

United States Air Force Scientific Advisory Board



Report on Future Air Force Vanguard Selection and Management Processes

**SAB-TR-01
19 October 2020**

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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE
WASHINGTON DC

24 September 2020

MEMORANDUM FOR THE SECRETARY OF THE AIR FORCE

SUBJECT: Final Report of the U.S. Air Force Scientific Advisory Board (SAB) FY20 Study on
Future Air Force Vanguard Selection and Management Processes

On behalf of the U.S. Air Force Scientific Advisory Board (SAB), I am pleased to forward to you the final report of the SAB FY20 Quick-Look Study on *Future Air Force Vanguard Selection and Management Processes*.

The SAB was tasked to assess options for selecting and managing future Vanguards and recommend options that are most likely to meet objectives of the Vanguard initiative with the intent of identifying selection and management processes that will maximize the potential for rapidly developing and transitioning game changing capabilities via Vanguards. To achieve this, the study (i) surveyed key Air Force stakeholders to determine Vanguard goals, constraints and mission drivers, (ii) surveyed government and commercial entities to understand their processes for selecting and managing complex prototyping programs, (iii) identified distinguishing elements of successful processes for such complex prototyping programs and recommend best practices, (iv) used current Vanguards as case studies and compared best practices with current and planned selection criteria, and (v) recommended metrics, analyses, and processes to inform selection and management of future Vanguard programs.

The SAB formed a task force to conduct information gathering and independent analyses on this topic. The Board as a whole then deliberated on this information provided by the task force, which led to the findings and recommendations in this final report. This report represents the view of the Board on this topic in response to your tasking.

The Scientific Advisory Board has fully endorsed the findings and recommendations in this report and urges their appropriate consideration and implementation.

A handwritten signature in dark ink, appearing to read "James S. Chow".

Dr. James S. Chow
Chair, Air Force Scientific Advisory Board



SECRETARY OF THE AIR FORCE
WASHINGTON

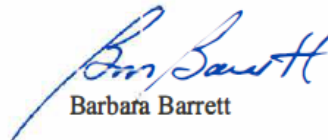
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MEMORANDUM FOR ALL MAJCOM-FOA-DRU

SUBJECT: United States Air Force Scientific Advisory Board FY20 Quick Look Study

I direct the United States Air Force Scientific Advisory Board (SAB) to conduct a Future Air Force Vanguard Selection and Management Processes study.

To accomplish the study, SAB members will gather relevant data by visiting Air Force units. Please provide your utmost support should they visit your location. If you believe your units have information that would support this study and would like to request a visit, please contact the SAB Executive Director, Lt Col Elizabeth Sorrells at (703)697-1109 or elizabeth.d.sorrells.mil@mail.mil.



Barbara Barrett

Attachment:
Future Air Force Vanguard Selection and Management Processes Terms of Reference

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Foreword

In April 2019 the Air Force released its new 2030 Science and Technology (S&T) Strategy. As part of that strategy, the Air Force recommends allocating at least 20% of the S&T budget to a transformational component intended to drive future force design, including a set of efforts called *Vanguards* - these are high-priority programs focused on developing and transitioning game-changing capabilities via prototyping and experimentation. While an initial process was in place to choose the first three Vanguard programs (Golden Horde, Navigation Technology Satellite-3, and Skyborg), the Air Force intends to implement a more formalized selection and management process to maximize the likelihood of successful Vanguard program execution and transition. Consequently, the Department of the Air Force Scientific Advisory Board (SAB) commissioned this study on “*Future Air Force Vanguard Selection and Management Processes (FVS)*” focused on helping to define a sustained selection and management process for future Vanguards.

The study panel engaged with numerous Air Force organizations to understand goals and constraints of these high-profile programs. This included organizations directly involved in the current Vanguard projects, those that are involved in planning the selection of the next set of Vanguards, and stakeholders who are invested in the success of future Vanguards. The panel found a variety of views on the definition and metrics for successful Vanguard programs, but also found several consistent positive characteristics among the existing Vanguards. The panel identified common characteristics of successful prior DoD Vanguard-like constructs, such as Air Force Development Planning Initiatives and Joint Capability Technology Demonstrations (JCTDs), as well as best practices from traditional and non-traditional agile commercial organizations and Venture Capital companies.

The Study Panel included members from Academia, Federally Funded Research and Development Centers (FFRDC), University Affiliated Research Centers (UARC), Industry, and advisors from the Air Force Research Laboratory (AFRL). These personnel represent a diverse set of technical and operational backgrounds. The undersigned acknowledge the outstanding efforts made by the members of the Study Panel, the volunteer Executive Officers, and Air Force SAB Secretariat members who all contributed long hours in support of this Study.



Dr. Melissa Choi
FVS Study Chair



Mr. Greg Simer
FVS Study Vice Chair

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Executive Summary

“Bottom Line Up Front”



- Concept ideation, exploration, and downselection phase of the selection process is the single most important key to success of this initiative
 - Requires clear articulation of disruptive needs and opportunities, and technology collection drawing from wider range of sources
- Successful Vanguard candidates should be assessed by an independent Validation Panel before being recommended to CDC for selection
- Achieving disruptive innovation, rapid pace, agility, and delivery of end-state capabilities requires Vanguards to be “operated like a start-up”
- When appropriate based on agreed-upon exit criteria, “de-Vanguarding” is essential to avoid endless pursuits and free up funds for other concepts
- Potential follow-on actions upon completion of a successful Vanguard include numerous options, not only a follow-on Program-of-Record
- If a future warfighting capability is “potentially transformational enough” to be a Vanguard, then it warrants DAF-level commitment and attention

Vanguards seek to provide transformational future force warfighting capabilities

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Introduction

In April 2019, the Air Force released the new 2030 Science and Technology (S&T) Strategy. As part of the 2030 S&T strategy, the Air Force recommends allocating at least 20% of the S&T budget to a transformational component intended to drive future force design. The flagship effort is a set of research initiatives designated as Vanguards—high-priority programs focused on rapidly developing and transitioning game-changing capabilities via prototyping and experimentation. The objective is to create the capability for rapid incorporation of emerging technology into existing and future weapon system platforms within short acquisition timelines. The maiden Vanguard selection process identified three technologies/capabilities that were already in the Department of the Air Force’s (DAF) acquisition process. The inaugural Vanguards are Golden Horde, Navigation Technology Satellite-3 and Skyborg.

Problem Statement

The 2030 S&T strategy endeavors to use the Vanguard programs to bring together DoD and industry experts and technologies to create leap-ahead, transformational capabilities. In order to facilitate the greatest likelihood of program execution and transition, the DAF must implement a formalized selection and management process. The DAF Scientific Advisory Board study on Future Air Force Vanguard Selection and Management Processes (FVS) was focused on developing and advising the process leading to sustained, successful Vanguard selection and management.

Study Organization and Process

The concept of rapid prototyping and fielding of maturing technology is not unique to the DAF, DoD or even this era of S&T development. The century-era aircraft development, developmental planning initiatives and flagship capability concepts are all examples of where the DAF sought to develop leap-ahead transformational capabilities. Additionally, organizations such as the Defense Advanced Research Project Agency (DARPA), Strategic Capabilities Office (SCO), research labs, industry, and various venture capitalist firms are working to take emerging technologies and create transformational capabilities. The FVS study panel reviewed past DAF/DoD programs and met with industry leaders to understand the key principles required in fostering an environment for Vanguard-like programs germinate, grow and eventually transition into a full capability. The study panel met with over 30 DoD and industry organizations to glean the best practices in regards to program solicitation, selection, management and transition.

Findings and Recommendations

The panel recommends a selection and management process with three distinct phases: (1) concept ideation, exploration and down selection, (2) concept validation and selection and (3) Vanguard execution and management. The Air Force should implement an objective and repeatable phase 1 process that will turn the best technical ideas from a broad range of sources into compelling game-changing capability concept “pitches.” These high-potential Vanguard candidates should be assessed in Phase 2 by an independent Validation Panel that includes external, concept-specific technical and operational subject matter experts before being recommended to the Capability Development Council for selection. Phase 3 should have the selected Vanguards operating “like a start-up” by leveraging successful program management practices from agile technology companies in order to achieve the required disruptive innovation, rapid pace and delivery of end-state capabilities demanded for Vanguards. While selecting transformational Vanguards is important, the panel recommends that the Air Force implement a disciplined, decision-gate process in each Vanguard timeline allowing the option of “de-Vanguarding” projects where appropriate to avoid endless pursuits and free up money for other concepts. Maximizing Vanguard success will require a broader definition of “transition success.” However, follow-on actions must be explicitly agreed upon during the selection process. Finally, the Department must demonstrate strong, visible and sustained commitment to the Vanguard initiatives, to on-going Vanguard programs and to resulting Vanguard follow-on actions in order to ensure the success of these transformational programs.

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Study Results

Study Tasking



- **Assess options for selecting and managing future Vandards and recommend options that are most likely to meet objectives of the Vanguard initiative**
 - **Survey key Air Force stakeholders to determine Vanguard goals, constraints and mission drivers**
 - **Survey government and commercial entities to understand their processes for selecting and managing complex prototyping programs**
 - **Identify distinguishing elements of successful processes for such complex prototyping programs and recommend best practices**
 - **Using current Vandards as case studies, compare best practices with current and planned selection criteria**
 - **Recommend metrics, analyses, and processes to inform selection and management of future Vanguard programs**

Identify selection and management processes that will maximize the potential for rapidly developing and transitioning "game changing capabilities" via Vandards

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With the current rapidly changing technological landscape, the way that the United States and its adversaries prepare for and execute military actions is in constant flux. The globalization of information and technology has allowed adversaries to rapidly close the technology gap previously enjoyed by the United States Air Force (DAF) in unprecedented strides. In order to maintain technological superiority, Secretary of the Air Force Heather Wilson published the Science and Technology Strategy: Strengthening DAF Science and Technology for 2030 and Beyond (S&T 2030). One key component of the S&T 2030 Strategy is the creation of Vanguard programs. Vandards are high-priority programs focused on developing and transitioning game changing capabilities. The Future Vanguard Selection and Management (FVS) Study was focused on helping to define a sustained selection and management process that will be Vanguard program agnostic. To this end, the FVS panel focused on the following aspects of Vanguard selection and management:

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- Identifying critical organizations and people that must be involved in Vanguards as either stakeholders, enablers and/or decision makers to understand fundamental goals and constraints.
- Understanding what processes, characteristics and best practices are inherent to organizations that successfully initiate, manage and transition Vanguard-like programs to include: government, commercial and Venture Capitalists (VC).
- Assessing selection and management processes used for current Vanguard projects and comparing these processes with identified best practices in order to make recommendations for future selection and management criteria that will create a sustained process, execution and transition pathway.

Background



Air Force 2030 S&T Strategy

Vision: An Air Force that dominates time, space, and complexity across all operating domains to project power and defend the homeland



- **The 2030 Strategy has three objectives:**
 - 1) *Develop and deliver transformational strategic capabilities*
 - 2) Reform the way science and technology is led and managed
 - 3) Deepen and expand the scientific and technical enterprise
- ***AF will allocate at least 20% of S&T to Objective 1 to drive future force design, including new “Vanguard programs”***
- **Vanguard programs are a key component of Objective 1, but they support (and are supported by) Objectives 2 and 3**

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In order to maintain technological superiority, the vision for the Air Force S&T enterprise, as outlined in the S&T 2030, is to “create an Air Force that dominates time, space and complexity across all operating domains to project power and defend the homeland.” The S&T 2030 has three objectives to enable this vision:

1. Develop and deliver transformational strategic capabilities.
2. Reform the way science and technology are led and managed.
3. Deepen and expand the scientific and technical enterprise.

While incremental improvements can improve the fighting capability of current DAF assets, technological superiority will require the development and fielding of fundamentally transformational strategic capabilities. In an effort to drive and influence future force design, the DAF plans to allocate at least 20% of its S&T budget to the development of transformational strategic capabilities—to include new “Vanguard programs.” While rooted in the first objective, the notion of designating special programs as “Vanguard” is a key component of all three S&T

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2030 Objectives. An aspect of the FVS study was to determine required actions, characteristics and processes that will enable Vanguards to take advantage of game-changing science and technology in order to provide new strategic and tactical capabilities to our nation's Airmen and warfighters.

Due to the unique nature and potential impact of Vanguard programs, the traditional program management approach currently employed for large acquisitions is not a good fit. The FVS study determined important aspects of program management that will allow Vanguard programs to be rapidly developed and transitioned. The focus on and subsequent success of Vanguard programs and their accompanying reformed management approach will expand the awareness, support and appreciation for the entire scientific enterprise in the DAF.

