The Role of Experimentation Campaigns in the Air Force Innovation Life Cycle: Proceedings of a Workshop

DETAILS

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Proceedings of a Workshop

Committee on the Role of Experimentation Campaigns
in the Air Force Innovation Life Cycle

Air Force Studies Board

Division on Engineering and Physical Sciences

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

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COMMITTEE ON THE ROLE OF EXPERIMENTATION CAMPAIGNS IN THE AIR FORCE INNOVATION LIFE CYCLE

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Preface

The U.S. Air Force Office of the Assistant Secretary for Science, Technology and Engineering asked the Air Force Studies Board of the National Academies of Sciences, Engineering, and Medicine to define and assess the current use of experimentation campaigns within the Air Force, evaluate barriers to their use, and make recommendations to increase their use.

To accomplish this work, the Committee on the Role of Experimentation Campaigns in the Air Force Innovation Life Cycle was established to (1) organize a workshop and (2) complete a consensus study with recommendations on how to best institutionalize experimentation within the Air Force. (Appendix A contains the committee's statement of task and Appendix B contains biographical sketches of the committee members.) The goal of the workshop was to bring together practitioners of experimentation methodologies from a broad cross section of the community with the intention of using these inputs to guide the subsequent consensus study activity.

The Workshop on the Role of Experimentation Campaigns in the Innovation Cycle was held in Washington, D.C., on January 27-29, 2016. Participants at the workshop presented a broad range of issues, experiences, and insights related to experimentation, experimentation campaigns, and innovation. These proceedings provide a summary of the workshop presentations; however, no attempt was made to develop consensus findings and recommendations. The agenda for the workshop appears in Appendix C and Appendix D lists the workshop participants. A list of acronyms and abbreviations is provided in the front matter.

The Air Force Studies Board and the committee recognize the contributions of the workshop participants and appreciate this opportunity to provide input on a subject of importance to the Air Force.

A NOTE ABOUT THE ABSTRACTS

The abstracts in these proceedings are those provided by or approved by the speakers; presentations shown on the agenda but without a corresponding transcript are those for which the speaker did not provide an abstract or declined the offer to include an abstract. The abstracts have been lightly edited for clarity.

Contents

Acronyms

A&A	Authorization & Accreditation
A5/8	USAF HQ Deputy Chief of Staff responsible for developing, managing and constantly assessing an Air Force strategy
ACTD	Advanced Concept Technology Demonstration
AFMC	Air Force Materiel Command
AFSB	Air Force Studies Board (of the National Academy of Engineering)
AFSC	Air Force Systems Command (deactivated)
ALC	Air Logistics Center
AMRAAM	Advanced Medium-range Air to Air Missile
ATP	Authorization to Proceed
AU	Air University (Maxwell AFB AL)
C4I	Command, Control, Communications, Computing & Intelligence
CAOC-X	Combat Air Operations Center-Experimental
COG	Cyber Operations Group
CONUS	Continental United States
COS	Cyber Operations (or Ops) Squadron
COTS	Commercial Off-The-Shelf (most common); Commercial Orbital Transportation System (specialized space usage)
CW	Cyber Wing
DAB	Defense Authorization Bill (Congressional)
DARPA	Defense Advanced Research Projects Agency
DCS	USAF HQ Deputy Chief of Staff
DIUx	Defense Innovation Unit-Experimental
DoD	Department of Defense
DP	Development Planning
DT&E	Developmental Test & Engineering
FAR	Federal Acquisition Regulation
HMS	His (Her) Majesty's Ship
IA	Information Assurance
ID/IQ	Indefinite Duration/Indefinite Quantity
IPR	Intellectual Property Rights
ISAC	Information Sharing Analysis Center
ISR	Intelligence, Surveillance & Reconnaissance
IT	Information Technology
JCIDS	Joint Capabilities Integration & Development System
JPL	Jet Propulsion Laboratory

LCMC	Life Cycle Management Center
LRIP	Low-rate Initial Production
MVP	Minimum Viable Product
NASA	National Aeronautics and Space Administration
NATO	North Atlantic Treaty Organization
NDAA	National Defense Authorization Act
OT	Other Transactions
OTA	Other Transactions Authority
PEM	Program Element Monitor
PEO	Program Executive Office
PM	Program Manager
POR	Program of Record
PPP	Public -Private Partnership
RCO	Air Force Rapid Capabilities Office
RPA	Remotely Piloted Aircraft
RPO	Rendezvous Proximity Operations
SaaS	Software as a System
SAF/AQ	USAF Office of the Assistant Secretary (Acquisitions)
SAF/AQR	USAF Office of the Assistant Secretary for Science, Technology & Engineering
SBIR	Small Business Innovative Research
TRL	technology readiness level (e.g., TRL 3)
UAV	Unmanned Air Vehicle
UFP	Unit Flyaway Price
USAF	U.S. Air Force
USC	U.S. Code
VC	Venture Capital

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Introduction

In *Development Planning: A Strategic Approach to Future Air Force Capabilities*[1]; the authors laid out a planning process intended to improve U.S. Air Force pre-acquisition technology development. The Development Planning Study highlights the need for broad use of experimentation and experimentation campaigns to inform development planning.

As a follow-on to the development planning study, the U.S. Air Force Office of the Assistant Secretary for Science, Technology and Engineering asked that the Air Force Studies board conduct a workshop and a study on the subject of experimentation campaigns. The workshop was to cast a wide net to capture a diverse set of perspectives on the subject, and the study was to build on information from the workshop to provide more focused and detailed findings and recommendations.

The workshop assembled speakers on four topics. First, the organizing committee sought input on the problem and the opportunity as seen by senior Air Force leaders, with presentations by:

- General Ellen M. Pawlikowski, Commander, Air Force Materiel Command,
- Dr. William A. LaPlante, former Assistant Secretary of the Air Force for Acquisition, and
- Colonel Chuck Ormsby, Military Deputy to the Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering.

Next, information was provided on best practices in experimentation both within and outside the Air Force. To share information on successful experimentation efforts within the Air Force, presentations were made by:

- David E. Hamilton Jr., former Director of the Air Force Rapid Capabilities Office,
- Robert Andrew Kirk Mitchell, former president of Teledyne Ryan Aeronautical, and former VP for Northrop Grumman Aerospace Systems, and
- Chet Wall, Civ., 90th COS, 318th Cyber Ops Group, 24th Air Force.

To share information on successful experimentation efforts outside the Air Force, the organizing committee invited three presenters from industry:

- Brett Lindenfeld, Vice President, Operations, Motiv Space Systems,
- Joel C. Sercel, Founder and Principal Engineer, TransAstra, and
- Arif Janmohamed, Partner, Lightspeed Ventures Partners.

Finally, the workshop focus turned to the identification of possible barriers to experimentation, with presentations by:

[1] National Research Council, 2014, *Development Planning: A Strategic Approach to Future Air Force Capabilities*, The National Academies Press, Washington, D.C.

