technology by the corporation. He was also responsible for the United Technologies Research Center. Dr. Hermann joined the company in 1982 as vice president of systems technology in the electronics sector and later served in a series of assignments in the defense and space systems groups prior to being named vice president of science and technology. A member of the American National Standards Institute (ANSI) board of directors since 2003, Dr. Hermann concluded a 2-year term as immediate past chairman in 2002, he also served as chairman in 1999 and 2000. Prior to joining UTC, he served 20 years with the National Security Agency with assignments in research and development, operations, and NATO. In 1977, he was appointed principal deputy assistant secretary of defense for communications, command, control and intelligence. In 1979, he was named assistant secretary of the Air Force for research, development, and logistics and, in parallel, was director of the NRO. Dr. Hermann is a member of the National Academy of Engineering. He received his Ph.D. in electrical engineering from Iowa State University.

LESTER L. LYLES is currently an independent consultant. He retired as commander of the Air Force Materiel Command, Wright-Patterson AFB. General Lyles entered the Air Force in 1968 as a distinguished graduate of the Air Force ROTC program. He has served in various command assignments, including director of the Medium-Launch Vehicles Program and Space-Launch Systems offices; vice commander of Ogden Air Logistics Center, Hill AFB. He served as commander of the center until 1994, then was assigned to command the Space and Missile Systems Center at Los Angeles AFB until 1996. General Lyles became the director of the Ballistic Missile Defense Organization in 1996. In May 1999, he was assigned as vice chief of staff at USAF Headquarters and commander of the Air Force Materiel Command in 2000. General Lyles received an M.S. in mechanical/nuclear engineering from New

Mexico State University. He has received honorary doctors of law from New Mexico State University and Urbana University. He is chair of the NRC's Aeronautics and Space Engineering Board and is a member of the NRC's Air Force Studies Board. He also serves as a member of the Secretary of State's International Security Advisory Board, and previously served on the President's Intelligence Advisory Board in the White House.

WILLIAM L. MELVIN is director of the Sensors and Electromagnetic Applications Laboratory at the Georgia Tech Research Institute, a University System of Georgia Regents' Researcher, and an adjunct professor in Georgia Tech's Electrical and Computer Engineering Department. His research interests include all aspects of radio frequency and acoustic sensor development. He has authored more than 180 publications in his areas of research interest and holds three U.S. patents on sensor technology. Among his distinctions, Dr. Melvin is the recipient of the 2006 IEEE AESS Young Engineer of the Year Award, the 2003 U.S. Air Force Research Laboratory Reservist of the Year Award, and the 2002 U.S. Air Force Materiel Command Engineering and Technical Management Reservist of the Year Award. He was chosen as an IEEE fellow for his contributions to adaptive radar technology and is also a fellow of the Military Sensing Symposium. Also, he is a member of the NRC Board on Army Science and Technology. Dr. Melvin received the Ph.D. in electrical engineering from Lehigh University.

DAVID J. NICHOLLS is currently the director of the Cost Analysis and Research Division at the Institute for Defense Analyses (IDA). This division analyzes the economic aspects of DoD decisions, estimates the full life-cycle costs of acquiring and operating forces, systems, and components, and advises on resource-based decision making. Prior to this, he was the senior advisor for root cause analyses in OSD's Office of Performance Assessments and Root Cause Analyses and had worked at IDA as a research staff member. Before civilian life, he served in the USAF for 26 years. His Air Force assignments included the following: vice commander and director of information operations of the Air Force Information Warfare Center; branch chief in the Office of the Assistant Secretary of the Air Force for Acquisition; operations research/systems analyst in OSD; and development engineer for the Air Force Materials Laboratory. In between these assignments, he served twice as an associate professor and director of the Applied Mechanics Laboratory at the U.S. Air Force Academy. He holds a Ph.D. in materials science from the University of Oxford.