Vanguard Overview

Definitions of a “Vanguard”



- **2030 Strategy Definition (April 2019)**
 - Vanguard programs will advance emerging weapon systems and warfighting concepts through prototyping and experimentation ... and demonstrate the viability of leap-ahead capabilities to warfighters
- **CDC-approved Definition (August 2019)**
 - Capability development efforts with enterprise commitment to deliver game-changing capabilities that transform operations for future force
 - Vanguard intended to build and demonstrate systems to test viability of transformational concepts
 - Not just tech demos; Vanguard are to be “Air Force efforts”
 - Align with “Air Force Operating Concept” and “Theory of Victory”
 - Involves AFRL commitment to fund 6.3, and DAF commitment to fund 6.4
 - *DAF commitment to transition is a distinguishing characteristic*

Vanguard definition has changed to focus on ensuring “transitionability”, but this may be incompatible with the inherently high-risk nature of developing “leap-ahead capabilities”

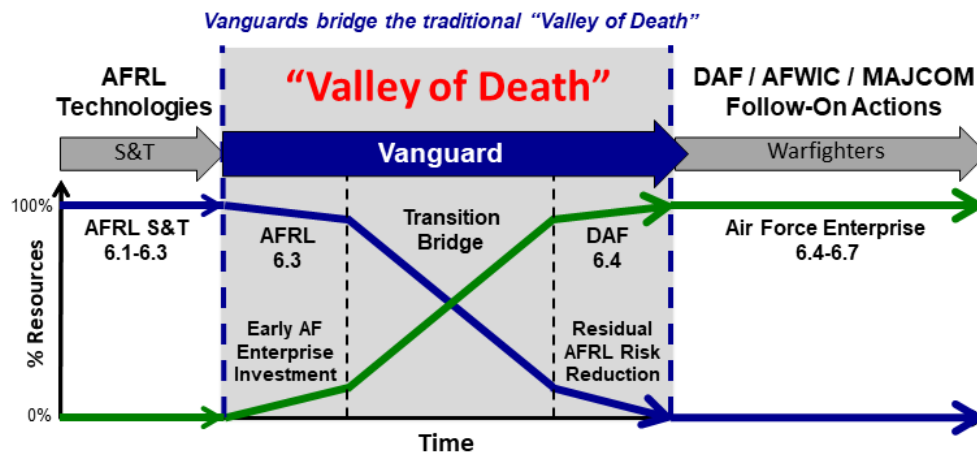
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While the Vanguard programs are a key tenant of the S&T 2030, a clear understanding of what sets apart a Vanguard program from other programs is missing. The S&T 2030 defines Vanguard programs as “... *programs which will advance emerging weapon systems and warfighting concepts through prototyping and experimentation...to demonstrate the viability of leap-ahead capabilities to warfighters...*” The Air Force Capability Development Council (CDC) defines Vanguard programs as: “*Capability development efforts with enterprise commitment to deliver game-changing capabilities that transform operations for future forces...*” While there is some overlap in Vanguard definitions, the CDC definition adds a new focus on transitionability. In fact, the “DAF commitment to transition” is called out as the distinguishing characteristic of a Vanguard. This creates a natural tension between the high risk nature of a game changing capability and the typically lower risk posture associated with a rapid transition. A Vanguard selection and management process that addresses this tension is critical to the successful implantation and execution of the S&T 2030.

Vanguards Are a Way to Bridge the “Valley of Death”



- AFRL technologies have historically had difficulty being transitioned to MAJCOM users; user takes on all follow-on funding and associated risk
- DAF/AFWIC-prioritized Vanguards are a new “bridge” for developing and fielding transformative warfighting capabilities from AFRL technologies



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Historically, a low number of Air Force Research Laboratory (AFRL) technologies have transitioned from the labs to the warfighters. This phenomenon has been named the Valley of Death (VoD). Typically, AFRL technologies (on the left) have had difficulty bridging the VoD. This phenomenon is not because of poor technology or lack of user interest, but more often because the major commands (MAJCOMs) (on the right) are expected to take on the remaining risk and funding without having thought about how the technology fits into their operations. Similarly, the acquisition community is not able to easily fit the new technologies into their current portfolios without drastic, and often painful, changes. These two hurdles are the greatest hindrance to technology transition.

The Vanguard programs are designed to bridge the VoD. The bridging occurs (as shown in the center) by bringing the technology developers together with the operational and acquisition communities from the inception of these high priority efforts. This joint approach allows the acquisition corps and the MAJCOM users the ability to develop acquisition strategies and Concept of Operations (CONOPS) concurrently with the development of the technologies. As depicted in the figure, the emphasis will still be on technology development in the beginning and transition at the end. However, the middle is where the joint effort happens and where the Vanguard programs

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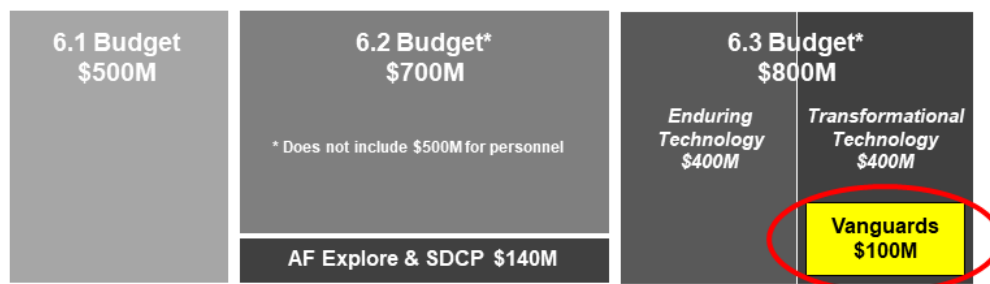
live. The Vanguard approach encourages the technology developers, acquisition corps and the end user to have a stake in the program as early in the process as possible. By having a resource stake in the Vanguard early on, the likelihood of continued support by the end user greatly increases while increasing the likelihood of successfully fielding the technology.

Vanguards Are Only a Small Fraction of Air Force S&T Budget



- Air Force 2030 S&T Strategy directs at least 20% of annual core S&T budget to *transformational capabilities*
 - These will represent \$540M of \$2.5B planned core S&T budget by FY24
 - But ... *Vanguards* are only a small part of *this* budget segment
 - Vanguards will account for only 4% of the total AF core S&T budget

Air Force Core S&T Budget (FY24)



Vanguards seek to have major game-changing impacts on 2030 warfighting capabilities ... but they represent only a small fraction of the core Air Force S&T budget

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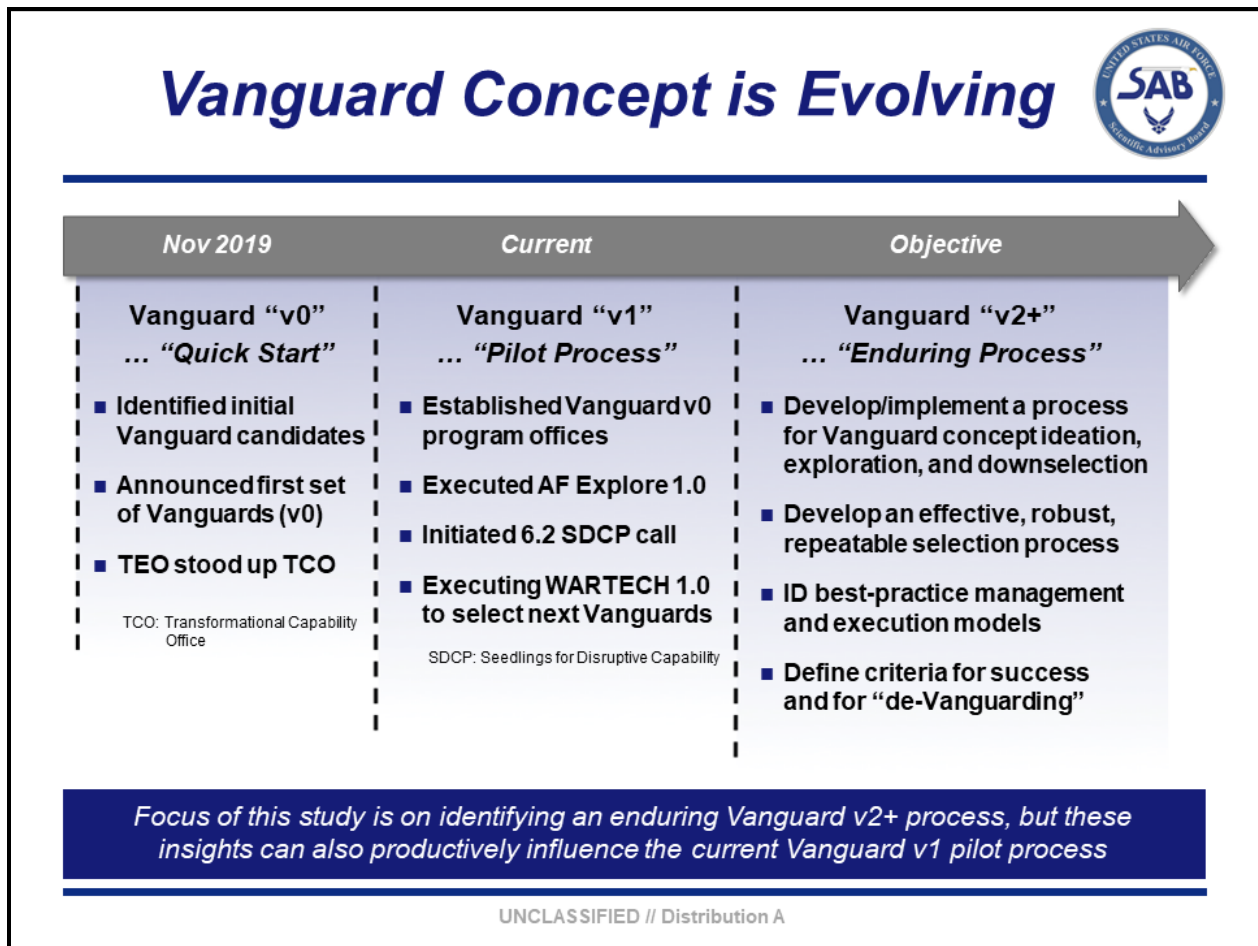
While Vanguards are expected to provide transformational strategic capabilities, Vanguards represent a relatively small portion of the Air Force S&T budget. The S&T 2030 Strategy directed at least 20% of the S&T budget go towards developing transformational technology. It is important to understand that the full transformational technology budget will not solely fund Vanguard programs. In reality, Vanguards are currently allotted only 20% of the budget for transformational technologies. Therefore, Vanguards are only planned to be ~\$100M/year or 4% of the core S&T budget.

Understanding that the funding for the Vanguard programs is limited, the FVS panel highlighted two main points. Firstly, it will be important to make best use of the limited funding. Therefore, the process used to select the Vanguards must be robust enough to identify programs and technologies that will result in true transformational strategic capabilities. While the Vanguards are high-risk ventures that are expected to fail periodically, it is important that the limited funds not be allocated to technologies that will likely succeed but only result in incremental improvements in warfighting capabilities. Secondly, processes must be in place to ensure that Vanguard programs “graduate” in a timely manner or move out of Vanguard status to ensure that the Vanguard fiscal needs do not grow to consume all of the transformational technology

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development budget. As is addressed in more detail later, the FVS panel found that the Vanguard programs are best viewed as part of a larger S&T portfolio designed to develop transformational capabilities. Focusing solely on the Vanguards without looking at the full DAF S&T portfolio runs the risk of excluding pivotal technological advancements.

Evolution of Vanguard Concept



The initial Vanguard process began in November 2019 (version 0 or v0) prior to the start of the FVS study and is expected to evolve through a three-stage process. Vanguard v0 was intended to be a quick-start phase to initiate projects with transformational capabilities for the DAF. The Technology Executive Officer (TEO) stood up the Transformational Capabilities Office (TCO) to execute and oversee the Vanguard Program. Under Vanguard v0, the initial three candidate programs were announced and are currently under development. However, the process used for selecting the projects in Vanguard v0 was not a rigorous, formalized selection process. The purpose of the FVS study is to help provide recommendations for creation and institution of a formal selection process.

The TCO is currently working to establish a Pilot Process for selecting the next round of projects for Vanguard version 1 (Vanguard v1). The TCO is working with the Air Force Warfighting Integration Capability (AFWIC) and Air Force (AF) Acquisition (AQR) to establish a more rigorous selection process for the new Pilot Process. This new process will identify the next round of Vanguard projects through internal and external calls for Vanguard concepts. This effort is

proceeding through a Seedlings for Disruptive Capability Program (SDCP) call in order to find projects within the Air Force and externally through the Air Force Explore (AFE) program. The AFE program provided awards in the area of global persistent awareness, resilient information sharing, rapid and effective decision-making and speed and reach of disruption and lethality. The AFE program is a partnership between the Air Force Acquisition Executive, AFWIC and AFRL to develop appropriate partnerships to bring advanced capabilities into the Air Force S&T portfolio. In addition, the Pilot Process will utilize the WARTECH process to select the next Vanguard projects. The WARTECH process will use a combination of modeling, simulation and analysis, and subject matter expert inputs to help determine the impact of various technologies under consideration for the Vanguard 1 iteration.

The FVS study is focused on helping to establish the enduring phase of the Vanguard program dubbed Vanguard version 2+. The goal will be the development of a repeatable v2+ selection process and the implementation of best practices for management of the Vanguard program while focusing on defining the criteria for success.

Vanguard v0: “Quick Start”



- Vanguard “v0” selections were a “Quick Start” implementation of the Vanguard concept
 - Not designed as a sustaining process
- First Vanguards declared in Nov 2019
 - Skyborg
 - Golden Horde
 - Navigation Technology Satellite 3
- Each is in a different state of technical maturity and “Vanguard readiness”, but common characteristics are emerging
 - Integrating multiple 6.3 AFRL programs
 - Developing “leave behind” capabilities
 - PEOs engaged in CONOPS and transition



Vanguard “v0” selection approach was not meant to be a sustaining process for “v2+”

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The Vanguard v0 program was designed as a quick-start and was not intended to be an enduring selection and management process. The first three programs in Vanguard 0 were announced in November 2019 after a very short selection process. The goal was to find projects having transformational impact and a high likelihood of success that could be designated as Vanguards. These Vanguards included Skyborg, sponsored by Program Executive Office (PEO) Advanced Aircraft, which is developing unmanned and low-cost wingmen aircraft used to support and expand the capabilities of fighter jets in combat. Golden Horde, sponsored by PEO Weapons, focuses on the development of networked, precision guided weapons that can sense, observe and react to enemy targets. The final selected Vanguard was Navigational Technology Satellite (NTS-3) which was sponsored by PEO Space and Air Combat System. The purpose of the NTS-3 program is to improve position, navigation and timing through technologies placed in geosynchronous orbit that will provide advanced capabilities through programmable communications called software defined radios (SDR).

The abbreviated selection process for Vanguard v0 resulted in three programs having various levels of maturity. However, the common benefits of the Vanguard v0 process include the synergistic effects from integrating 6.3 AFRL technologies that would not been traditionally

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integrated at this phase in the Air Force's S&T development portfolio. This processes is also developing the idea of leave-behind capabilities that will impact the Air Force more broadly. For instance, the development of the SDR capabilities for NTS-3 will impact a wide range of Air Force needs even if a full constellation is not developed and placed into orbit. Another aspect of Vanguard 0 is that the PEOs are engaged from the outset. This key aspect helps circumvent the VoD and improves the likelihood for a transition to a formal follow-on program. This change is important for programs like Skyborg where the connection to the PEO is creating a technology pull from the user. Thus, there are positive indications that Vanguard 0 is an important process for the US Air Force in changing the model for rapid innovation of advanced technologies. The FVS panel would like to retain the positive aspects of the Vanguard 0 as an enduring process is developed and implemented.