- Lt. Gen Steve Kwast, Commander and President, Air University,
- Lieutenant General C.D. Moore (retired), Commander, Air Force Life Cycle Management Center, and
- Dr. Camron Gorguinpour, Director of Transformational Innovation for the United States Air Force, Office of the Assistant Secretary of the Air Force for Acquisition.

Together, these presenters offered unique insights on the importance of experimentation, as well as the tremendous challenges of institutionalizing experimentation within the Air Force.

The report summarizes the views expressed by individual workshop participants. While the committee is responsible for the overall quality and accuracy of the report as a record of what transpired at the workshop, the views contained in the report are not necessarily those of all workshop participants, the committee, or the National Academies of Sciences, Engineering, and Medicine.

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The Problem as Seen by Senior Air Force Leaders: The Need for Experimentation

Senior Air Force leaders provided input on problems and opportunities in experimentation campaigns in the innovation cycle, as seen by senior U.S. Air Force (USAF) leaders, with presentations by the following speakers:

- General Ellen M. Pawlikowski, Commander, Air Force Materiel Command (AFMC), presented her perspective to the workshop on her experiences as the Commander of AFMC and as a senior USAF acquisition leader regarding the Air Force's need for experimentation.
- Dr. William A. LaPlante, former Assistant Secretary of the Air Force for Acquisition, presented his remarks to the workshop on "Making Experimentation and Innovation a Part of Air Force Acquisition Culture."
- Colonel Chuck Ormsby, Military Deputy to the Deputy Assistant Secretary of the Air Force for Science, Technology and Engineering, presented remarks to the workshop on behalf Dr. David Walker, Deputy Assistant Secretary of the Air Force for Science, Technology, and Engineering.

While the speakers presented to the workshop separately, the comments they provided lend themselves to a single summary.

COMMON THEMES

Overall, the speakers commented that properly executed experimentation campaigns can be the key to innovation in the Air Force and cited a rich history of success in this area. Unfortunately, as indicated by the speakers, the proper use of experimentation campaigns is too rare in today's Air Force. They stressed that experimentation has been well studied and what is needed is help understanding how experimentation campaigns can be institutionalized and made a dynamic part of developmental planning efforts in today's Air Force.

- *Organization.* The speakers commented on the difficulty of institutionalizing innovation in a large organization such as the Air Force and avoiding the problem of experimentation campaigns falling in the "white space" between organizational units that have other primary objectives and outcomes to produce.
- *Culture and environment.* The speakers commented on the need for a culture that is tolerant of risk, embodies the idea of failing fast before investing big, and can distinguish between a failed experiment (an experiment poorly executed) and a disappointing outcome from a well-run experiment.
- *Leadership.* The speakers commented on the need to institutionalize experimentation rather than rely on "personality driven" experimentation that disappears as soon as the leader leaves.

The speakers also commented on the critical need for leadership support for the successful execution of experimentation campaigns.

- *Required capabilities.* The speakers commented on the need to ensure that knowledge of best practices for conducting experimentation campaigns is widespread and that the basic “tools of experimentation” are in place where they can be readily accessed by teams of planners, technologists, and operators.
- *Sustainability*. The speakers commented on the need to ensure that successful experimentation efforts do not languish and are sustained and employed over time.

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Air Force Practices Versus Best Practices

EXPERIMENTATION INSIDE THE AIR FORCE

WHAT THE RAPID CAPABILITIES OFFICE DOES THAT MORE OF THE AIR FORCE SHOULD CONSIDER DOING

David Hamilton
CEO at Eagle Aerie, Inc., and
Former Director of the Rapid Capabilities Office

The Rapid Capabilities Office Overview

The Rapid Capabilities Office (RCO) originated with former Air Force Chief of Staff General John Jumper and former Secretary of the Air Force James Roche to expedite the testing, evaluation, and fielding of select combat support and weapons systems for warfighters. At the time, Jumper and Roche were frustrated with the inability of the existing acquisition system to keep up with the demands of the warfighter and felt that the Air Force had lost something of its ability to develop and deploy new systems. The RCO was designed around a "return to the future" concept that would attempt to apply older methods from previous programs, such as the F-117 Nighthawk, to the modern acquisition needs of the warfighter. The RCO reports directly to senior leadership and maintains the largest classified fund and, at the same time, with the smallest staff of any Air Force Program Executive Office (PEO).

The RCO faced resistance from its inception. Several existing organizations in the Research & Development and Acquisition system opposed the organization because of the different procedures and processes they used. Bureaucratic "road blocks" were a regular occurrence. As a result, the RCO needed to be strategic with regard to how it dealt with other acquisition organizations; thus, every RCO project faced business challenges as well as technical ones.

Despite the perception that the current rules and regulations are too restrictive, the RCO found that they had quite a bit of leeway, as long as they had senior leadership support. The RCO leadership met regularly with Air Force senior leadership and monthly with the Secretary of Defense. The connection with top leadership was the key to the RCO's success. The RCO avoided bureaucratic "roadblocks" by changing the terminology used by the RCO; involving a variety of different specialty personnel, including lawyers, contracting officers, financial personnel, and so on; and ensuring effective communication with other acquisition groups. When the RCO encountered challenges, it could call upon top level support to achieve its goals.

The RCO's staff, in addition to being diverse in professional background and expertise, also consisted of handpicked personnel who demonstrated innovative thinking and risk taking. The RCO provided them with an environment conducive to innovation and risk taking. Additionally, the environment set up by the RCO and its connection to the warfighter *changed the perception* of system and weapons development processes. The connection to the warfighter and the necessity to meet the warfighter's constantly changing needs greatly enhanced morale and motivation in the RCO and drove decision making and planning; the needs of the warfighter set the "milestone" schedule and pace of each project.

Washington, D.C., Air Defense System Experimentation Case Study

The RCO was tasked with setting up an enhanced air defense system for Washington, D.C., to defend against a possible terrorist attack. The RCO settled on a plan to deploy a ground-based AMRAAM (Advanced Medium-range Air to Air Missile) system. Air Force leadership agreed and wanted the system in place before the next inauguration. The RCO developed a plan to purchase, integrate, and deploy a Swedish ground launch system, using a Spanish communications configuration, employing existing AMRAAMs, and built to be air launched. The ground launch system would also need to integrate with existing radars and other defense systems. The RCO's proposal was met with skepticism by other service branches and acquisition groups. Nevertheless, the tests of the system at Eglin Air Force Base were successful. The system was rapidly integrated with existing defense infrastructure and deployed around the capital. The combination of a critical need, senior leadership support, and a campaign of experimentation led to the rapid and successful deployment of an effective new air defense system in and around the capital.

GLOBAL HAWK: ADVANCE CONCEPT TECHNOLOGY DEMONSTRATION (ACTD) CASE STUDY ON SUCCESSES AND OBSTACLES

Robert Mitchell
Consultant, Former Vice President for Northrop Grumman Aerospace Systems

Background

Global Hawk, initially called Tier II+, is a high-altitude, long-endurance, unmanned system comprising an air vehicle with an array of intelligence, surveillance, and reconnaissance (ISR) sensors, a ground-control system, and communications architecture capable of command and control and sensor data dissemination world-wide. Global Hawk is now a well-established U.S. Air Force (USAF) program of record. Other variants include the U.S. Navy Triton, and there are German and North Atlantic Treaty Organization (NATO) variants as well as several systems under consideration by other nations.