THOMAS E. ROMESSER is an independent consultant. Dr. Romesser was chief technology officer for Northrop Grumman Aerospace Systems until the start of 2012 and sector vice president of Aerospace Systems. In these roles, he provided senior leadership representation with customers, universities, industry, and the rest of the corporation. He also was responsible for technology development to support future programs while maintaining close linkage to legacy programs. Prior to this assignment, Dr. Romesser was sector vice president and general manager of the Technology and Emerging Systems Division for Northrop Grumman's former Space Technology sector. In this role, he was responsible for the development and execution of space technology's strategy to support both near- and long-term business objectives, system enhancements, and technology leverage for new business pursuits. He oversaw activities of the Directed Energy Systems and Advanced Concepts organizations as well as the Space Technology Research Laboratories. Previously, Dr. Romesser was vice president of technology development where he was responsible for the identification, development, and acquisition of Space Technology's strategic technologies and managed discretionary investments in technology and product development. Dr. Romesser joined Northrop Grumman via the acquisition of TRW in 2002. A vice president since 1998, he previously served as vice president and deputy of the Space and Electronics Engineering organization. Prior to that, he was vice president and general manager of TRW's Space and Technology Division where he was responsible for spacecraft hardware and software engineering; manufacturing, testing, and space vehicle production; as well as chemical and solid-state laser design and development; sensor systems, space and tactical propulsion systems; and research in the physical, chemical, and engineering sciences. Since joining the company in 1975, he has been involved in the development and management of a broad range of high technology capabilities that have established and maintained Northrop Grumman's reputation and enabled technological differentiation in the marketplace. Dr. Romesser earned a bachelor's degree in physics from Manhattan College and master's and doctorate degrees from the University of Iowa. He is also a graduate of the USC Executive Management Program. He was elected a fellow of the Directed Energy Professional Society in 2002 and is a member of the National Academy of Engineering.

SONYA F. SEPAHBAN serves as senior vice president of engineering development and technology at General Dynamics Land Systems. Her role includes the complete portfolio of GD military ground systems for the U.S. DoD and worldwide customers. Throughout her career, Sonya has held leadership positions across a broad spectrum of general management, engineering, production, quality, and technology. She is an expert in U.S. and international industrial and government-led development of aircraft, manned spacecraft, satellite systems, and ground vehicles. Previously, Ms. Sepahban served as the sector vice president of mission excellence at Northrop Grumman Space Technology from 2006 to 2009. Earlier she was vice president of system engineering, where she was responsible for developing and implementing the overall system engineering strategy which included the improvement and control of system-engineering processes across all of the sector's programs and business and technology-development initiatives. Prior to that, Ms. Sepahban served as vice president and deputy of technology development, where she was responsible for identifying, developing, and acquiring the space technology sector's broad base of strategic technologies, including those involved in space exploration initiatives. Prior to that position, Ms. Sepahban served as vice president and deputy general manager of engineering. She joined Northrop Grumman in 1997 from NASA's Johnson Space Center, where she worked on programs such as the space shuttle, the International Space Station, and the Crew Rescue Vehicle during a 10-year career there. Ms. Sepahban earned a B.S. from Cornell University, an M.S. in chemical engineering from Rice University, and an MBA from the University of Houston.

DAVID VAN WIE is the Precision Strike Mission Area Executive at JHU/APL, addressing science and technology challenges in the areas of fluid dynamics; structural sciences; detection system information fusion; signal and information processing; guidance, navigation, and control; command and control instrumentation and analysis; and radio frequency technologies. His responsibilities involve leading diverse research and development teams addressing asymmetric multi-domain system concepts for use in permissive and anti-access/area-denial environments including detection and targeting systems, kinetic engagement systems, and electronic attack. Dr. Van Wie holds a research faculty position in the Department of Mechanical Engineering at JHU. He served on NRC committees addressing conventional prompt global strike, civil aeronautics, future Air Force needs for survivability, boost-phase missile defense, and reusable booster systems. Dr. Van Wie also served as a member of the U.S. Air Force Scientific Advisory Board conducting studies on hypersonic systems, small precision weapons, virtual training technologies, future launch vehicles, and munitions for the 2025+ environment, and he served as the vice chair and chair for the 2010 and 2011 Air Force Research Laboratory Science and Technology reviews, respectively. Dr. Van Wie is a fellow of the AIAA, an active member of the U.S. science and technology community, and has published extensively in the fields of high-temperature fluid dynamics, plasma aerodynamics, and hypersonic airbreathing propulsion systems.