Prior Vanguard-Like Constructs



Prior Examples

- Developmental Planning Initiatives
- Flagship Capability Concepts
- Air Force ATDs
- ACTDs / JCTDs
- SCO programs
- DARPA programs
- AF Ventures Program

Common Success Characteristics

- MS&A role in concept development, validation, selection, and execution
- Defined project timeline w/ off-ramps
- Frequent demonstrations involving user community
- On-going coordination on CONOPs
- Top-cover support for program
- Committed S&T funding level
- External buy-in with “skin-in-the-game” from the beginning

Vanguard construct is not unique in its goal of providing transformational capabilities with an assured follow-on path; leverage best practices from prior constructs

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These new Vanguard programs are not the first attempt to solve the VoD issue. AFRL and the Air Force Life Cycle Management Center (AFLCMC) have tried many different methods over time to bridge the Acquisition VoD. The original Air Force Development Planning (DP) initiatives, executed from the 1950s through the early 2000s, employed key principles such as: mission-area analyses, accelerated development cycles, top Air Force funding commitments, handpicked management teams of developers that are dedicated with limited number of individuals, support of the acquisition community and operators, rapid prototyping and robust experimentation. By employing these principles, the following programs were realized: the initial C-5 transport, F-15 air-superiority fighter, F-16 multirole fighter, F-117 Stealth fighter and Global Positioning System. DP and the associated best practices waned in the early 2000s from a lack of congressional support.

In the late 2010's, AFRL grouped critical 6.3 efforts into “Focused Long Term Challenges” which morphed over time into “Flagship Capability Concepts.” While the idea of focusing Lab investments into important DAF problems had considerable merit and good intent, transition from 6.3 to 6.4 required financial commitments from the receiving 6.4 Program Elements through the Program Objective Memorandum (POM) process. Oftentimes, while AFLCMC and their MAJCOM supporters supported these Flagship Capability Concepts (e.g. Hypervelocity

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Penetrating Weapon) through formal letters, the POM funding bridges were never synchronized with the Program of Record (PoR). The Vanguard process attempts to correct this transition weakness to assure Vanguard programs have a financial landing pad in 6.4 Program Element POM requests.

Through the course of the study, the FVS panel found several overarching success characteristics that appeared in both civilian and DAF Vanguard-like programs. The top success characteristics are highlighted on the figure above. While many of the characteristics were found to help a Vanguard-like program to succeed, no characteristic appeared to play a bigger role than that the end user have skin in the game from the program onset. In order for Vanguards to succeed, the end users must be involved in the solicitation, selection, development and transition process from the beginning. In conjunction with the early user involvement, DAF-level top cover must be present. Only through strong DAF support will the AQR see that the Vanguards are important enough to apply top human capital to these efforts. Through incorporating all success characteristics addressed on the slide, the Vanguards will have a solid foundation from which to launch the development and fielding of truly strategic transformational technologies.

What Makes a Good Vanguard?



- **Vanguards may vary in scope, risk, and end-state, but each should have the following characteristics to meet Vanguard objectives**
 - **Seeks to develop a transformational Air Force warfighting capability that can provide a sustained advantage over a relevant adversary**
 - **Focuses on coordinated development of one or more 6.3 programs not previously being integrated into a warfighting capability**
 - **Has aggressive but achievable technical objectives, milestones, and end-state, with early testing to assess mitigation of highest risks**
 - **Has DAF/AFWIC buy-in regarding its value in future force design**
 - **CONOPS are deemed credible by relevant operational community**
 - **Has DAF-level commitment to support follow-on activity if threshold end-state criteria are met, including possible Program-of-Record**

There is no “one size fits all” set of criteria for what a Vanguard should be, but these characteristics provide selection guidelines that support the purpose of Vanguards

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There was no one size-fits-all definition of a good Vanguard because the Vanguard programs will vary in scope, risk and end state. Several common characteristics for Vanguards were identified. They range from broad characteristics like “meet the definition of a Vanguard from the S&T 2030 strategy” through more specific characteristics like coordinating multiple programs and laying out aggressive, but achievable, technical objectives. Additionally, it is important that the Vanguards have key DAF component and end user buy-in with credible relevance to the operational community. While each Vanguard will be different, these are the characteristics upon which the FVS panel built the proposed selection criteria.

In addition to the general characteristics on the chart, it is important to understand the difference between the characteristics that make a good Vanguard candidate, listed above, and what makes a Vanguard a successful program. The final bullet, namely “Has DAF-level commitment to support follow-on activity if threshold end-state criteria are met, including possible Program-of-Record” seems to be clear cut. However, not every AFRL Vanguard is destined to a long lifetime. In AFRL, some war fighting technologies are like cell phones—developed, fielded then thrown away in 3-5 years because of technology obsolescence. Many technologies developed for Special Operations Command, CYBER and One-off Small satellites are examples of potential AFRL Vanguard-like

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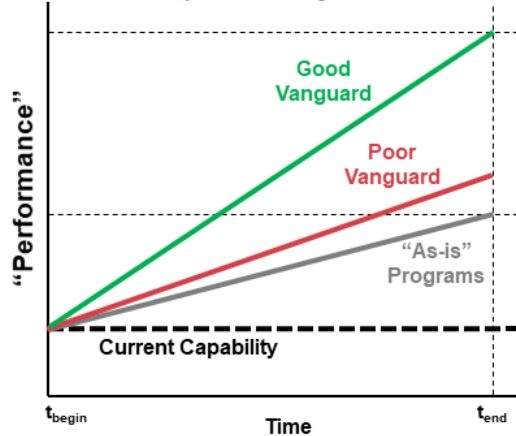
efforts that are meant to provide a short term technological boost before being disposed. The concept of “Transformational Air Force Warfighting Capabilities” must be viewed through the lens of technological obsolescence, as some technologies are destined for only short-term DAF use.

“Additionality”



- Many VCs use “additionality” as a key principle when they assess whether an investment in a technology venture is warranted

Well-chosen Vanguards should produce a high degree of additionality from the Vanguard investment



- Additionality is the added performance that will result if the investment is made, beyond the performance that will occur even if the investment is not made
- A useful metric as one part of assessing the suitability of Vanguard concepts
- Vanguard must show significant benefit over sum of underlying “as-is” programs
 - As-is programs will advance performance even if not part of a Vanguard concept
 - A good Vanguard will accelerate maturity and follow-on readiness – reduces time to availability of warfighter capability

Achieving a high degree of “additionality” is the hallmark of a good Vanguard program

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When a program is selected as a Vanguard, the understanding is that the Vanguard designation will be able to accelerate the development in a rapid, game-changing manner. One measure of merit employed by the VC community to determine whether an investment in a technology is warranted is *additionality*. Additionality is the idea that investment in a specific program will improve the program beyond what would have occurred over the course of normal events/timelines. In other words, the investment accelerates and improves the project performance and capabilities beyond organizational inertia.

Acceleration to maturity is one measure of additionality that is relevant to Vanguard programs. Acceleration shortens the project timeline and produces the end product more rapidly than if there were no additional resources. These resources may include direct funds, additional personnel and skills and greater access to laboratories and test facilities. This is a key component if the solution addresses a new adversary threat or closing a newly identified allied vulnerability.

Greater effectiveness can also be measured as the capability over risk. The additional focus and resources committed to the project can “burn-down” the highest identified risks earlier in the program leading to an improved design earlier in development. This reduces late-cycle design

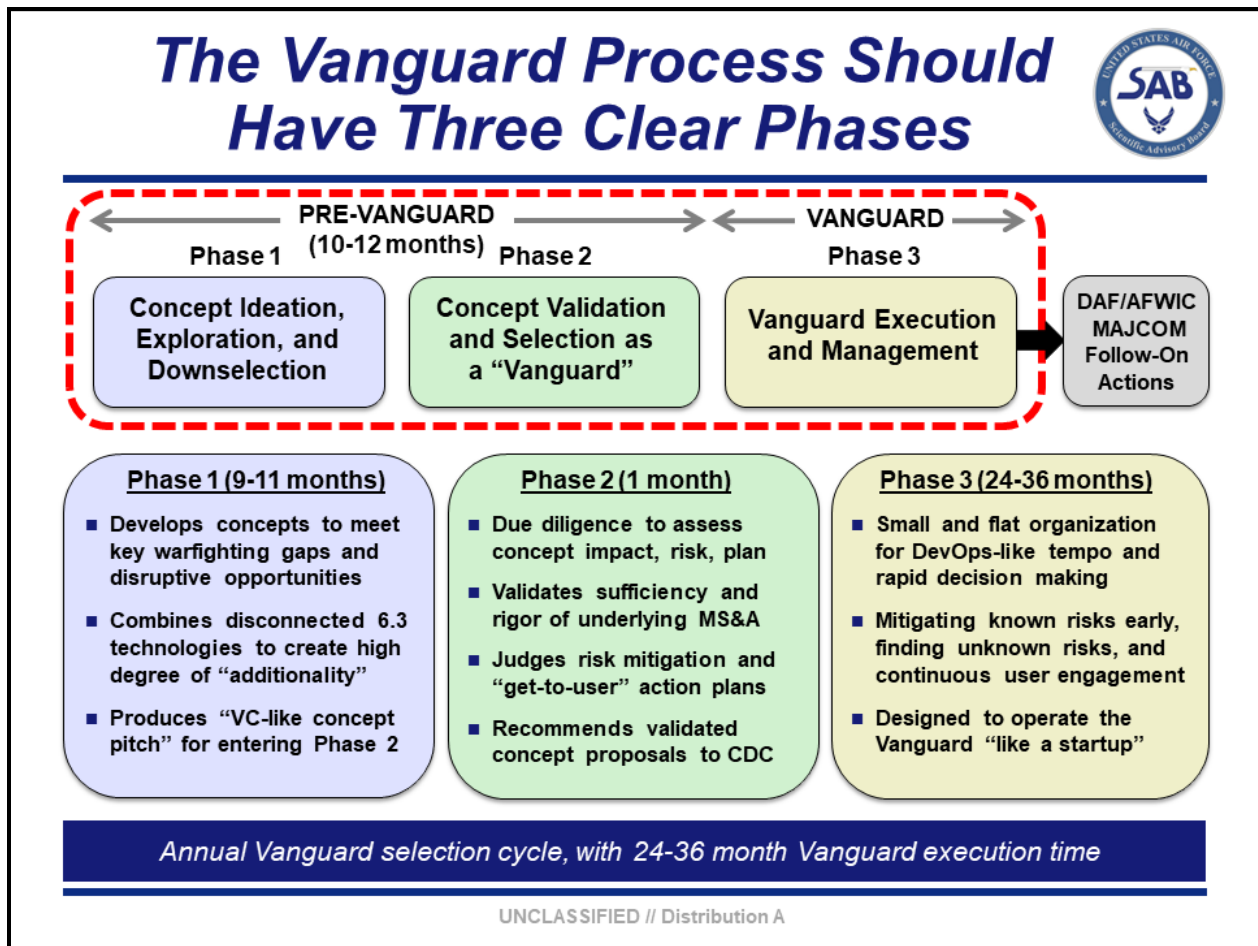
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updates that can be expensive from both cost and schedule. The additionality can also take the form of early proof-of-concept features, which can identify issues with capability performance that may not have been seen until Development Testing and Evaluation (DT&E) under normal development. The result of additionality is to drive the Capability/Risk ratio to a higher value earlier in the program resulting in greater effectiveness and improvements to the DAF.

Another implementation of additionality is the incorporation of key features that would not have been possible without the increased focus. These features may only have been identified as “key” to the program’s success due to a larger team exploring intended functions. A Vanguard program is designed to have MAJCOM involvement throughout the development cycle so that other organizations can review its intended capabilities and CONOPS. The larger focus can help prioritize elements and add features that may be of high utility.

A Vanguard program with a high degree of additionality will demonstrate measurable improvement in one or more key attributes. The FVS Panel encourages the use of measurable metrics to demonstrate improvements throughout the Vanguard process.

Vanguard Phases



The proposed Vanguard process is designed to optimize transformational development to produce capabilities to enhance AF effectiveness. While utilizing the entire Vanguard flow is key to maximizing impact, it is important to understand the key phases of the process from concept creation to delivery for end-use. The Vanguard process should have three clear phases:

Phase 1: Concept Ideation, Exploration, and Downselection—turning concepts into candidates

Phase 2: Concept Validation of the candidates and Vanguard Selection

Phase 3: Maturing the Vandguards through the Execution and Management phase.