Advanced Concept Technology Demonstration

What is truly unique about Tier II+ is the origin of the program as a Defense Advanced Research Projects Agency (DARPA) Advanced Concept Technology Demonstration (ACTD), developed in accordance with Section 845, "Other Transactions Authority." The language included in the 1994 Defense Authorization Bill stated the following:

> "Other Transactions" for prototype projects are acquisition instruments that generally are not subject to the federal laws and regulations governing procurement contracts. As such, they are not required to comply with the Federal Acquisition Regulation (FAR), its supplements, or laws that are limited in applicability to procurement contracts.

Aside from the technology challenge associated with such a system, the program was also an experiment in how to change the way we do business programmatically and technically; hence, the results are relevant for consideration by this panel.

Program Structure

Contracting Approach

DARPA leadership embraced the other transactions language, and the Tier II+ contract, awarded to Teledyne Ryan Aeronautical in mid-1995, was described as a “new way of doing business.” The contracting approach was unique; the initial one-page agreement asked for the best capability within a \$10 million (\$1994) average Unit Flyaway Price (UFP) for vehicles 11 through 20. The agreement, signed by Mr. Larry Lynn, head of DARPA, and Mr. Robert A.K. Mitchell, president and CEO of Teledyne Ryan Aeronautical, also allowed that either party could “walk” at any time during development. The final contract included a performance specification, but all of the numbers were expressed as goals that could be traded, as necessary, to stay within the hard \$10 million UFP requirement.

Program Management

Mr. Lynn established a policy of insight versus oversight, and Mr. Mitchell restructured Ryan Aeronautical to create a new commercial Strategic Business Unit. Leadership and staffing on both sides was highly selective, focused on engineering capability, a willingness to work in a close knit government/contractor environment with a joint commitment to succeed. The program was run along an extremely aggressive schedule with tight control of requirements, disciplined configuration control, and an accurate understanding of program cost and schedule status. Critical decisions were made quickly, issues were resolved expeditiously, if necessary, by the creation of task teams and action centers. The entire organization was collaborative with little distinction between contractor and government. The program managers and every integrated product team worked together in the same physical locations.Neither party ever wanted to exercise their right to “walk.”

Technical Performance

There are many benefits for an ISR system that can operate at high altitude for long endurance. At 65,000 feet, the Tier II+ aircraft would fly in relatively benign atmospheric conditions and well above most convective weather. Flights above 60,000 feet are also above the U.S. Class A-controlled airspace and above all other traffic except for similar high-altitude aircraft such as the U-2, and from 65,000 feet, the sensors can cover a large geographical area. However, the design of such an aircraft is extremely challenging. To be successful, the Tier II+ unmanned air vehicle (UAV) had to be autonomous from take-off through landing, the sensors were required to provide coverage over large geographical areas to high resolution, and the communications architecture had to enable reliable command and control as well as wide-band sensor data transmission and downlink from half way around the globe. And, in many respects, the operational environment for a high-altitude, long-endurance UAV is comparable to the spacecraft environment—power is limited, temperatures are extreme, and thermal management requires a complex balance of heat absorption and rejection through radiation. Fault tolerance, failure identification, very high system reliability and the associated redundancy management system are absolutely critical to success. Aerodynamically, the aircraft had to operate in a narrow speed and altitude range bounded by stall limit and mach limit (often called the coffin corner). To achieve these capabilities, a four-part strategy of (1) experience, (2) off the shelf, (3) early test, and (4) margin for growth was adopted. All of the government representatives were experts. Ryan had decades of UAV experience, as had the other team members. All critical subsystems were selected from existing programs, and every aspect of the system was tested to failure, including the vehicle management system. A software stress-testing approach was developed at the program Authorization to Proceed (ATP) and continued up to first flight. By that time, every imaginable failure and the system response had been simulated or tested; there was absolutely no tolerance for a failure in flight. The inevitable growth in size, weight, power, and software was planned for and was accommodated within the margins, so there was no need for any major weight reduction or other recovery initiatives. Moreover, the $10 million UFP was firm, so everything had to "buy its way" onto the aircraft; there were no capabilities that did not contribute to military utility.

Results

The results of the Tier II Plus development program are worth noting. From a program management standpoint, all of the critical decisions were already made by mutual agreement, so program reviews were short and only a means of formally documenting the design progress. Every element of the system was tested to the extent there were no surprises. The schedule was 7/24 with no breaks (including holidays). Roll-out occurred at month 21 and the first vehicle was shipped to Edwards Air Force Base and was ready to fly in 24 months, effectively from a clean sheet start. At that time, however, a parallel program (Tier III Minus/Dark Star) had suffered a catastrophic loss during take-off, so the Tier II+ program went into a holding mode while all of the systems and software were re-checked and re-tested, delaying the first flight by 9 months. There were no significant changes made to the system, and the first flight actually occurred in February 1998, 33 months from ATP. Cost performance was also notable, and with the exception of some growth in the sensor area, the entire development was conducted within budget. Finally, the $10 million UFP would have been achieved except for congressionally mandated funding and procurement constraints.

Summary and Conclusions

The Tier II+ ACTD was a major success, due to the 1994 Defense Authorization Bill Section 845, "Other Transactions Authority," and the ensuing commitment by both government and industry to work in a different and highly innovative way. The contracting approach was innovative, the program organization was innovative, and the design itself was innovative. The entire program could be described as a highly successful and innovative technology and organizational experiment.

Quick Reaction Effort to Provide an Air-Enabled Cyber Capability

Chet Wall
90th COS Technical Advisor, 24th AF, 688th CW, 318th COG

On January 27, 2016, Mr. Chet Wall presented his remarks to workshop on the 24th Air Force's "Quick Reaction Effort to provide an Air-enabled Cyber Capability."

EXPERIMENTATION OUTSIDE THE AIR FORCE

MOTIV SPACE SYSTEMS—A "NEW SPACE" COMPANY

Brett Lindenfeld
Vice President of Operations, Motiv Space Systems

Innovation Lessons from a Startup

Motiv Space Systems was founded by three colleagues in 2014. We had previously worked together at another small business for several years, and before that had first started work at the Jet Propulsion Laboratory (JPL). Our previous small company had been acquired by a much larger aerospace and defense company. Ultimately, it became clear that there were still significant opportunities for the unique qualities a small business brings to the market place. Thus, despite the risks involved in launching a startup, we felt compelled to start anew and Motiv was born. While there was risk, we recognized the potential for value creation for ourselves and our potential customers. There was also the opportunity to control our own destiny and to work with people that we enjoyed working with.