C

Meetings and Speakers

INAUGURAL MEETING
JANUARY 30-31, 2014
THE KECK CENTER OF THE NATIONAL ACADEMIES
WASHINGTON, D.C.

Sponsor Perspectives and Origin of Study
Dr. David Walker (SES), Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering

Historical Perspectives
Gen Alton Slay (USAF, Ret.), Former Commander, Air Force Systems Command

Historical Perspectives
Col John Twigg (USAF, Ret.), SPO Director, Classified Systems Program Office, Aeronautical Systems Division, Wright-Patterson AFB, OH

Results of Recent Studies at the Institute of Defense Analyses
Dr. David Nicholls, Director, Cost Analysis and Research Division

OUSD(AT&L) Perspectives
Mr. Stephen Welby (SES), Deputy Assistant Secretary of Defense for Systems Engineering

SAF/AQ Perspectives
Dr. William LaPlante (SES), Principal Deputy, Office of the Assistant Secretary of the Air Force (Acquisition)

HAF/A8 Perspectives
Mr. Richard Hartley (SES), Assistant Deputy Chief of Staff for Strategic Plans and Programs, Headquarters U.S. Air Force
HAF A3/5 Perspectives
Mr. Harry Disbrow (SES), Associate Deputy Chief of Staff for Operations, Plans and Requirements, Headquarters U.S. Air Force

MEETING 2
FEBRUARY 25-26, 2014
AIR FORCE LIFECYCLE MANAGEMENT CENTER
WRIGHT-PATTERSON AIR FORCE BASE, OHIO

Air Force Life Cycle Management Center Overview, Approach to DP, and SIMAF
Col Teresa Quick, Lt Col Jack Donahue, John Lee, Maj Shana Figueroa, Capt Erica Anderson, and SIMAF rep. (Mr. Randy Levine/Tim Menke)
AFLCMC/WW (Fighter and Bombers Directorate)
Ms. Jeanne Fox, Chief, Fighters and Bombers Capability Planning
AFLCMC/WL (Mobility Directorate)
Col John Newberry, Deputy Director, Mobility Directorate
AFLCMC/WI (ISR and SOF Directorate)
Mr. Ed Schlereth, Chief, Requirements/Integration
AFLCMC/WK (Tanker Directorate)
Mr. John Slye, Acting Deputy PEO, Tanker Directorate
AFLCM/SS (Strategic Systems)
Lt Col Robert Allard, Chief, Strategic Missile Systems
F-15 EPAWSS Cost vs. Capability Curve Methodology
Lt Col Jason Voorheis, Materiel Leader, F-15 EPAWSS Program Manager AFLCMC/WW
AFLCMC/EB (Armament Directorate)
Col Ken Echternacht, Deputy Director, Armament Directorate
AFLCMC/HI (Business and Enterprise Directorate)
Mr. Greg McCan, Chief, Development Planning Branch
Developmental Planning and Intelligence, Surveillance, and Reconnaissance
Mr. Randy Brown (SES), Director, ISR Directorate, HQ AFMC
Air Force Research Laboratory Perspectives
Mr. Tom Fischer, Director Engineering and Technical Management

Panel Discussion
Mr. Frank Campanile, U.S. Air Force (Ret.)
Mr. Joe Lusczek Jr., Technical Director of Air Force Aerospace Systems Design and Analysis (Ret.)
Mr. Jim Mattice, SES (Ret.), Former SAF/AQ, Former DAS for Research and Engineering, and Former ASC/XR