The first phase is key to supporting the overall transformational S&T development pipeline in the DAF. It is designed to create a rich set of concepts addressing the full range of DAF interests, including options to close AFWIC-defined "gaps" to MAJCOM-identified game-changers. These concepts utilize a number of technologies, inside and outside of the DAF, to create the capability and they can draw from the entire national S&T community. These concepts are reviewed and a select group are provided the resources to clarify key impacts and further refine the solution and

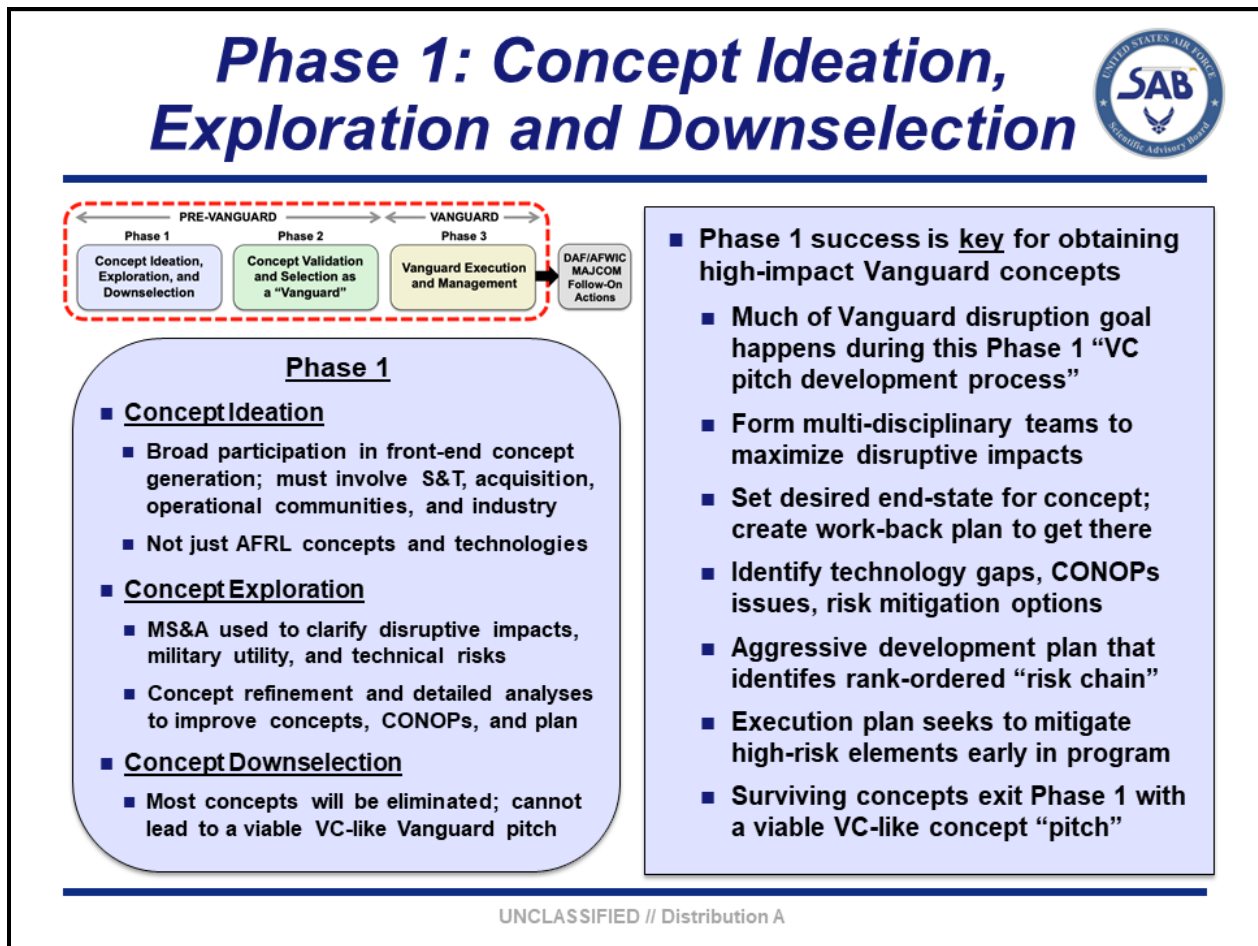
potential applications. From this pool, the most highly-impactful concepts are chosen to continue their development as candidates.

The second phase is designed to move the concepts from developed ideas to well-thought out programs. In order to be selected as a Vanguard and progress on an accelerated pace to produce capability that can be used by DAF, a thorough review from validation panels is required. During this step of the process, the results of the concept development, including Modeling, Simulation and Analysis (MS&A), are reviewed and the key risks are identified. If a concept has demonstrated high opportunity value and the risk-mitigation profile is deemed acceptable by a diverse group of DAF functions, the concept is moved forward to concept selection. The select group of proto-programs is presented to the Capabilities Development Working Group (CDWG) for final candidate portfolio review. Ultimately, the CDC evaluates the proposals for possible selection as an official Vanguard. Most concepts do not become a Vanguard or are even selected for Phase 2. This does not mean that they do not have merit. It simply means that they may need further development or better definition. At the conclusion of the twelve-month Phase 1/Phase 2 cycle, a few programs may be selected as DAF Vanguard Programs.

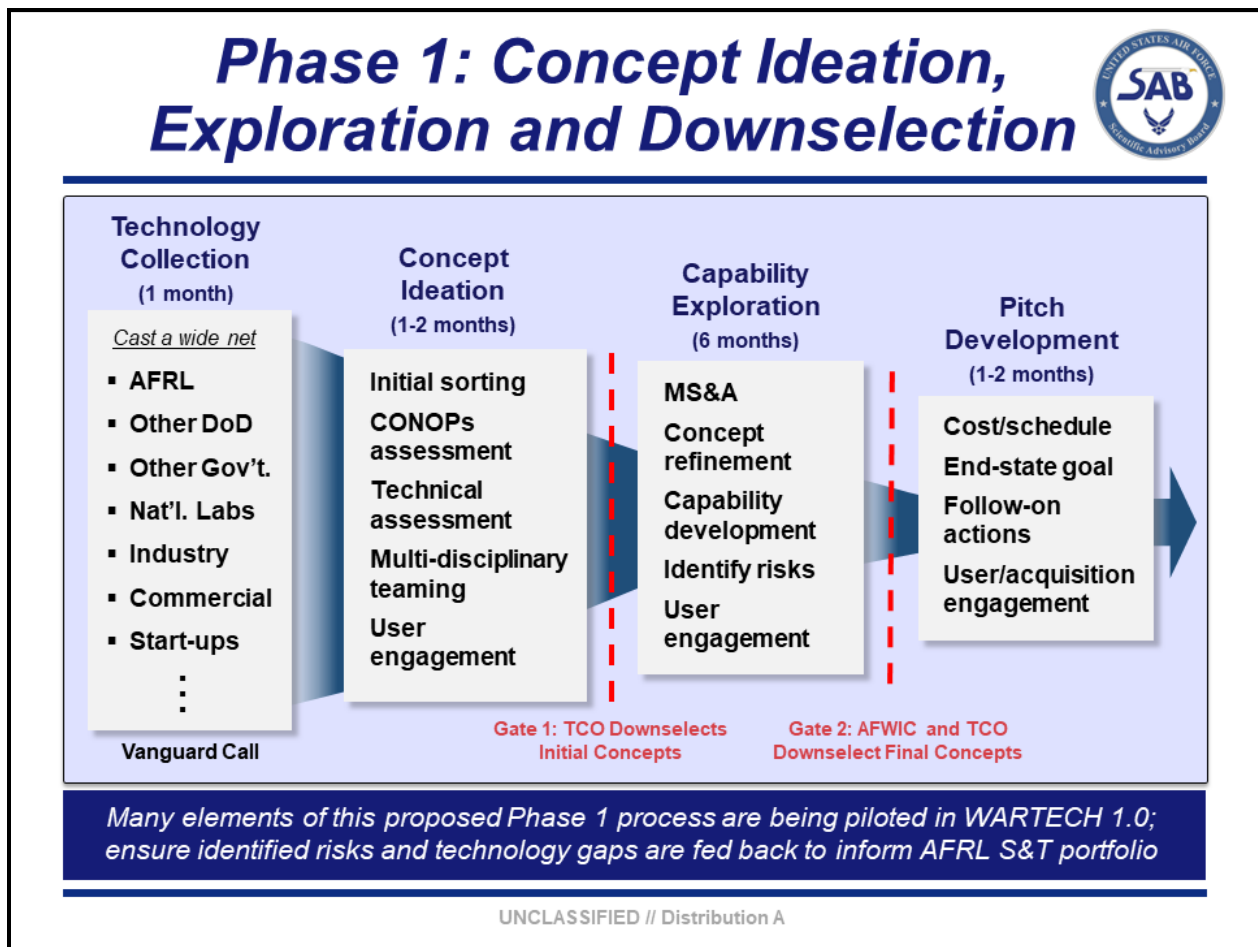
The final phase of the Vanguard process is the maturing of the program to a developed capability for use by DAF components. Through phase 2 definition, the program's timeline, milestones and agile development should be finalized with commitments from the MAJCOMs. During the Vanguard's typical development cycle (24-36 months), the program is monitored by an O-5/O-6 Advisory Group to ensure that value to the MAJCOMs is maintained and the scope and focus do not drift. Given the disruptive nature of Vanguard concepts and the ever-changing adversary environment, there is a chance that a particular Vanguard will lose its value to DAF and may be "deVanguarded" with its technology retained but the integrated concept's impact reduced.

Although not explicitly part of the Vanguard selection and management process, appropriately defining the follow-on actions that will occur after the Vanguard finished is key to transitioning the capabilities to an end user. Transition is a major measure of success for the Vanguards. Therefore, the panel must consider this as a key part of the Vanguard process.

Phase 1



Phase 1 is composed of three steps: Concept Ideation, Concept Exploration and Concept Down selection. The FVS panel determined that getting this phase right was key for obtaining high impact Vanguard concepts because Phase 1 is where most of the disruption to the current system would be realized. Multi-disciplinary teams will be formed to take the initial concepts and turn them into something more capable. These teams will work with the users to get buy-in on CONOPS, issues, concerns and develop the risks. The goal coming out of this phase is to develop what the FVS panel is calling a VC-like concept pitch. This is a very detailed and rigorous plan outlining processes, impacts, risks and risk mitigation actions. This process is shown in more detail in the following figure.



The first step of the Phase 1 process is Technology Collection. AFWIC and the TCO issue a call for technologies aimed at filling a potential capability gap. The call must consider ideas not just from AFRL but also from the DoD, government, national lab, industry, commercial and startup organizations. The timeline for the first step is nominally 1 month.

Step 2, Concept Ideation, is the evaluation of CONOPS, rapid technical assessment and formation of the consolidated multidisciplinary Vanguard candidate teams. User engagement is critical during the concept ideation step. This step should be completed within 2 months. A down selection process occurs following concept ideation. This down selection identifies the concepts that are sufficiently developed to reasonably be selected as a Vanguard program.

During Step 3, Capability Exploration, a smaller set of candidate concepts are rigorously explored. This step includes MS&A to better understand and refine the technical concepts, risks and operational utility. A key element is performing capability development iterations with the users to help ensure relevance and identify key risks. After six months, the outcome of step 3 is the final set of potential Vanguard concepts.

Through the final step of Pitch Development, the Capability Exploration efforts are leveraged to develop a clear, concise, compelling project statement that includes the cost and schedule, end-state goal, follow-on actions, risk identification and burn down plan and planned user and acquisition engagement.

Phase 1: Concept Ideation, Exploration and Downselection



- All-calls for “good ideas” are too broad; AFWIC must provide a more specific “wish list” for Vanguard calls, but be open to additional ideas
- Phase 1 participants should include:
 - S&T community (TEO, AFRL TDs, Space Force, FFRDCs/UARCs, industry)
 - Acquisition community (SAF/AQ, AFLCMC/XZ, Space Force)
 - Operational community (AFWIC, MAJCOMs, Space Force)
- Emphasis is on concept ideation, then MS&A to assess, refine, clarify and validate each concept, and determining the main risks in it
 - Identify technical and integration risks, planned risk mitigation approaches and options, and risk removal costs, for each element of “risk chain”
 - AFRL gains insights for 6.2/6.3 “risk-filler” programs that can be run concurrently with Vanguard to provide additional risk-removal options
- Provides basis for concept viability assessment and downselection

Surviving concepts must exit Phase 1 with a clear and analytically supported description of their disruptive impacts, CONOPS, technologies, gaps, options, risks, and cost

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AFWIC should identify Vanguards based on their value in Future Force Planning. Moreover, the Vanguard candidate solicitation needs to be open to additional, unique concepts as transformational capabilities may not always be identified in existing gaps or opportunities. The FVS panel strongly suggests that the S&T, acquisition and operational communities be heavily involved during phase 1 to help refine and shape the Vanguard concepts. Due to the unique nature of space warfare, the US Space Force should be an active participant as well.

MS&A is an essential tool in supporting refinements and clarification to potential Vanguard concepts. In addition to highlighting the innovations and impact of a candidate Vanguard, MS&A is important in identifying the main risks of the concept. Identifying and understanding the risks, their impact and proposed mitigation will give Air Force leadership confidence in investing funds and support in the Vanguards. While proposed Vanguard efforts are not basic research, it is critical that the risks and mitigations identified through the concept ideation phase influence research across AFRL. Ultimately, the VC-like approach developed in Phase 1 can become the basis for concept viability assessment and down-selection addressed in Phase 2.

Recommendation #1

Recommendation #1



Phase 1: Vanguard Concept Ideation, Exploration, and Downselection

- **Use Phase 1 described herein to implement an objective and repeatable process for developing Vanguard concepts that will achieve compelling game-changing capabilities from the best available technical ideas**
 - **Stimulate a robust pipeline of capability-enabling technologies through focused data calls led by AF TCO and AFWIC's Innovative Solutions Division**
 - **Include technologies from a wide range of sources, not only AFRL**
 - **Ideate concepts based on an AFWIC "wish list" and broader disruptive ideas**
 - **Form initial concept exploration teams to provide preliminary assessments of potential disruptive impacts, CONOPS, technologies, and risks**
 - **Engage w/ AFWIC and MAJCOMs for future force design and operational inputs**
 - **Concepts passing first downselection then undergo deeper concept exploration involving rigorous MS&A, concept refinement, and stakeholder engagement**
 - **Final downselected concepts develop "pitch package" w/ analytically supported description of concept, end-state goal, cost/schedule, follow-on options**

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The FVS panel's first recommendation is focused on Phase 1. The panel recommends implementing an objective and repeatable process, described above, for developing Vanguard concepts that will achieve compelling, game-changing capabilities from the best available technical ideas.