How We Managed Risk

At the outset, our approach to managing risk in a startup was to develop dual-use technology and products that would be developed through government contracts but could eventually find uses in commercial market segments. This approach would help to buffer the ups and downs in the government procurement cycle. We also adopted a broad systems engineering view and pursued opportunities in the motion control arena (broadly, "anything that moves") so that we would not pigeon-hole ourselves when we did not know what would be successful. We were opportunistic and experimented with many ideas—for example, acquiring a license from Caltech technology that had been developed by one of our first employees when they were at NASA JPL. As a small company, we were nimble enough to decide and execute the license in a matter of weeks, when it could easily have taken more than a year at a larger, more bureaucratic organization.

Following these key decisions, we continued to develop a platform based on our skill sets and strove to identify how we could apply what we knew while opportunistically solving customer challenges. With each win, we gained recognition for our work to the point we competitively won a significant robotic element on the Mars 2020 Rover mission. Our work has focused on developing platform solutions—in robotics, in sensor systems, in robotic manipulators (robotic arms), and components and subsystems for the same—but we also began to experiment and integrate our solutions across these platforms to create novel versatile solutions such as an advanced Rendezvous Proximity Operations (RPO) sensor suite for a technology development program. Our view was that while some of these may be niche solutions, they could expand to promising high-value opportunities that we would not know unless we experimented with new ideas and put them in front of customers.

Key Factors for Motiv's Success

Our ongoing success story could be summarized in terms of a few critical lessons.

- *Pursue incremental and iterative development*. We actively experimented with different ideas and iterated until we got strong positive feedback in terms of contract wins.

- *Be opportunistic*. We did not limit ourselves to building only products that we believed the customer would want, but rather based our product and service offerings on what the customer was telling us. If we did not have a particular capability, we would license it or build smart partnerships with other companies to deliver a solution that had clear value.
- *Stay agile*. As a small business, we knew that we could not afford to have too many people onboard and not be able to support them as contract dollars fluctuated. Instead, we have maintained and continue to modestly grow a small staff of about 15 people, but we have access to flexible staffing through our team of subcontractors and consultants so that we have, effectively, a team of about 23 full-time employees. However, our relationships with our consultants, crucially, is not based on just economics but also on trust and mutual value. The consultants are treated just like full-time employees and fully integrated into projects but also allowed conveniences such as working remotely.

Many of these lessons have been drawn from the practices at the original Skunkworks, where a blindingly fast iterative development process, undistracted by bureaucracy, was the norm. Through such practices, Motiv has worked to value all of its employees as trusted partners and to respect them as talented, productive individuals. The result has been year-over-year revenue growth of 100 percent.

How Government Could Engage Small Business Better (for Mutual Benefit)

Our company has worked with different parts of the U.S. government and has observed that more could be done to efficiently harness the power, talent, and creativity within small businesses that want to do business with the government. For example, contracting processes could be simplified and shortened so that the focus is on unleashing the creativity of these companies rather than in zealously avoiding contracting mistakes. In our opinion, the government would be better off failing (making contracting mistakes) in some cases than expending the money and time to prevent failure with 100 percent certainty. By focusing on the contract alone and not trusting the power of the individuals and teams, a lot of value is wasted. Instead, the government should expand programs like the SBIRs (Small Business Innovative Research), which are good models of contracting approaches that are efficient and simplified and focus on trusting, empowering, and supporting the contractors, just as we do our employee-partners.

DISRUPTIVE INNOVATION: WHAT IT IS AND WHY IT IS IMPORTANT

TAXONOMY AND LANGUAGE OF INNOVATION

Joel Sercel
Founder and Principal Engineer, Trans Astra

To innovate successfully, an organization must first distinguish between the different types of innovation, commensurate with its goals and limitations, before it can decide how to foster such innovation. For example, the innovation that sustains the current order and status quo (*sustaining innovation*) is often of two varieties—*evolutionary innovation* improves a product in an existing market in ways that customers are expecting (e.g., fuel injection system versus carburetor), while *revolutionary innovation* (also called discontinuous or radical innovation) is innovation that is unexpected but nevertheless does not destroy existing markets (e.g., automobile versus horse-drawn carriages), both providing similar solutions for human transportation.[1]

On the other hand, a *disruptive innovation* is an innovation that creates a new market and value network and eventually disrupts an existing market and value network, displacing established market leaders and alliances (e.g., the Ford Model T and mass production of lower-priced automobiles changed the transportation industry).[2] Disruptive innovation may require an entirely different set of operating conditions and mindset than sustaining innovation, thereby creating near-term challenges to both the disrupted and the disrupter. The disruption, or up-ending, of the current ecosystem of a business is almost never embraced by "market insiders," and the disrupters present difficulty initially in terms of lower gross margins, smaller target markets, and poor appeal of the disruptive product to customers, as measured by existing performance metrics. Only agile organizations that have the willingness to adapt have any chance of surviving the attack of the disrupters.

Some Historical Perspectives

Both sustaining and disruptive innovation are created by concerted efforts in experimentation, where the results may be unexpected success or failures but the learning paves the way for future success. A case in point is the *HMS Mary Rose*, one of the first British naval vessels to be fitted with broadside cannons and launched in 1512. It is considered to be a transitional point in naval warfare because coordinated volleys from all the guns on one side of a ship were possible for the first time in history. However, the ship was eventually sunk in battle, supposedly because its gun ports were left open when the ship was turning. Should the "broadside guns" concept be considered a failure? On the contrary, while the experiment was a failure, lessons from the experiment paved the way for major future improvements in naval warfare with lasting impact.

But why is it important to distinguish between sustaining and disruptive innovation? The reason is that efforts to focus on and foster sustaining innovation can actually stand in the way of and delay the significant value creation from disruptive innovation. For example, sustaining innovation and traditional thinking of naval staff continued to advance sail-powered naval vessels well into the 19th century, when in fact the future lay in steam-powered naval craft (e.g., *HMS Dreadnought*, 1906), which led to the disruption of traditional naval power.

Innovation Through Public-Private Partnerships: Some Historical Lessons

An important model for creating disruptive innovation is the public-private partnership (PPP) between the U.S. government and industry that launched the great American railroad and accelerated America to superpower status. While it can be argued that the companies that benefited received unfair advantages from the government, the end result was that the government had access to unprecedented transportation infrastructure that quickly accelerated the country to economic superpower status.

A similar model for PPP-driven innovation is currently taking shape in the commercial space industry under the auspices of NASA's commercial orbital transportation services (COTS) program with existing and new entrants like Orbital ATK and Space X. While the United States dominated the commercial space launch market in 1980, with 100 percent market share, U.S. market share had vanished by 2002, simply because space launch costs were unaffordable to anyone but the U.S. government. With the launch of the COTS program, the United States has once again dominated the industry with 60 percent market share as of 2014. The reason may simply be that the government gave U.S. companies the

[1] Clayton Christensen, "The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail," Harvard Business School Press, Boston, 1997.

[2] Ibid.

freedom to exploit all commercial opportunities beyond its government contracts, and that allowed the companies to develop superior cost models that also created savings for the U.S. government. In addition to giving the contractors the "commercial upside," some specific factors that drove the success of this new model were the following: fixed price contracts, a simple set of requirements, measurable objectives, competition, the customer's ability and willingness to properly monitor technical progress, the customer's ability to disengage from contractors when work performance did not meet objectives, and follow-on contracts from the government that sustained these companies.