MEETING 3
MARCH 27-28, 2014
SPACE AND MISSILE SYSTEMS CENTER
LOS ANGELES AIR FORCE BASE, CALIFORNIA

Commander's Time
Lt Gen Ellen Pawlikowski, Commander, Space and Missile Systems Center
SMC/XR (Development Planning Directorate)
Col Scott Beidleman
SMC/SY (Space Superiority Systems Directorate)
Col Bradley Buxton
SMC/MC (Military Satellite Communications Directorate)
Mr. Robert Aalseth/Capt Matthew Glaser
SMC/EN (Engineering Directorate)
Mr. Tom Fitzgerald/Capt Cheng
SMC/LR (Launch Systems Directorate)
Maj William Britton
SMC/GP (Global Positioning Systems Directorate)
Lt Col Brian Bailey/Capt Frank Clark
Cyber Developmental Planning Efforts (AFSPC)
Mrs. Jaye Lovelace, Development Planning Lead, Air Force Space Command
Air Force Nuclear Weapons Center (AFNWC)
Mr. Michael Martinez/Ms. Jeannie Thurston
AFPEO/SS (Strategic Systems Directorate)
Mr. Stephen Amburgey
SMC/WM (Defense Weather Systems Directorate)
Capt Clayton Rieber
SMC/IS (Infrared Space Systems Directorate)
Col James Planeaux
SMC/AD(Advanced Systems and Development Directorate)
Col Troy Brashear, Director, Space Development and Test Directorate

MEETING 4
APRIL 29-30, 2014
THE KECK CENTER OF THE NATIONAL ACADEMIES
WASHINGTON, D.C.

Operational Requirements Side of the Development Planning Process
Gen John Michael Loh (USAF, Ret.), Former Air Force Vice Chief of Staff, Former Commander, Air Combat Command

HAF/A2 Implementation of 2012 AFSB ISR Report; Intelligence Planning as a Component of Preacquisition Development Planning
Ms. Lisa Mazur (SES), Special Advisor, Director of ISR Strategy, Plans and Analysis (A2D), DCS, Intelligence, Surveillance, and Reconnaissance

Advanced Air Refueling Capability Concepts (AARCC) (Remote)
Col Michael Peet, Chief of Strategic Planning, Air Mobility Command

Air Force Global Strike Command Perspectives on Development Planning (Remote)
Mr. Thomas "Scott" Browning, AFGSC/A5PP, Policy and Process Branch

Perspectives on Development Planning
Mr. Robert Carl Shofner (SES), Program Executive Officer for Business and Enterprise Systems (BES) and Director of the BES Directorate, Maxwell Air Force Base

Air Combat Command Perspectives on Development Planning
Mr. Robert "Blaze" Burgess, Chief, Planning, Programming and Requirements Division (A8X), HQ ACC

Joint Capabilities Integration Development System
Mr. Kirk Dickenson, JCIDS Requirements Analyst, Air Force Space Command

U.S. Army Perspectives on Development Planning
Mr. Kris Gardner, Director, C3I, Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology

U.S. Navy Perspectives on Development Planning
Mr. Arthur Barber III (SES), Deputy Director of the Assessments Division, Office of the Chief of Naval Operations (N81)

MEETING 5
MAY 19-20, 2014
THE KECK CENTER OF THE NATIONAL ACADEMIES
WASHINGTON, D.C.

Air Force Development Planning Structure
Mr. Steven Munday, Office of the Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering

Observations on the State of Air Force Engineering
Mr. Eric "Rick" Abell (SES, Ret.), Steamboat Springs Services
General Electric's Approach to Development Planning for Cyber
Dr. Richard Puckett, Chief Security Architect, General Electric
3M's Approach to Strategic Planning
Mr. Eric Forbes, Global Key Accounts Manager, Aerospace and Commercial Transportation Division
Development Planning in Industry
Ms. Sonya Sepahban, Senior Vice President, General Dynamics Land Systems
New Ways to Think Strategically for the Department of Defense
Dr. Sheila Ronis, Chair, Department of Management, Walsh College

MEETING 6
JUNE 17-19, 2014
ARNOLD AND MABEL BECKMAN CENTER
OF THE NATIONAL ACADEMIES
IRVINE, CALIFORNIA

Computational Research and Engineering Acquisition Tools and Environments Program
Douglass Post, Chief Scientist, DoD High Performance Computing Modernization Program, Associate Director for the CREATE Program