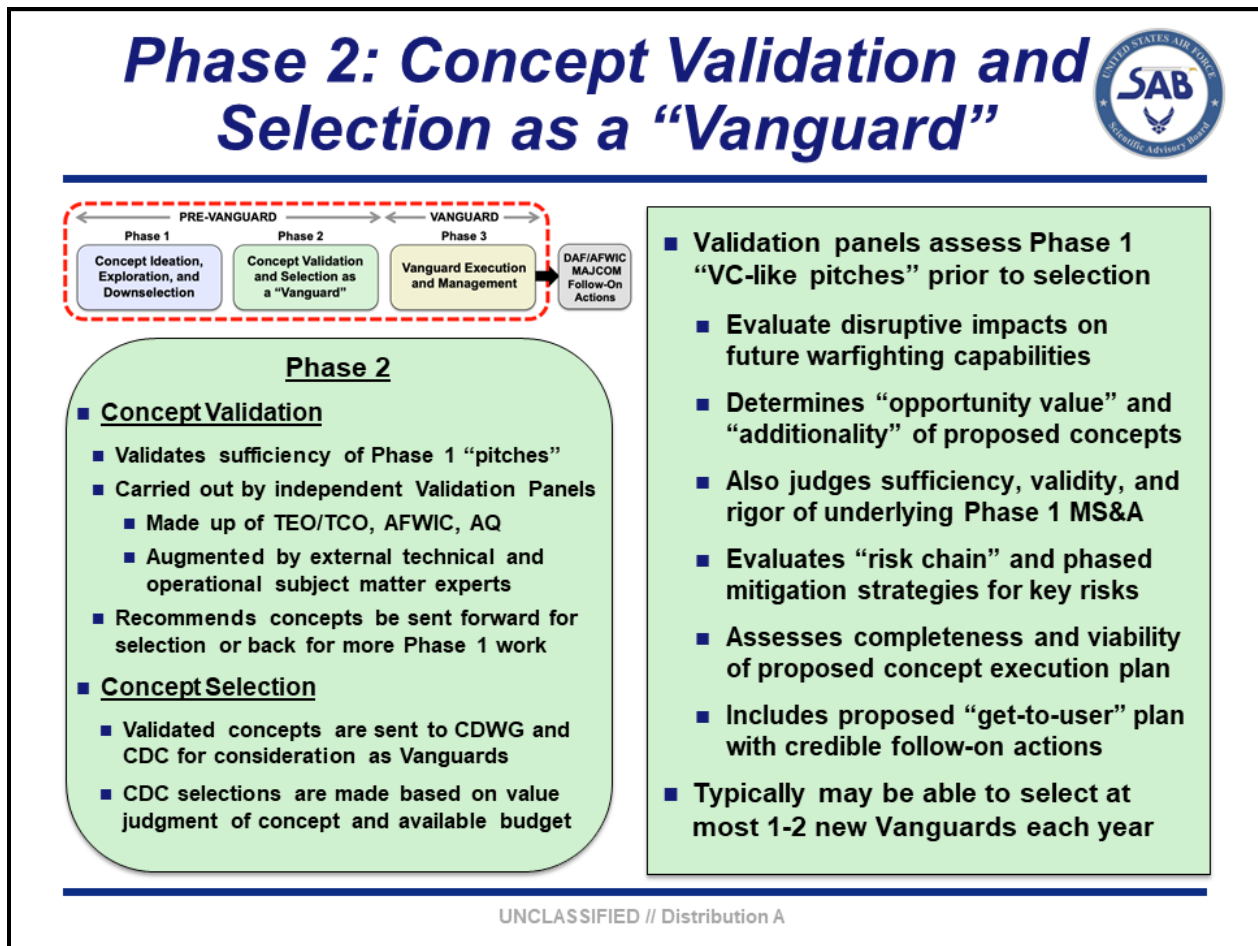
A robust pipeline of technologies must be developed through focused data calls. To that end, the process must be open to a wide range of sources beyond just AFRL. The pipeline and technology calls need to ideate the concepts driven by, but not limited to, the AFWIC "wish list." The technology/capability list should come from concept exploration teams that engage with the users and the acquisition communities. Once selected, the potential ideas must have a team that works to refine the concepts and then perform the rigorous MS&A concept refinement and even more stakeholder engagement to come up with a very concise pitch package that's analytically supported and rigorous. The pitch must include the concept definition, the end-state goal, analytical support indicating practicality of meeting the desired end state, cost and schedule and follow-on options presented in a very credible way.

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Phase 2



Phase 1 products are well-developed Vanguard project proposals that clearly explain the quantitative benefits of each concept and the associated objectives. The purpose of Phase 2 is to assess the overall quality of these proposals before presentation to the CDC selection board and to recommend 1 or 2 projects that best meet the Vanguard criteria established in Phase 1.

An accurate assessment of proposals requires a standing panel of DAF stakeholders from TEO/TCO, AFWIC and AQR. Additionally, the panel should include independent subject matter experts having significant experience in the technologies and applications relevant to each concept. It is essential that knowledge of the difficulties and constraints imposed by concept integration into the larger DAF ecosystem be sufficiently represented on the panel.

The Validation Panel would make perform assessments using the criteria listed on the right side of the above figure. The highest priority factors are the degree to which the disruption causes change to warfighting techniques and the attendant effects. The effects are captured by the "additionality" over and above the expected future warfighting improvements, as described earlier. It must be

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evident that all applicable internal and external 6.1-6.3 efforts as well as other external new technology developments have been properly considered as contributors to the concept proposal.

To validate proposal claims, the panel would challenge the assumptions made in the value analyses, the adequacy and credibility of MS&A tools used to conduct the analyses, the completeness of cost and risk assessments, realism of the project plan and the prospects for successful follow-on activities. The prospects for successful follow-on activities are especially critical to help ensure a successful project, which may enter a PoR or perhaps motivate additional S&T. While the project proposal may be technically excellent with manageable risks and a useful schedule and acceptable cost, there is additional work needed to cultivate relationships with the end users. End users should be active team members early in the process and have the opportunity to personally gain confidence in the concept and how it will fit with existing systems and/or future spirals. This will require the definition of specific milestones and criteria that lend credibility to achievable performance, reliability, reduced risk, cost estimates and other utility factors such as ease of use, hardware/software/functional integration requirements and manufacturing feasibility.

The Validation Panel ranks all proposals and recommends 1 or 2 for selection by the CDC. The recommendations and rankings would first be reviewed by the CDWG to ensure all DAF interests have been properly considered.

Phase 2: Concept Validation and Selection as a “Vanguard”



- Vanguard concept validation should be based on “achieving disruptive impacts by integration of otherwise disconnected 6.3 programs into new high-value warfighting capabilities”; more than “speed to a POR”
 - Vanguard requires higher level of *risk tolerance* to meet stated goal
- Assessments of proposed execution plans should look for focus on “*risk up front*” – i.e., attacking biggest risks early in program
 - Called “*out of order*” development in VC community; *take biggest risks first*
- Vanguard pitches rejected in Phase 2 still provide value to AF S&T
 - Helps Phase 1 participants understand perceived weaknesses of concept
 - Rejected concepts can be repropose after additional Phase 1 preparation
 - Rejected concepts help inform AFRL transformational S&T portfolio choices

Independent assessments by Validation Panels of proposed Vanguard concepts from Phase 1 are essential for providing CDC with viable Vanguard choices

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A key characteristic of a Vanguard is the disruptive quality of the concept and not necessarily the speed to become or be part of a PoR. Typically, highly disruptive concepts are very new and may rely on emerging technologies and/or novel system integrations. Thus, a relatively high level of technical risk can be expected. Institutional risk acceptance and concept acceptance may be additional hurdles. Therefore, a key imperative is that risks be properly identified and assessed with effective mitigation plans. This is probably one of the most important reasons for review by an independent Validation Panel. Projects designed to meet current critical needs that necessitate immediate fielding must recognize that risk could have an even greater impact in terms of cost and delay.

The FVS Panel found that the VC community emphasizes early reduction of the highest risks to accelerate progress towards key decision points. They call it “Out of Order” development. The idea is to first identify and tackle the weakest link in the risk chain in order to raise confidence in overall success early in the project. Otherwise, a normal build-up of system complexity may occur for several years before an insurmountable problem is discovered.

The “Out of Order” approach implies the highest risks must be correctly identified and that mitigation is aggressively pursued early in the project schedule. This may pose difficulties in procuring and developing components needed for early risk mitigation tests. An effective alternative is to use surrogate components that are not the subject of the risk reduction, but allow testing of functions or components that do represent the risks of interest. Thus, a test sequence which captures key risks early and then “backfills” as additional components become available is suggested. A related idea is to run new software and/or hardware functions in a “shadow mode” during early tests to discover problems without sacrificing success of the more immediate testing. New components (e.g., a new guidance sensor) in shadow mode are run concurrently with the more established components under the same test conditions, but are not yet functionally coupled. Post-test analyses can determine effectiveness and problems of a coupled design until the next test verifies coupled performance.

Given the effort expended during Phase 1, expectations are that proposals rejected in Phase 2 will still provide value in some way. For example, proposed concepts may be identified as more appropriate for additional S&T work because certain performance gaps or system integration hurdles are uncovered during the Phase 2 assessment. The proposal might then be tagged as a potential future Vanguard proposal. The Validation Panel may also recognize that a proposed concept meshes effectively with another existing S&T effort. The Panel or CDWG may direct proposers to explore such options. The best outcome is that the proposed concept is found suitable for direct transition to a PoR, thus skipping the need to go through the Vanguard process.

Recommendation #2

Recommendation #2



Phase 2: Vanguard Concept Validation and Selection

- **Establish a Phase 2 Vanguard Concept Validation Panel, independent of Phase 1 concept teams, to assess highest potential Vanguard candidates**
 - Panel should be comprised of standing members from TEO/TCO, AFWIC, AQ, augmented by concept-specific technical and operational SMEs
 - Consider including experts outside of Air Force; e.g., commercial, VC
 - **Assesses “VC-like pitch package” for each concept based on:**
 - Disruptive impact on future warfighting capabilities
 - Credibility and rigor of MS&A
 - Completeness and viability of execution plan, including cost and schedule
 - Feasibility and utility of proposed follow-on actions
 - **Recommends appropriate next step for each concept:**
 - Recommend as a Vanguard candidate to CDWG and CDC ... or:
 - Request further detailed refinement of concept pitch
 - Suggest further risk reduction via S&T (6.1-6.3) testing and demonstrations
 - Suggest concept be designated a 6.3 Transformational Capability program

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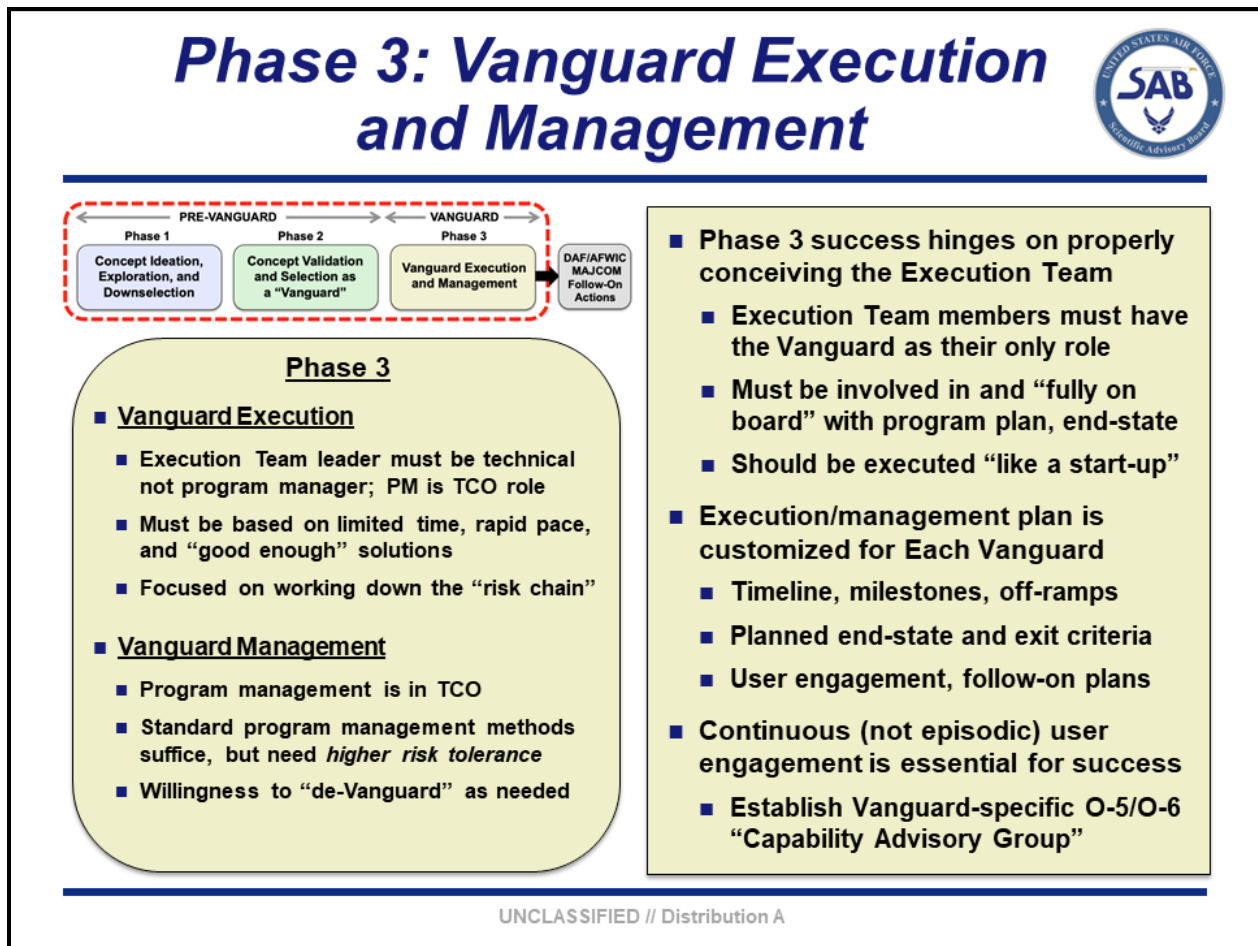
Recommendation #2 is to establish an independent Phase 2 Concept Validation Panel to rigorously assess all aspects of the Vanguard project proposals and ensure that selected projects have the greatest potential to add new strategic transformational DAF capabilities. At a minimum, it is expected that concept proposals contain credible evidence for both exceptional warfighting benefit and the prospects for project success via MS&A, preparatory actions with future stakeholders and thorough planning.

A daunting challenge for the Concept Validation Panel is to accurately rank many excellent, and possibly disparate, proposals. This can only be done if the Panel members have the appropriate expertise and diversity to clearly understand the technologies involved, the modeling and analyses and all system integration implications. Judicious attention must be given to selection of the Panel Chair and members who can properly assess proposal details against the metrics listed on the chart. Key elements are the completeness of risk assessments, risk mitigation plans and prospects for a successful result.

For proposals that are not selected, the Validation Panel is responsible for identifying alternative follow-on efforts as mentioned earlier. These efforts may include additional risk reduction, redirection to other 6.1-6.3 activities or possibly a PoR.