Another PPP may be in the making for near- and deep-space exploration technology, with opportunities to create lower-cost space transportation infrastructure by private companies so that the materials needed to power deep-space craft may actually be sourced not on Earth but in space itself. Companies like Trans Astra, for example, are endeavoring to mine asteroids for water and carbon dioxide, some of the key ingredients of rocket propellants. Opening up opportunities and providing sustained support to new entrants with fresh thinking can in fact lead to a new set of disruptive capabilities in space, with potential for unprecedented value in many areas that are yet unimaginable.

Some Rules for Successful Innovation

Several key characteristics are critical to an organization's ability to successfully create innovation, whether sustaining or disruptive, with most innovative organizations having a mix of both types of innovation.

1. The mission has to be highly focused.
2. The organization has to be flat, and lines of authority have to be clear (i.e., everyone knows who the boss is), so that decision making is rapid.
3. Innovators have to be protected by senior leadership and relieved of distracting staff work, such as excessive documentation.
4. The leader has to be an "innovator" in mindset, or else the other innovators will not follow him/her.
5. The organization has to have the ability to hire (and fire) readily, based on a meritocracy, so that the best talent can be brought in and inserted into the right positions.
6. The people should have the skills to communicate the new paradigm.
7. The leadership has to encourage a culture of mission focus, not organizational focus, with incentives based on long-term rather than short-term performance.

Final Thoughts

Disruptive innovation cannot be a luxury for the USAF enterprise, because if it focuses on sustaining innovation alone, it runs the risk of being disrupted by a competitor (in this case, a nation state). Disruptive innovation creates new paradigms that give unfair advantage to the disrupter by providing new and different ways of thinking. Such disruptive innovation requires safe spaces for innovators. Fostering a culture that embraces experimentation and innovation can create dividends in terms of disruptive potential, setting the USAF on a path to re-gaining its air dominance.

INNOVATION MODELS FROM THE VENTURE CAPITAL WORLD

LESSONS FROM VENTURE CAPITAL INDUSTRY: HOW INNOVATION AND RISK ARE MANAGED

Arif Janmohamed
Partner, Lightspeed Venture Partners

Venture capital (VC) firms like Lightspeed from Silicon Valley have spearheaded several waves of disruptive changes in the technology industry, from enterprise infrastructure and mobile technologies to software-as-a-service (SaaS), through their judicious investments in and astute management of numerous startup companies, particularly in Silicon Valley.

While Silicon Valley startups are very different from large governmental organizations like the USAF enterprise, many of the lessons from the VC model may, nevertheless, be relevant to the Air Force's experimentation campaign with regard to identifying and investing in the teams that work together, disrupt, innovate, and iterate toward success. In particular, the USAF could learn about how to think about innovation, how to organize teams to foster innovation, and how to cost-effectively take on large, expensive problems.

Recognize and Exploit Dramatic Innovation

Lightspeed Venture Partners is a global VC firm with a relatively small team of 18 investment professionals managing over $4 billion in capital. The funds are invested over a 10-year investment horizon, deployed incrementally as needed to grow about 40 portfolio companies at any given time. Lightspeed typically invests in companies with product still at an early conceptual stage, or before customers have committed, which corresponds in Department of Defense (DoD) parlance to a technology readiness level (TRL) of 4 (TRL-4). The firm looks for companies with good "product-to-market fit" (i.e., customers want this product) and with the potential for large breakthroughs. Lightspeed's partners then help the companies to mitigate technical risk (which is to be expected in potentially large breakthroughs) and/or market risk (i.e., Is there some indication that customers really want this?). The firm then follows a phased investment strategy, initially investing limited capital to address the problem cheaply and early (about $1 million to $10 million in the first 12-18 months). If the key questions are answered (and risk reduced), the company follows through on the funding commitment, to enable the creation of a "generally available" product, the build-up of the team, and/or the capture of beta customers ($5 million to $15 million over the next 18-24 months). Thus, Lightspeed has helped new companies to broadly disrupt the business of enterprise information technology—storage, servers, networking, cloud computing services, big data, SaaS, and so on—not only through creation of new business models, but also by leveraging the newest infrastructure and tools (e.g., cloud resources to build and test code) to get to a minimum viable product (MVP) sooner and to build the companies faster and cheaper.

Economics of the VC Model

The economics of the venture capital model are somewhat skewed, with 75 percent of the profits accruing to only the top 25 percent of the VC firms—that is, the gap between the best and the rest is large and is driven by companies with true disruptive potential. Investments are typically made in the first 2 to 4 years of the fund's life and they are "harvested" in the next 6 years. The firm undertakes an intensive vetting process with a final selection rate of only 0.4 percent

The early-stage startup portfolio will have failures, but also has the potential to yield a few home runs that will more than pay for the rest. Typically, each early-stage investment fund will have some companies that will eventually go out of business (10-30 percent mortality rate); some that will do slightly better than break-even (returning 2-4 times the original investment within the 5- to 10-year investment horizon); and a handful that will significantly outperform, going public or being acquired at extremely high valuations (returning 10-30 times the original investment). Of course, it is very difficult to identify the winners in advance. So, rather than holding back on the number of investments and presuming some unrealistic confidence in being able to pick winners, the firm chooses to invest in a sufficiently large (yet manageable) number of companies to increase the odds of a home run, with clear "expectations of some failure" built into the model. This is the experimentation model in VC investing, supplemented by active company oversight and astute picking of teams with the highest potential for (and track record of) success.

The VC Process

The VC partnerships are typically small teams that are well-aligned to the common goal of fund profitability. Therefore, they collaboratively make decisions yet compete for limited investment resources and exert most of their effort to find, justify, and make the big bets, because success requires making and winning the big bets. The partners therefore winnow more than 5,000 incoming investment leads to about 500, and then about 50 are sponsored by the individual partners and vetted by the firm as whole. With partners holding each other accountable, about 20 investments are made per year. In this portfolio view, the firm seeks to diversify investments but still holds out for the biggest and boldest opportunities in search of the home runs. With the recognition that risk and reward go together, the firm actively pursues risk reduction after the seed investment. It gets the portfolio companies to identify and reduce key technical risk, and to get customer feedback to see if the customer really wants the product.

Alternate VC Models

Alternate VC models include the corporate venture capital model practiced by larger enterprises seeking to bring in external innovation to supplement their existing portfolio of goods and services. Analysis of investment value may not be as rigorous as at the pure VC firm, but the lesser rigor is offset by other strategic drivers such as reseller or original equipment manufacturer opportunity, "option" value (to have the right but not the obligation to acquire the company at a lower cost in the future), or even learning value (to learn about new markets as they evolve).

Characteristics of Winning Teams

Talent value in the team is perhaps most crucial. VC firms seek out the "10Xers"—that is, individuals whose output is 10 times that of their average peer. Examples include team founders who have made disproportionate contributions elsewhere. VC firms look for or assemble team members who have generally worked together successfully. They focus on teams of "doers"; no time for analysis/paralysis. Teams have to be in agreement, based on trust and honesty, and decision making in the best teams is typically driven by the leadership that is a "cult of one person."

Freedom to Succeed Follows Freedom to Fail

VC firms encourage their portfolio companies to focus on speed, execution, agility, a willingness to risk failure, and succeeding by learning from failures. For example, the well-known tenets of Facebook (and by extension, Silicon Valley) are "Move fast and break things," "Done is better than good," and

"What would you do if you weren't afraid to fail?" The success of Facebook and others has encouraged a mindset of experimentation: put something out there (in front of a customer) and then iterate, instead of iterating to perfection in the absence of feedback. VC firms seek to foster a culture in which one asks, "If risk is expected and failure is accepted, what can you do?" and embrace entrepreneurs with bold visions who will be willing to pivot if their original vision is wrong. The mantra of the valley is "Build, measure, learn" (ref. Eric Reiss, *The Lean Startup*), "and if necessary, pivot, but pivot early and without fear." Everyone is made to understand that there will be no serious repercussion for failure, provided one is honest in his/her assessment of opportunity and risk. Most importantly, the VCs emphasize that the opportunity cost of time is far greater than opportunity cost of capital.

Some Recommendations

- *People.* Build small, nimble, empowered teams that can pivot quickly. Find 10Xers: extraordinary talent requires extraordinary results.
- *Decision making.* Avoid bureaucracy or analysis/paralysis in the decision-making process. Build, measure, and then honestly assess. If something is not working, cut bait early.
- *Managing risk.* Innovation is, after all, a set of calculated risks. Teams should have bold visions and plan to disrupt big markets, but they should parse these big challenges into smaller manageable pieces and take incremental steps. The focus should be first on a MVP, to avoid over-committing early. Failure is ok and should be encouraged, but teams should fail fast. Teams should also iterate rapidly and constantly repeat the cycle of "measure, test, and repeat." For government investments, playing it safe may save taxpayer money, but at the risk of losing time.
- *Celebrating success.* Teams should celebrate incremental wins.

Great Innovation Examples and Their Key Features

Small nimble teams building iteratively towards a large bold vision. Apple's iPhone design team initially had only 20 people and 100 at its peak. Amazon's initial Cloud team had only 14 people but quietly created a $7 billion business.

4

Better Experimentation in the Air Force: Barriers and Levers

MAKING EXPERIMENTATION PART OF THE CULTURE

Lt. Gen. Steven Kwast
Commander and President, Air University, Maxwell Air Force Base

On January 28, 2016, Lt. Gen. Kwast presented his remarks to workshop on "Making Experimentation a Part of the Culture in Air Force Developments."

LIFE CYCLE MANAGEMENT CENTER PERSPECTIVES ON BARRIERS

Lt. Gen. C.D. Moore (Ret.)
Executive Vice President, Dayton Aerospace, Former Commander Air Force Life Cycle Management Center

With the standup of the Air Force Life Cycle Management Center (AFLCMC) in 2012, nearly all non-space acquisition and product support responsibilities within the Air Force were consolidated into a single organization. In hindsight, this initiative had both positive and negative implications on the culture of experimentation within the Air Force's acquisition and product support community.

Under this reorganization, AFLCMC took on the consolidated responsibility of more than 3,000 programs managed at 9 large continental United States locations and more than 70 worldwide sites. In order to build a consistent and more effective way of doing business across these many locations, AFLCMC embraced three key principles: speed with discipline, trust and confidence, and unity of purpose. In addition, AFLCMC established several key objectives to guide the stand-up and unifying actions of the organization. These objectives helped build common ways of doing business across the organization and facilitated breaking down us-versus-them attitudes, what was eventually embraced as a "geo-agnostic" operating model. The two AFLCMC objectives with most direct relevance to organizational experimentation were

1. Launch high confidence sustainable programs, and
2. Standardize and continuously improve center processes.

The focus on process discipline produced both the desired effects as well as some unintended consequences, particularly on previous experimentation tendencies within certain programs of record (POR) across the center. With program offices working full time and resource stressed to deliver specific, approved requirements while operating under greater pressure to employ process discipline, experimentation has become less likely to "fit" within a cost/schedule/performance POR framework. On the other hand, the focus on launching high confidence programs helped build a re-energized developmental planning (DP) process intended to facilitate a renewed culture of experimentation. This initiative had some early success and has proven to be a step in the right direction with respect to experimentation.

With these two objectives in mind, there were several challenges that needed to be overcome. For one, a push for process standardization and greater process discipline, accompanied by expanded layers of business oversight, has in hindsight tended to stymie process tailoring in support of faster-to-field experimentation within PORs. In addition, the push for "owning the technical baseline" has energized a more rigorous system engineering approach and greater U.S. government involvement in the design review process. Applying this enhanced rigor too broadly and deeply seems to have caused a deleterious effect on experimentation within PORs where innovation and "speed to field" were historically part of the culture.

With the focus on launching high confidence programs, the center worked to re-grow a DP process with targeted experimentation using enhanced analytical live virtual constructive tools and greater collaboration across the center's wide (i.e., aircraft, munitions, C4I) program responsibilities. Although a step in the right direction, limited resources dedicated to DP has restricted the number of concepts that could be evaluated in a robust experimentation environment and, subsequently, constrained the ability to evaluate new, innovative warfighting approaches. The DP chokepoint is dedicated resources—manpower and money.

With this backdrop, experimentation barriers could be addressed with some recommended actions. For starters, there should be a push for and support of more process tailoring to facilitate experimentation within PORs. The responsibility and authority to approve this process tailoring should be as low as possible to allow prudent risk taking at the appropriate level (i.e., program executive office, program manager). Furthermore, "speed" should be equally as important and balanced with "discipline" in program execution, particularly where experimentation has the potential of introducing significant new capabilities to the field. In addition to process tailoring within PORs, experimentation would be enhanced with an expansion of dedicated DP capability through greater resource application (manpower and funds), preferably targeted at functional/technical teams (i.e., SIMAF, capability planning teams, product support enterprise initiatives) dedicated to experimentation in partnership with industry, laboratories, and program offices. These dedicated execution teams are optimally situated and motivated to bridge between science and technology and PORs, and best positioned to take advantage of rapidly evolving analytical tools to demonstrate the value of innovative concepts via experimentation. Finally, with greater resources dedicated to the DP process, there would be more opportunities to pull in ideas from industry, both large and small, as well as from U.S. government laboratories. In taking these steps, the Air Force would be better positioned to enhance the role of experimentation in the innovation cycle.

PERSPECTIVE ON ACQUISITION BARRIERS TO INNOVATION AND EXPERIMENTATION

Dr. Camron Gorguinpour
Director of Transformational Innovation to the Assistant Secretary of the Air Force for Acquisitions (SAF/AQ)

The job of the Transformational Innovation office for the Air Force (transform.af.mil) is to identify, experiment with, and ultimately implement new ideas for how the Air Force (AF) can do business with contractors to buy products and services. Acquisitions include not only cutting-edge technologies but also legacy systems. The current process is widely seen as broken. We are trying to break down barriers to acquisition efficiency that have been placed with the good intention of protecting the government's interest but, unfortunately, thwart better end results. Our office works on a variety of projects, both experimentation- and non-experimentation-related.