A particular follow-on challenge noted by the FVS Panel is the distinction between system requirements for a Vanguard project and the requirements associated with a system to be fielded. An early concept development effort is typically guided by relatively “light” requirements to expedite design and test functions. The miniature air-launched decoy (MALD-N) program, for example, began as a SCO project but transition was hampered by a lack of program requirements. The project might have met the VoD but for some strong advocates in the Navy program. Thus, the Validation Panel needs to not only be conscious of this distinction, but also help facilitate a future transition by encouraging early participation by the end system developers and users including the start of follow-on requirements development during the early stages of the Vanguard project.

Phase 3



Once the Vanguards have been selected, the process moves to Phase 3: Vanguard execution and management. The expectation is that a non-traditional management structure and process will be needed in order to achieve the pace, agility and coordinated delivery of the desired disruptive end-state capabilities. In this regard, the Vanguards will benefit from a "start-up" like operational construct in which there is a small, flat organization empowered to make rapid decisions and move at a rapid development and operations (DevOps) tempo. Applying best practices from agile development organizations will also facilitate uncovering of unknown risks, early risk mitigation and ensuring continuous user engagement.

An agile process starts with the proper conception of the Execution Team. Commitment and focus are a key element of success and demand that the Execution Team members be fully committed to the program, have a firm understanding and desire to achieve the defined end-state and be isolated and assigned to the Vanguard project full-time. Similarly, the Execution Team leader must bring technical knowledge and focus to the team without the distractions of program management. The program manager should be at the TCO level. The leader should also bring an urgency to drive

toward intermediate milestones at a rapid pace and be able to select the “good enough” solutions in order to continue to drive down the “risk chain.” Balancing this technical drive, the TCO will be able to apply many standard program management methods to track timelines, milestones and off-ramps with a higher risk tolerance and a willingness to initiate “de-Vanguarding” as needed.

Also important is the ability to recognize upfront that each Vanguard will require a customized execution and management plan. While the Vanguards will all share common elements—a rapid development pace, intermediate milestones and knowledge points, predefined off-ramps and exit strategies and continuous user engagement—the specifics will depend on the technology and systems under development. For example, it is anticipated that there could be significant variability in the size and scope of the system under development, as well as the size and scale of maturation required to drive the need for program-specific criteria and milestones.

An essential element of the tailoring of the program plan is continuous, not episodic, user engagement. A known best practice to aid in this process is to establish a Vanguard-specific O-5/O-6 “Capability Advisory Group” with a charter to keep the team focused on the end goal. This group will help the program minimize zero-value-added reviews, reporting and similar obstacles. It will also help to avoid the requirements creep that has plagued many traditional programs. Ideally, there would be on-site user personnel to highlight, enable and motivate this continuous user engagement.

Phase 3: *Vanguards Should be “Operated Like a Startup”*



- **Emphasis on disruptive innovation, rapid pace, agility, and delivery of end-state capabilities to users requires a “startup-like operating model”**
 - **Separate program management from technical execution, so small, flat, agile technical execution team can focus solely on maximizing technical progress**
 - **Board of Directors led by program manager in TCO maintains “thin line” control of technical execution team and serves as the interface to AFWIC**
 - **Provides personnel oversight, and recognition from within the “company”**
 - **Dedicated, agile technical execution team must have diversity of technical capabilities and strongest possible technical depth**
 - **Team size, skill sets, and *mindset* must support DevOps-like execution, rapid decision making, and urgency to “get product to the user”**
 - **Frequent prototyping, testing, and experimentation to inform decisions for quickly developing “good enough” capabilities for users**
 - **“Risk up front” approach focused on successive *burndown* of risk chain**
 - **Frequent all-voice meetings to solve issues (technical, process, organization)**

Vanguards require a fundamentally different operating model than do traditional programs

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Vanguards require a fundamentally different operating model than traditional programs. During the execution and management phase the FVS panel sees an opportunity to pull in the best practices from VC and start-up companies. A startup mindset, focused on disruptive innovation, rapid pace and agility, is well matched to the Vanguard initiative. A common element of success in the VC community is the separation of program management from technical execution. Therefore, a small, flat, agile technical execution team can focus solely on maximizing technical progress. For Vanguards, this construct would have the technical execution team answer to a Board of Directors composed of knowledgeable and invested agents. The Board of Directors should be led by a program manager in the TCO who also serves as the primary interface to AFWIC to insure programmatic alignment with strategic intent. This program management structure also enables the feel of a company moving toward a common goal and allows for personnel oversight and recognition from within the program as opposed from home organizations.

The construction of the technical execution team is equally important. First and foremost, it should comprised of full-time, dedicated people that bring a diversity of technical capabilities and the strongest possible technical depth in relevant areas. Similarly, the team size, skill sets and mindset must all support DevOps-like execution, rapid decision making and an urgency to get products to

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the user. It is also important that members of this team have the ability to rotate out when their contributions are complete and not hang-on looking for other assignments.

In order to attract and retain the top talent for the technical execution team, the key personnel assigned to the Vanguard must receive their “ratings” from Vanguard management and not their line management. In some previous Vanguard-like efforts where people were matrixed from other organizations, the highly motivated and talented technical personnel were effectively punished by their line management because their day job supervisor “didn’t know what he/she was doing.” The supervisors of the technical execution team must understand and endorse that the Vanguard effort will require 100% effort on the part of their employee. The Vanguard managers must be responsible for evaluating employees and make them eligible for special performance awards for contributing well beyond standard expectations. Without the ability to reward the members of the execution team, it will NOT be possible to attract the best talent to the Vanguard programs.

In terms of technical execution, it is important that the team also follow best practices for rapid development. Key steps include frequent prototyping, testing and experimentation to enable incremental progress and decision making to insure “good enough” capabilities are rapidly achieved for the users. Risk management is similarly accelerated by adoption of a “risk up front” approach focused on successive burn down of a risk chain. Finally, bringing the full team together frequently for technical status progress, process application and organization issues will ensure solutions are robust and informed from multiple perspectives earlier rather than later.

When is “De-Vanguarding” Appropriate?



- **De-Vanguarding is CDC-level decision to remove Vanguard designation and resourcing from an on-going Vanguard program**
 - Continuous monitoring of progress and issues in a Vanguard is done by its Board of Directors; if appropriate it recommends de-Vanguarding to CDC
- **Potential reasons (exit criteria) for de-Vanguarding include:**
 - Unacceptable performance shortfalls with no viable recovery options
 - Unmitigatable technical or integration issues in an essential program aspect
 - Unacceptable increases in projected remaining cost and/or schedule
 - Became unnecessary or obsolete (e.g., changes in technology, threat, etc.)
 - Better opportunities became available (e.g., alternate means to achieve same or similar capability; more impactful capability is now achievable, etc.)
- **De-Vanguarding gives feedback to AFWIC, MAJCOMs, AFRL, industry**
 - e.g., informs need for possible new programs in AFRL 6.2/6.3 S&T portfolio

Inherently high risks in Vanguards make occasional need to de-Vanguard both expected and necessary; de-Vanguarding is not the same as “failure”

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Just as important as selecting and executing the Vanguards is deciding when it is time to stop executing a Vanguard. Due to the inherently higher risks associated with the disruptive goals of Vanguards, expectations are that there will be an occasional need to “de-Vanguard” a program. The FVS panel uses the term “de-Vanguard” to refer to the situation where a CDC-level decision is made to remove the Vanguard designation and resourcing and return a project to lower-level action and adjudication. The process would be initiated by the Board of Directors as a result of issues, concerns, or changes noted as part of the Vanguard’s continuous monitoring. In this context, de-Vanguarding is not the same as failure—it is a programmatic action within a broader portfolio of transformational development.

There are a number of reasons that a program might be considered for de-Vanguarding. Some of these are related to technical challenges—such as when the team realizes unacceptable performance shortfalls with no viable recovery options or when there is an unmitigatable technical or integration issue in an essential program aspect. With a goal to get to the users, it is also possible that unacceptable increases in projected cost and/or schedule could cause the priority of the capability to drop. Similarly, the concept might become unnecessary or obsolete as a result of changes in technology and/or threats. Additionally, there might may be better opportunities, such

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as a new alternative, to achieve the same or similar capability or the availability of a more impactful capability.

Regardless of the reason, de-Vanguarding should be viewed from the perspective of the positive outcomes. De-Vanguarding gives data-driven feedback to AFWIC, MAJCOMs, AFRL and industry on critical technologies and capabilities. De-Vanguarding can also inform the need for new or enhanced programs in the AFRL 6.2/6.3 S&T portfolio to build future, related capabilities. It will also create opportunities for potentially more impactful concepts to receive the resources and visibility needed to advance warfighting capabilities.

Recommendation #3

Recommendation #3



Phase 3: Vanguard Execution and Management

- **Implement Vanguard program management practices described herein, leveraging successful examples of agile, rapid technology development in the government, commercial marketplace, and the venture community**
 - **TCO to act as VC managing Transformational Portfolio**
 - **Fund and oversee Vanguards and other 6.3 transformational programs**
 - **Mine and develop pipeline for future Vanguard candidates**
 - **Establish “Board of Directors” led by TCO for each Vanguard**
 - **Create Vanguard program offices and execution teams with “start-up” culture, mindset, and the corresponding set of management practices identified herein**
 - **Separate program management role from focused technical execution team**
 - **Provide PMs with autonomy and agility to manage programs, with aggressive timeline to get at least a minimum viable product (MVP) to users**
 - **Ensure Vanguard personnel management, oversight, and recognition come from within the “start-up company”, even if personnel are matrixed from elsewhere**
 - **Execution team will give full commitment to the organization that evaluates them**

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The FVS Panel has two recommendations to insure an effective implementation of Phase 3.

The first of these recommendations is to implement Vanguard program management practices described herein, leveraging successful examples of agile, rapid technology development in the government, commercial marketplace and the VC community. Central to this recommendation is to have the TCO act as if it were a Venture Capitalist overseeing and managing a Transformational Portfolio Fund. This would require the TCO to oversee the Vanguards as well as other 6.3 transformational programs. The TCO should have an active role in mining and developing a pipeline for future Vanguard candidates and the selection of talented AFRL/contractor personnel needed to successfully execute the Vanguard. For each Vanguard, the TCO would establish and lead a Board of Directors that would be responsible for monitoring the progress and assessing the future value of the Vanguard in order to protect TCO investments. The Board of Directors would also have the primary responsibility to manage scope creep and remove obstacles such as excessive reporting and briefing requests. Answering to the Board of Directors would be a Vanguard program office and Execution Team that operates with a “start-up” culture, mindset and

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corresponding set of management practices. These practices, informed from industry-wide lessons learned, start with the separation of the program management role from the focused technical execution team. It also empowers the program managers with the autonomy and agility to make the decisions needed to achieve aggressive timelines toward at least a minimum viable product deliverable to users. It also ensures that the Vanguard personnel management, oversight and recognition come from within the start-up company. This aspect of the team management is critical as personnel are matrixed from elsewhere. If implemented appropriately, the execution team members will give their full commitment to the organization that evaluates them.

Recommendation #4

Recommendation #4



“De-Vanguarding”

- **Implement a disciplined decision-gate process in each Vanguard project timeline, with “de-Vanguarding” where appropriate as described herein**
 - **Assess progress against milestones, performance goals, development risks, and projected readiness for potential follow-on actions**
 - **Periodically determine projected “additionality” based on current program state and currently anticipatable end-state, and de-Vanguard if/when appropriate**
 - **e.g., unmitigatable technical issues, threat change, alternate capability**
 - **De-Vanguarding assessment for any given Vanguard is performed by its “Board of Directors”, with recommendations provided to CDC for decision**
 - **Potential actions after de-Vanguarding may include:**
 - **Technology and/or concept spin-offs to other projects**
 - **Starting new 6.1/6.2 programs to address gaps**
 - **Further development of component technologies in 6.3 portfolio**
 - **De-Vanguarding ≠ failure!**

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Consistent with the start-up mentality, achieving the rapid development goals for a Transformational Portfolio Fund will also require discipline in project evaluation. There should be a defined process for assessing progress against milestones, performance goals, development risks and projected readiness for potential follow-on actions. Similarly, a periodic determination of the projected “additionality” based on current program state and currently anticipatable end-state will help to inform if/when de-Vanguarding is appropriate. Such a decision could be initiated from various perspectives, including unmitigatable technical issues, changes in threats, or availability of an alternate capability. This de-Vanguarding assessment should be performed by the Board of Directors. The Board of Directors then provide a recommendation to the CDC for a final decision. Using the perspective of a Transformational Portfolio Fund management process, the de-Vanguarding actions can be put in proper perspective—they are not failures and will inform potential alternate actions that might include technology and/or concept spin-offs to other projects, initiation of new 6.1/6.2 programs to address identified gaps, or further development and refinement of component technologies in the 6.3 portfolio.

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Vanguard End-State and Follow-On

Vanguard End-State and Follow-On Actions



- Every Vanguard has an *intended* end-state in its program plan and an *actual* end-state upon its completion (e.g., residual asset or capability)
- *Transition success* should *not* be defined solely as a Program-of-Record; other equally valuable follow-on actions may be more appropriate
 - Operational experimentation with end-state assets or capabilities
 - Capability demonstration with a non-fieldable prototype
 - Integrated system that can be provisionally used in the field
 - Insertion into a follow-on program
 - Direct entry into operational use
 - Commercial development
- DAF/AFWIC-directed follow-on actions could include:
 - Further SDPE-led experimentation with end-state assets/capabilities
 - MAJCOM direction to explore MU/TTPs using end-state assets/capabilities
 - Cross-Service experimentation with end-state assets/capabilities

A successful Vanguard may lead to follow-on actions other than a Program-of-Record

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The SAB Panel heard several times during this study that the implied success of a Vanguard required incorporation into a DAF PoR. However, several organizations, to include DARPA, indicated that Vanguard success should not be solely defined in this manner. Several follow-on actions may be more appropriate and provide greater military utility for the Vanguard than direct adoption into a PoR. Several alternative measures of success are listed in the chart. They range from expanded operational experimentation, to direct entry into operational use to adaption into the commercial environment for further (and potentially broader) development. Vanguards must be genuinely experimental and data-driven as they progress through their execution phase. Therefore, DAF/AFWIC may need to direct follow-on actions if the initially-intended application is determined to be no longer viable or if they determine a broader DAF impact of the Vanguard. While it is unlikely at this stage of selection, if more fundamental limitations are identified during the Vanguard's execution that limit the Vanguard's war fighting capability, then a return to AFRL for more basic exploration may be warranted. In these rare cases, such an approach will reduce the resource allocation rate while the basic concerns are addressed. The only unacceptable outcome for a Vanguard would be to permit a sequence of unplanned extensions that would greatly

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expand the time duration of the Vanguard beyond its intended four-year horizon. The Vanguard must either stay on its planned trajectory, pivot early, or fail early. Vanguards must never be permitted to become long-term enduring research and development efforts unto themselves. Close and continuous coordination between the DAF/AFWIC leadership, the Vanguard leadership and the leadership of the targeted program office will be essential to the timely transition of the Vanguard programs.

The Vanguard initiative emphasizes genuine experimentation and data-driven processes to evaluate the utility of transformative war-fighting technical innovations. The selection criteria for Vanguards are rigorous. However, the utility of the innovation may change through further experimentation. Furthermore, the nature of the threat that the Vanguard would address and the battle-space situation can evolve rapidly with time. These changes may alter the utility of the intended Vanguard end-state. With proper management, the actual end-state of the Vanguard program may have even greater utility to the DAF than the original intended end-state.

It is noteworthy to remember that not all AFRL 6.3 Programs must transition via a PoR to be useful to the warfighter. For example, AFRL's "Angel Fire" program placed persistent High Definition video Intelligence, Surveillance and Reconnaissance assets over Bagdad and Mosul during the insurgency and was used heavily by the Marines while AFLCMC simultaneously procured Gorgon Stare—Angel Fire's replacement. On paper, Angel Fire did not transition as a PoR. However, the sensor system and ground subsystems transitioned seamlessly. When Vanguards are graded on their success in the future, the DAF needs to consider similar interim or non-traditional transition capabilities that Warfighters can use quickly. This is especially true if the final technology solution takes more time through traditional acquisition channels.

Many possible transitions of Vanguards, other than to the intended PoR, are listed in the briefing slide above. It is important to emphasize that further commercial development of Vanguard programs may present ideal follow-on utility for the DAF. For example, close arrangements have been made between the first round of Vanguard programs and commercial space operations and data management systems. While this arrangement constitutes a different way of doing business within the DAF, with proper attention to security and other logistical concerns, these commercial operations may lead to much faster adaptation to the rapid change in these important technology areas. This helps keep the DAF warfighting capabilities at the forefront of the rapidly advancing capabilities. There is definite utility in adopting commercial and venture models in the structure of future Vanguard efforts. This operational alignment to agile and rapid prototyping, evaluation and development may lend itself well for ongoing commercial collaborations as the Vanguard program proceeds.

The DAF/AFWIC takes the lead in the identification and development of new innovations to advance strategic warfighting capability. Therefore, they are in an excellent position to determine the optimal military utility derived from multiple possible follow-on opportunities throughout the Vanguard development and transition. Transition planning is essential throughout the Vanguard effort. The relationship between the Vanguard's leadership, the leadership of the targeted program offices and the DAF/AFWIC is essential throughout the progression of the Vanguard—not just at

the point of transition once the Vanguard program is complete. The Vanguard program is a genuinely new way of rapidly advancing transformational technology within the DAF. Therefore, it is essential to get this process right early in the program. This process will build confidence throughout the DAF and the broader Defense Community in the utility of Vanguard and similar programs to rapidly advance warfighting technology and maintain the United States' military as the strongest and most effective fighting force throughout the world.

Recommendation #5

Recommendation #5



Vanguard Deliverables and Follow-On Actions

- **Define the meaning of Vanguard “transition success” more broadly than just becoming a Program-of-Record, but require agreement on specific Vanguard “follow-on actions” as part of Phase 2 selection criteria**
 - **As part of Vanguard concept “pitch” entering Phase 2, identify set of potential end-states and corresponding follow-on actions as described herein**
 - **Follow-on actions and associated provisional funding plans must be agreed upon by relevant entities (e.g., AFWIC, PEO, MAJCOM, TCO)**
 - **Vanguard end-state should be a residual asset or capability that could enable:**
 - **Further SDPE-led experimentation**
 - **Fieldable prototypes**
 - **MAJCOM direction to explore TTPs or conduct MUA**
 - **MAJCOM-funded follow-on capability development**
 - **Air Force corporate-level funding of a Program-of-Record**
 - **Coordinating appropriate follow-on actions is a key role for DAF and AFWIC**

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The definition of “Transition Success” for each unique Vanguard project will likely be as varied as the Vanguard programs. There is certainly no single Vanguard transition success metric since each Vanguard will be in a class by itself. It is essential that the Vanguard transition be planned and established during the Vanguard definition and selection process and that the transition plan be updated as the Vanguard progresses toward completion. The Vanguard leadership team must work closely with the targeted program office and the DAF/AFWIC Leadership throughout the Vanguard’s development. The Vanguard transition plan should be re-negotiated, when appropriate, as the Vanguard matures and advances. Furthermore, genuinely new assets and capabilities that have resulted from the Vanguard must be identified and added to the warfighting capabilities across the DAF for flexible applications wherever the new utility may prove beneficial. Done properly, there will be no ambiguity on how the Vanguard should transition at the end of its development. This disciplined approach to exit planning is the key to the success of the Vanguard program. Discipline will be critical for transitioning the Vanguards in a timely manner to their PoR or to their negotiated exit and is key to building user confidence in the Vanguard process and the DAF’s

new business procedures to place advanced technology and new innovations in the hands of the warfighter in an unprecedented, short timeframe.

Vanguard Leadership

AFWIC Role is Essential for Vanguard Success



AFWIC Mission: Drive integration through centralized enterprise design and capability planning

- **Success of Vanguard initiative depends on AFWIC's ability to:**
 - **Articulate key gaps and disruptive opportunities to inform Vanguard concepts that support "Future Force Design" and "Theory of Victory"**
 - **Connect AFRL and TCO with emerging CDC and MAJCOM priorities**
 - **Assist with MS&A for Phase 1 concept development/downselection**
 - **Validate candidate Vanguard alignments w/ Future Operating Concept**
 - **Recommend prioritized list of candidate Vanguards to CDC**
 - **For on-going Vanguards, align 6.4 prototyping funding to enable them, and defend planned Vanguard funds in Air Force budget process**
 - **Recommend continuation or de-Vanguarding of existing Vanguards**

AFWIC is a relatively new organization that must quickly reach its full mission capability to achieve the transformational future force capabilities that Vanguards seek to provide

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High-risk, high-payoff technology programs can require significant user pull in order to stay on track. However, users often need help understanding what a new and complex technology trade space has to offer. AFWIC will need to help users gain that understanding. Success of the Vanguard initiative is heavily dependent on AFWIC—a relatively new organization which may not yet have the full range of functionality needed to provide critical military context across the full lifecycle of Vanguard programs. Thus, as the Vanguard initiative progresses, AFWIC may need to progress in tandem in its capability to identify and articulate everything from key capability gaps to technology opportunities relative to future force design. Furthermore, AFWIC needs to act as a bridge between those key capability gaps and opportunities by connecting technologists and users, helping with MS&A of new concepts and prioritizing candidate Vanguards. Once a Vanguard program is underway, AFWIC will need to assist with aligning the necessary funding for the Vanguard to transition and defend those funds in the budgeting process. Finally, AFWIC will be critical in connecting technology outcomes to operational needs, in assessing the likelihood of success of existing Vanguards and in recommending their continuation or de-Vanguarding.

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Vanguards Must Have DAF-Level Commitment



- **If a future warfighting capability is “potentially transformational enough” to be a Vanguard, then it warrants DAF-level attention**
 - **Vanguards are not simply AFRL technology demonstrations; they are AF efforts to test viability of transformational warfighting concepts**
 - **Vanguard initiative requires AF enterprise coordination of support from acquisition, operational, S&T, and test communities**
- **Without DAF-level commitment to the Vanguard initiative, it will not provide the transformational capabilities being sought**
 - **DAF leadership must signal top-cover and risk tolerance for inherently high-risk programs that seek to enable leap-ahead capabilities**
 - **AF Council will need to make resource allocations for Vanguard follow-on actions; may involve directing MAJCOM follow-on roles**

The Vanguard initiative will not succeed in delivering game-changing capabilities unless it has strong, visible, and sustained commitment at the DAF level

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The warfighting capabilities and development process that the Vanguard Initiative seeks to develop are transformational and could be disruptive to the status quo. The proposed Vanguard process will likely run counter to current military and acquisition culture. It will be necessary to demonstrate a high tolerance for risk and occasionally even celebrate failure in a program to reinforce the idea that not all high-risk technologies can succeed. If there is not some level of failure, the Vanguard programs are not likely high-risk enough to provide strategic transformational capabilities.

To combat the natural antibodies that can arise in the face of disruption, DAF-level commitment to Vanguard success is critical. Such commitment includes bringing together support from acquisition organizations, operations, the science and technology community, as well as the test and training communities. The Vanguard initiative will require focused, continuous encouragement to keep all the various elements engaged and coordinated throughout the full Vanguard process. Such commitment may also require making difficult resource allocation decisions to support transition and related follow-on activities to transform Vanguard outcomes into future force capabilities. Without sustained commitment from DAF-level leadership, the Vanguard Initiative has little chance of success.

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Recommendation #6

Recommendation #6



DAF-Level Commitment and Support

- **Demonstrate strong, visible, and sustained DAF-level commitment to the Vanguard initiative, to on-going Vanguard programs, and to resulting Vanguard follow-on actions**
 - **Champion and provide top-cover for inherently high-risk but potentially game-changing Vanguard programs**
 - **Ensure participation of acquisition, operational, S&T, and test communities during Vanguard concept development and validation phases**
 - **Coordinate as needed to enable Vanguard follow-on actions**
 - **Accelerate achievement of full AFWIC mission capability to ensure it defines key gaps and disruptive opportunities for transformational future force capabilities that Vanguards seek to provide**

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Overall, DAF-level commitment to and unrelenting support for the Vanguard Initiative will be critical to its success. This commitment requires championing the initiative overall as well as providing top cover for individual programs. It means ensuring the right participation from the right communities, organizations and people, including AFWIC. In particular, it means accelerating AFWIC to its full potential so that it can be the right organization to serve the Vanguard Initiative across the full program life cycle. It means embracing a culture of high-risk tolerance in order to enable the benefits of high payoff rewards.

Conclusion

Summary of Recommendations



Recommendation	Suggested Implementation Timeline*	Suggested OPR
1. Implement an objective and repeatable process for Vanguard concept ideation, exploration, downselection	Vanguard 2+	AF TEO
2. Establish independent Phase 2 Validation Panel to assess high potential candidates and make Vanguard selection recommendations	Vanguard 2+	SAF/AQ AF/A5
3. Implement “start-up-like” Vanguard program management and execution practices	Vanguard 2+	AF TEO
4. Establish disciplined decision-gate processes, and de-Vanguard as appropriate	Vanguard v1	AF TEO
5. More broadly define Vanguard “transition success”	Vanguard v1	SAF/AQ AF/A5
6. Ensure DAF-level Vanguard support	Vanguard v1	CDC

* Identify earlier opportunities to pilot when possible

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With the release of the 2030 S&T strategy, there is a renewed push to rapidly develop and deliver strategic transformational capabilities. The flagship effort is a set of research initiatives designated as Vanguards—high-priority programs focused on rapidly developing and transitioning game-changing capabilities via prototyping and experimentation. The inaugural Vanguard selection process is important as it shows the DAF is focused on this initiative. However, the current process is not an enduring process that will generate the best future capabilities. After collaboration with over 30 DAF, DoD and industry organizations, the FVS panel developed a process that has a high likelihood of enduring during the selection and management of future Vanguard programs. This process incorporates the best practices in regards to program solicitation, selection, management and transition. In order to establish this enduring process, the FVS panel has 6 recommendations that, if incorporated, will facilitate the establishment of this enduring selection and management process.

The panel recommends a selection and management process with three distinct phases: (1) concept ideation, exploration and down selection, (2) concept validation and selection and (3) Vanguard

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execution and management. The Air Force should implement an objective and repeatable phase 1 process that will turn the best technical ideas from a broad range of sources into compelling game-changing capability concept “pitches.” These high-potential Vanguard candidates should be assessed in Phase 2 by an independent Validation Panel that includes external, concept-specific technical and operational subject matter experts before being recommended to the Capability Development Council for selection. Phase 3 should have the selected Vanguards operating “like a start-up” by leveraging successful program management practices from agile technology companies in order to achieve the required disruptive innovation, rapid pace and delivery of end-state capabilities demanded for Vanguards. While selecting transformational Vanguards is important, the panel recommends the Air Force implement a disciplined, decision-gate process in each Vanguard timeline allowing the option of “de-Vanguarding” projects where appropriate to avoid endless pursuits and free up money for other concepts. Maximizing Vanguard success will require a broader definition of “transition success.” However, follow-on actions must be explicitly agreed upon during the selection process. Finally, the Department must demonstrate strong, visible and sustained commitment to the Vanguard initiatives, to on-going Vanguard programs and to resulting Vanguard follow-on actions in order to ensure the success of these transformational programs.

Suggested Offices of Primary Responsibility (OPR) and implementation timelines are indicated in the right two columns of the table above. While the goal of the FVS study was to inform the future (v2+) Vanguard selection and management processes, the SAB panel identified opportunities for earlier implementation of several of the recommendations. In fact, close coordination between the Panel and the TCO during the study has resulted in some of the recommendation being piloted already in the Vanguard v1 process.