Cultural Barriers to Innovation: Fear of Failure

Innovators in Silicon Valley and elsewhere often say that innovating requires a fearless acceptance of failure. However, there is an intense fear of failure within DoD. No one wants to see AF leadership dragged before Congress after a major failure. So, it is not unreasonable that fear of failure can be debilitating. There is a rich "oral history" of failed acquisition reform within DoD. You are warned of failure: "I tried that 15 years ago." You ask, "What happened? What did you try? Why didn't it work?," but there usually isn't a satisfactory reply. What we need is more rigor to explain failings. Every experimentation effort, including ours in acquisition reform has failures. Some of our failures include not getting to meaningful acquisition milestones fast enough, but our record of failures is limited because we are still a new organization.

Barriers and Work-Arounds to Sourcing External Innovation: Special Contracting Vehicles

DoD has launched an initiative to source innovation from Silicon Valley and has created Defense Innovation Unit-Experimental (DIUx). It is not that the AF cannot identify or access innovation wherever it is—it is not a "geographic problem"—but the AF lacks efficient business processes to acquire these innovations. There are other contracting vehicles, such as In-Q-Tel (for innovations in the Central Intelligence Agency [CIA]) and On Point (for the U.S. Army). These are essentially government-backed venture capital firms that do good work. However, these have not created AF projects. Our office tried to create a comparable entity for the AF, but eventually decided to leverage the existing entities. In fact, the AF has all the constructs it needs to change its acquisition system to efficiently source innovation. Separate from how the AF might acquire innovative technology through In-Q-Tel, and others, is the question of whether the innovations are likely to benefit the AF and offer a strategic return on investment beyond potential financial gain.

The challenge is to engage the "non-traditional defense contractors" who do not normally do business with DoD because it is too difficult—long timelines to get to funding, lengthy application process to compete for business, restrictive intellectual property rules, security rules, auditing, and international trade restrictions. One solution we are experimenting with is the Other Transaction Authority (OTA). In fact, In-Q-Tel and On Point were created using Other Transactions (OTs). These can be used for any type of research, development, test, and engineering activity, up to low-rate initial production (LRIP). DoD has the legal right to enter into what is explicitly not a contract or agreement but just a transaction with a company, starting with a clean slate and drawing up a circumstance-specific transaction. Standard Federal Acquisition Regulations (FAR) do not apply. There are some restrictions with respect to type of company that can participate, but the rules are flexible by design. We just need to use them. One can execute a project from TRL-1 through low-rate initial production all under one OT, and the OT also becomes a sole-source justification triggered by meeting technical and cost milestones. While OTs have been discouraged since 2000, there is currently little disincentive to use of OT. Most people do not, however, understand the basic rules to structure OTs. In fact, the recent award of RD-180 replacement leveraged OTs because the purchase was for a specific purpose—to achieve an industry cost-share.

There are many obstacles to acquiring innovation: contracting, financial management, legal—it takes but one person to kill a project. A pro-active contracting officer, especially a head of contracting, is like gold. Congress is expanding authority for OTs in the 2016 National Defense Authorization Act (NDAA). The authority has been made permanent, and the limit for transactions has been raised from $100 million to $250 million without Office of the Secretary of Defense (OSD) approval; higher amounts require OSD approval. The transition from OT to production contract has also been made more flexible. In our OT, we trimmed the intellectual property clauses to resemble more compact commercial Intellectual Property Rights (IPR) contracts. Government auditing rules have vanished because they do not apply to the non-traditional OTs. We will be championing more use of OTs in the coming year and expanding the contract vehicle that we created to use it. Another even more esoteric authority, which is seldom used, is experimentation authority 10 U.S.C. 2373 for the purchase of equipment for experimental purposes in certain broad subject areas, including aerospace, space, transportation, energy, signals, etc. Our general counsel will advise on its applicability and any restrictions. Another authority, NDAA Section 804, also waives all sorts of Joint Capabilities Integration and Development System and other requirements at the front end, for rapid delivery, and for prototyping and experimentation. There is further opportunity to make additional changes in NDAA 2017, as needed.

Lack of use of these authorities may stem from general management's aversion to risk of potentially being reprimanded for "bending the rules," if the project fails. However, current AF leadership is strongly supportive of these types of contracting improvements. Early career professionals are also enthusiastic, but middle management is risk averse. With this open vehicle, we can make a legitimate pitch and honestly demonstrate that the revised process expands competition, lowers cost, and gets acquisition done in 3 weeks instead of 2 years. The vast majority of people in government are well-intentioned folks, trained to accept as a given that the process, as it is, is working as intended, which is to limit risk and get things done and to make incremental progress. Other things sound nice and exciting until you try to do them, and then they're prone to failure; that's where people stop paying attention. So we have got to create a space where people feel comfortable trying new things, and we have had some success in that.

Strategies to Communicate/Expand AF "Open Systems" Approach

"Open architecture" is the right approach to innovation development. This may not apply to legacy or unique systems, but we believe that more than 50 percent of AF programs should move toward some form of open architecture, to avoid lock-in to single vendor and potentially high cost, limited technical innovation, and delays in innovation capability reaching the warfighter. However, if the standard contracting process takes 2 years and the Information Assurance (IA) process another 2 years, the value of open architecture is wiped out. We, therefore, combined an Army acquisition model called the "Other Transaction Consortium," which has been in use for over a decade. The Army Contracting Command B issues a transaction to a consortium instead of an individual company, with the consortium evolving in company constituents over time. A company can join by completing a one-page online application, a $500 joining fee, and can then view and respond to government requirements, if it chooses. The Army's process requires a white paper as well, followed by a down-selection, proposal, and award. The entire process from white paper to award takes on average less than 2 months.

We then combined another acquisition model called the Plug Fest, an industry event hosted by the Office of the Secretary of Defense (OSD) where vendors plug in their equipment into an open architecture with published requirements to demonstrate performance and interoperability. Vendors are scored against a baseline, and a winner is selected. However, in the current Plug Fest, a winner may not receive a contract award. Our change allows for a contract award to the winner within 1 month; all that is needed is a constant-schedule proposal, and not even a technical write-up. Such a non-FAR-based OT award cannot be protested. IA may take another 6 months, but even that would be better than the status quo. Furthermore, the open architecture system itself may have a certified security layer that alleviates the IA burden. We are working with AF Life Cycle Management Center (AFLCMC) to implement an expedited Authorization and Accreditation (A&A) process that runs in parallel to the acquisition process. Metrics for performance evaluation are now milestones in the Developmental Test and Engineering (DT&E) process, so that the acquired product is not a finished product, and some work can be performed post-award.