Appendix A: FVS Terms of Reference

DAF Scientific Advisory Board FY 2020 Quick Look Study

Future Air Force Vanguard Selection and Management Processes

Background

An effective Air Force science and technology (S&T) enterprise is essential to enable warfighting capabilities to meet the objectives of the National Defense Strategy. In April 2019 the Air Force released its new 2030 Science and Technology Strategy. As part of this strategy, the Air Force will allocate at least 20% of its S&T budget to a transformational component intended to drive future force design. This component will include a set of research projects called Vanguard programs, which will seek to advance emerging weapon systems and warfighter concepts via prototyping and experimentation, with a goal of transitioning to an Air Force Program of Record. The initial set of Vanguard programs are (i) Golden Horde (collaborative networked autonomy for smart munitions, including Small Diameter Bomb I and Miniature Air Launched Decoy); (ii) Navigation Technology Satellite-3; and (iii) Skyborg (manned-unmanned teaming for fighter aircraft). While an initial process was in place to determine the candidate Vanguards, going forward the Air Force intends to implement a more formalized selection and management process to maximize the likelihood of successful Vanguard program execution and transition to Programs of Record. The Air Force will thus benefit from an independent study that assesses a wide range of options for how Vanguard selection and management might be structured and recommends options that are most likely to meet the objectives of the Vanguard concept.

Charter

This quick look study will:

- Survey key Air Force stakeholders relevant to the Vanguard concept, including AFWIC, AFMC, AFRL, SAF/AQ, AF/ST and MAJCOMs, to determine overall goals, constraints and key mission drivers for Vanguard programs.
- Survey government and commercial entities to understand their processes for selecting, executing, tracking and transitioning or terminating complex prototyping programs.
- Identify distinguishing elements of these processes that enable successful prototyping and recommend best practices that may be suited for current and future Vanguard programs.
- Using one or two initial Vanguard programs as case studies, compare the recommended best practices with the process and assessment criteria used in their selection, including operational suitability, technical maturity, integration readiness and other factors.

- Recommend metrics, analyses and processes to inform the selection and subsequent management of future Vanguard programs to maximize the potential for rapidly developing and transitioning “game changing technologies” to Programs of Record.

Study Products

Briefing to SAF/OS and AF/CC in May 2020. Publish report in August 2020.

Appendix B: Study Members

Study Participants



Study Leadership

- Dr. Melissa Choi, Study Chair
- Mr. Greg Simer, Study Vice Chair

Additional SAB Members

- Dr. Werner Dahm, EXCOM
- Dr. Michael Bear
- Dr. Rodney Bowersox
- Dr. Robert Duncan
- Dr. Samuel Graham
- Dr. Eric Hall
- Dr. Ryan Hersey
- Dr. Brian Kent
- Gen (ret) Lester Lyles
- Dr. Alan Pue
- Mr. David Robbins
- Dr. Stefanie Tompkins

AFRL Representatives

- Mr. Chris Ristich (SDPE and TCO)
- Mr. Tim Sakulich (AFRL/RX)
- Lt Col Ethan Holt (AFRL/RXA)

Executive Officers / Support Staff

- Lt Col (sel) Ken Corigliano (Co-lead)
- Maj Jed Sherman (Co-lead)
- Maj Kenitra Fewell
- Maj Daniel Sabatelli
- Capt James Corcoran
- Capt Eamon Cullen
- Capt Casey Hawkins
- Capt Jonathan Poole
- Capt Alexa Thomsen

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Appendix C: Study Meetings, Briefings, & Site Visits

Briefings and Site Visits 		
DAF / MAJCOMs ▪ AFWIC ▪ SAF/AQR ▪ AFMC/CC ▪ AFLCMC ▪ AFRCO ▪ AF/ST ▪ AF Chief Scientists Council	AFRL (cont'd) ▪ Center for Rapid Innovation ▪ AFRL/RD ▪ AFRL/RH ▪ AFRL/RI ▪ AFRL/RV ▪ AFRL/RW ▪ AFRL/RX ▪ AFRL/RV	Venture Capital (VC) Firms ▪ Accel ▪ Incubic ▪ Khosla Ventures ▪ Vulcan Capital ▪ Kleiner Perkins ▪ Battery Ventures
AFRL ▪ AFRL/CC ▪ AFRL/CA ▪ AFRL/RS (SDPE) ▪ AFRL/RST (TCO) ▪ AFRL/XP	Other DoD / IC ▪ DARPA ▪ SCO ▪ NRO ▪ NIC	FFRDC/UARC/Nonprofit ▪ Battelle ▪ JHU APL ▪ MIT Lincoln Laboratory ▪ RAND
		Commercial Industry ▪ Aurora Flight Sciences

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Note: The briefings listed below are those presented to the Future Air Force Vanguard Selection and Management (FVS) Study Panel during the many data gathering and fact-finding meetings conducted during the course of the FVS study. The presenters that are cited below may not be the actual briefing authors cited within the actual briefing materials. A few of the briefings presented, due to classification restrictions, may not be specifically listed below.

13-16 January 2020, Irvine, California

1. *Air Force S&T Strategy & Future Vanguard Selection*, Tim Sakulich, Executive Lead for AF Strategy Implementation, Air Force Research Laboratory
2. *Program Overview*, Dr. Richard Joseph, Chief Scientist of the United States Air Force
3. *Current Vanguard Programs*, Maj. Gen. Michael Fantini, Director, Air Force Warfighting Integration Capability

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4. *Program Overview*, Chris Ristich, Director, Air Force Strategic Development Planning and Experimentation Office

10-14 February 2020, Dayton, Ohio

5. *Navigation Technology Satellite 3 (NTS-3) Program Overview*, Brian Mettling, Air Force Life Cycle Management Center
6. *AFRL Plans and Programs*, John Miller, Air Force Research Laboratory
7. *Vanguards: A Conceptual History in the Air Force*, Gen. Lester Lyles, DAF (Ret), General Dynamics Corporation
8. *Skyborg Program Overview*, Dr. Patrick Berry, Air Force Research Laboratory
9. *Acceleration of Innovation*, Dr. Amy Heintz, Technical Fellow, Battelle Corporation
10. *AFWIC Future Wargames Outbrief*, Matthew J. O'Malley, Strategic Development Planning and Experimentation
11. *AFRL Leadership Perspective on Vanguard Selection*, Brig. Gen. Evan Dertien, DAF, Commander, Air Force Research Laboratory
12. *AFMC Leadership Perspective on Vanguard Selection*, Gen. Arnold Bunch, DAF, Commander, Air Force Materiel Command
13. *AFRL Center for Rapid Innovation (CRI) Overview*, Dr. Alok Das, Director, AFRL Center for Rapid Innovation
14. *Chief Scientist Panel*, Dr. Richard Joseph, Chief Scientist of the United States Air Force
15. *Golden Horde Program Overview*, Norma Taylor, Air Force Research Laboratory

2-6 March 2020, Washington, D.C.

16. *Strategic Capabilities Office Process Overview*, Col. Nathan Diller, Air liaison officer to Strategic Capabilities Office
17. *Program Overview*, Greg Hebner, National Intelligence Council
18. *Program Overview*, Richard Silberglitt, RAND Corporation
19. *Construct and Capabilities Overview*, Lt. Col. Robert Volesky, Air Force Warfighter Integration Capability (AFWIC)
20. *Aurora's Rapid Prototyping Culture and Experience*, John Tylko, Chief Innovation Officer, Aurora Flight Sciences

- 21. *Venture Capital Culture Overview*, Vinod Khosla, Founder, Khosla Ventures
- 22. *Vulcan Capital Overview*, Chris Orndorff, Chief Investment Officer, Vulcan Capital
- 23. *Rapid Technology Development*, Milton Chang, Managing Director, Incubic Management
- 24. *Path to Development*, Richard Wong, General Partner, Accel
- 25. *Rapid Acquisition and Artificial Intelligence*, William Bailey, Air Force Rapid Capabilities Office
- 26. *Program Development and Execution*, Kristin Lorenze, MIT Lincoln Labs
- 27. *MALD-N: A Transition Success*, Louis Colangelo, Johns Hopkins Applied Physics Lab

23 April 2020

- 28. *Vanguard Discussion*, Dr. Yvette Weber, Acting Deputy Assistant, SAF/AQR

10 March 2020

- 29. *Program Overview*, Ilya Fushman, Kleiner Perkins
- 30. *Program Overview*, Alex Benik, Battery Ventures

11 March 2020

- 31. *DARPA Vanguard-like Constructs*, Dr. David Honey, Deputy Director, DARPA; Dr. Ralph Sandfry, Chief of Staff, DARPA

13 March 2020

- 32. *JCTD Overview and History*, Glenn Fogg, Former USD(R&E)

Appendix D: Acronyms and Abbreviations

AF: Air Force

AFE: Air Force Explorer

AFLCMC: Air Force Life Cycle Management Center

AFRL: Air Force Research Laboratory

AFWIC: Air Force Warfighting Integrating Capability

AQR: AF Acquisition

CDC: Capability Development Council

CDWG: Capabilities Development Working Group

CONOPS: Concept of Operations

DAF: Department of the Air Force

DARPA: Defense Advanced Research Projects Agency

DevOps: Development and Operations

DT&E: Development Testing and Evaluation

DoD: Department of Defense

DP: Development Planning

FFRDC: Federally Funded Research and Development Center

FVS: Future Vanguard Selection and Management

JCTD: Joint Capability Technology Demonstrations

MAJCOM: Major Command

MALD-N: miniature Air-launched Decoy

MU: Military Utility

MUA: Military Utility Assessment

MS&A: Modeling, Simulation and Analysis

NTS-3: Navigational Technology Satellite-3

OPR: Office of Primary Responsibility

PEO: Program Executive Office

POM: Program Objective Memorandum

PoR: Program of Record

S&T: Science and Technology

S&T 2030: Science and Technology for 2030 and Beyond

SAB: Scientific Advisory Board

SCO: Strategic Capabilities Office

SDCP: Seedlings for Disruptive Capability Program

SDR: Software Defined Radio

TCO: Transformational Capabilities Office

TEO: Technology Executive Officer

TTPs: Training, Tactics and Procedures

UARC: University Affiliated Research Center

VC: Venture Capital

VoD: Valley of Death

Appendix E: Initial Distribution List

Air Force Leadership

SAF/OS – Secretary of the Air Force
AF/CC – Chief of Staff of the Air Force
SAF/US – Under Secretary of the Air Force
AF/CV – Vice Chief of Staff of the Air Force

Air Force Secretariat and Air Staff

SAF/AQ – Assistant Secretary (Acquisition)

- SAF/AQI – Information Dominance Directorate
- SAF/AQL – Special Programs Directorate
- SAF/AQR – Science, Technology and Engineering Directorate
- SAF/CIO A6 – Chief Information Officer and Information Dominance Directorate
- SAF/A6C – Air Force Chief Data Officer

AF/CVA – Assistant Vice Chief of Staff
AF/RE – Chief of the Air Force Reserve
AF/ST – Chief Scientist of the Air Force
AF/TE – Directorate of Test and Evaluation
AF/A1 – Deputy Chief of Staff for Manpower, Personnel and Services
AF/A2 – Deputy Chief of Staff for Intelligence, Surveillance and Reconnaissance
AF/A3 – Deputy Chief of Staff for Operations
AF/A4/7 – Deputy Chief of Staff for Logistics, Installations and Mission Support
AF/A5/8 – Deputy Chief of Staff for Strategic Plans and Requirements
AF/A9 – Deputy Chief of Staff for Analyses, Assessments and Lessons Learned
AF/A10 – Deputy Chief of Staff for Strategic Deterrence and Nuclear Integration
NGB/CF – Chief of the Air National Guard

Air Force Major Commands

Air Combat Command

- ACC/A3 – Directorate of Air and Space Operations
- ACC/A5/8/9 – Directorate of Plans, Programs and Requirements

Air Education and Training Command
Air Force Global Strike Command
Air Force Materiel Command
Air Force Reserve Command
Air Force Space Command
Air Force Special Operations Command
Air Mobility Command
Pacific Air Forces
U.S. Air Forces Europe

Other Air Force Elements

Air Force Research Laboratory

- AFRL/CC – Commander
- AFRL/CZ – Chief Technologist
- AFRL/RI – Information Directorate
- AFRL/RV – Sensors Directorate
- AFRL/RV – Space Vehicles Directorate
- AFOSR – Air Force Office of Scientific Research

Air Force Lifecycle Management Center

Air Force Operational Test and Evaluation Center

Air Force Rapid Capabilities Office

Air Force Space and Missile Systems Center

Air Force Test Center

Air Force Warfighting Integration Center

National Air and Space Intelligence Agency

Combatant and Regional Commands

United States Africa Command

United States Central Command

United States European Command

United States Northern Command

United States Southern Command

United States Special Operations Command

United States Strategic Command

United States Transportation Command

Other Department of Defense and Service Advisory Boards

Army Science Board

Defense Policy Board

Defense Science Board

Naval Research Advisory Committee

Office of the Secretary of Defense and Defense Agencies

Under Secretary of Defense (Acquisition and Sustainment)

Under Secretary of Defense (Research and Engineering)

Defense Advanced Research Projects Agency

Defense Innovation Unit

Defense Innovation Board

Defense Threat Reduction Agency

Defense Information Systems Agency

National Geospatial-Intelligence Agency
National Reconnaissance Office
National Security Agency

Other Military Services

Assistant Secretary of the Army (Acquisition, Logistics and Technology)
Assistant Secretary of the Navy (Research, Development and Acquisition)
Office of Naval Research

Joint Chiefs of Staff

Chairman, Joint Chiefs of Staff
Vice Chairman, Joint Chiefs of Staff
Joint Chiefs of Staff, Director for Intelligence (J-2)
Joint Chiefs of Staff, Director for Operations (J-3)
Joint Chiefs of Staff, Director for Logistics (J-4)
Joint Chiefs of Staff, Director for Strategic Plans and Policies (J-5)
Joint Chiefs of Staff, Director for Joint Force Development (J-7)
Joint Chiefs of Staff, Director for Force Structure, Resources and Assessment (J-8)

Other United States Government Agencies and Organizations

Central Intelligence Agency
Intelligence Advanced Research Projects Activity
National Aeronautics and Space Administration

Libraries and Data Repositories

Air Force Institute of Technology Library
Air University Library
Defense Technical Information Center
Library of Congress
National Defense University Library
Pentagon Library
U.S. Air Force Academy Library
U.S. Army Command and General Staff College Library
U.S. Army War College Library
U.S. Marine Corps Command and Staff College Library
U.S. Military Academy Library
U.S. Naval Academy Library
U.S. Naval War College Library

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