Our demonstration involved 19 companies, of which 14 were non-traditionals. They naturally formed teams as we sat back and watched with interest. They were developing on their own dime. About 12 teams ultimately formed, 6 made it to the final acquisition event, and 3 demonstrated end-to-end products. We awarded to two, and the reason we could award to two was that costs were so much less than our estimates; it cost only a bit more to fund both to see how they would work. Time from award to product was perhaps 4 months, of which 1 month was for paperwork at one-third of current cost, primarily for "customer hand-off" documentation. We did not meet our 3-week target, in part because we were relying on an unfamiliar Army contract vehicle. In the end, we got better capability at lower cost from a greater variety of vendors, including non-traditional contractors, all at greater speed. AFRL has now created our own AF OT consortium vehicle. There are nuances to be worked through, but we at least have a contract vehicle with which to work. There is an effort to acquire major weapons systems using this OT vehicle. FAR creep may limit its use, but a call for reform favors our efforts.

The Army has multiple OT consortia, organized by subject area: Ordnance, C4ISR, Cyber, and so on. The AF plans to have just one consortium for all manner of "open architecture" systems. If ultimately successful, each program will create its own OT consortium to better address requirements and competition. There are other similar AF vehicles: Combat Air Operations Center-Experimental (CAOC-X), Information Sharing Analysis Center (ISAC) at Warner-Robbins Air Logistics Center (ALC), and the Cyber Innovation Center at Hanscom AFB, etc. That said, some people prefer more traditional yet efficient acquisition approaches (e.g., multi-award ID/IQs which are also effective). However, they are more applicable to a limited set of vendors (5-50) who will provide something specific. OT consortia vehicles support an infinite number of companies.

5

Closing Statement

The range of topics and perspectives presented by the speakers clearly demonstrate the breadth of possible areas of focus, and the need for a workshop to precede our larger forthcoming study. The problem they have described is “wickedly” complex, with many moving parts, competing objectives, and restraints. The workshop’s greatest impact on the subsequent study has been to redirect the focus of the study from experimentation itself toward the implementation of experimentation campaigns in the Air Force.

The committee is grateful to each of the presenters for their time and their expertise in helping us understand the nature of the problem we are to address in our study.

Appendixes

A

Statement of Task

As part of the study, The Role of Experimentation in the Innovation Cycle, the committee will plan and conduct a 3-day public workshop that will result in a workshop proceedings style report meant to direct and inform the direction and focus of the subsequent consensus study. The statement of task encompassing the workshop and study is detailed below:

The need for this Workshop and Study was highlighted by the recently completed "Development Planning, A Strategic Approach to Future Air Force Capabilities: A Study." As a result, the Experimentation Workshop and Study was requested by the U.S. Air Force Office of the Assistant Secretary for Science, Technology and Engineering.

Statement of Task: An ad hoc committee consisting of retired government, industry and academia was formed to:

1. Define the current state of practice of experimentation within the Air Force (AF).
2. Assess the role of experimentation in the innovation life-cycle and address how it can support the Air Force's future technology requirements.
3. Evaluate the role of risk management and experimentation in the innovation life cycle.
4. Evaluate current legislative, organizational or other barriers that limit the use of experimentation within the AF.
5. Review and recommend best practices for incentivizing experimentation based on an assessment of comparable S&T organizations.
6. Recommend metrics that can be implemented across the AF to monitor and assess the use and value of experimentation.
7. In addition the committee will address any other factors deemed to be relevant such as organizational structure or concepts of operation that could enhance the likelihood of successfully implementing a robust experimentation program within the Air Force acquisition community.

B

Committee Member Biographies

GENERAL LESTER L. LYLES (USAF, Retired), NAE,[1] *Co-Chair*, is an independent consultant. He retired as Commander of the Air Force Materiel Command, Wright-Patterson Air Force Base, Ohio.

DR. ALEX MILLER, *Co-Chair*, is the William B. Stokely Chair of Management in the University of Tennessee's College of Business Administration. He was the founding director of the Aerospace-Defense Executive MBA program and the former associate dean of Executive Education at the University of Tennessee.

LTGEN TED BOWLDS (USAF, Retired) is a consultant, CEO, board member, and retired U.S. Air Force General with more than three decades of experience leading strategy, planning, organizational development and administration for high-profile, complex commercial and military organizations.

LTGEN CHARLES R. "CR" DAVIS (USAF, Retired) is chief operating officer at Seabury Group. Prior to retiring from the U.S. Air Force (USAF), Lieutenant General Davis was military deputy, Office of the Assistant Secretary of the Air Force for Acquisition, the Pentagon, Washington, D.C. He also led USAF Acquisition for more than a year, while the Assistant Secretary of the Air Force (Acquisition) position was vacant.

MR. BLAISE J. DURANTE is the director of Blaise J. Durante & Associates, Inc. Mr. Durante retired as a member of the Senior Executive Service, was the Deputy Assistant Secretary for Acquisition Integration, Office of the Assistant Secretary of the Air Force for Acquisition, Washington, D.C.

DR. ANTONIO L. ELIAS, NAE, is executive vice president and chief technical officer of Orbital ATK. In 2012, Dr. Elias was named executive vice president and chief technical officer of Orbital Sciences.

DR. IVY ESTABROOKE was appointed as the executive director of the Utah Science, Technology and Research Agency (USTAR) in May 2014. Prior to moving to Utah, Dr. Ivy served as a program officer for 8 years at the Office of Naval Research (ONR). She managed a high-risk /high-payoff research portfolio, including innovative neuroscience programs and cutting-edge social and computational science programs, and developed and implemented a strategy for examining emerging technology areas.

MR. DAVID E. HAMILTON is CEO at Eagle Aerie, Inc., and is president of Guardtime Federal, LLC. Mr. Hamilton served 29 years in uniform for the Air Force, retiring in 2003 in the rank of Colonel. After a short stint in the private sector, he then returned to the Department of Defense as a member of the Senior Executive Service as the director of the Rapid Capabilities Office serving for 11 years until retirement in August 2014.

[1] NAE, National Academy of Engineering.

DR. BERNADETTE JOHNSON is chief technology officer at Massachusetts Institute of Technology (MIT) Lincoln Laboratory. Her responsibilities include the development of the laboratory's long-term technology strategy and the coordination of collaborative research with MIT campus. Prior to this position, Dr. Johnson was assistant head of the Homeland Protection and Tactical Systems Division.

MR. WILLIAM JOHNSON graduated from Cornell University with a B.S. and an M.E.E. in electrical engineering. He is an independent consultant and sole proprietor of WMJ Associates, LLC, which he established in July 2007. In this capacity he has advised government and industry leaders on management and leadership matters involving the acquisition of complex systems.

DR. JOSEPH LAWRENCE is a distinguished research fellow at the National Defense University (NDU) Center for Technology and National Security Policy, and is a senior research associate in the Applied Research Laboratory at the Pennsylvania State University (PSU ARL). Prior to his 2012 Intergovernmental Personnel Act appointment from PSU ARL to the NDU faculty, Dr. Lawrence from 2005 was the director of transition for ONR.

MR. ROBERT ANDREW KIRK MITCHELL (NAE) is a consultant. He served as vice president for Northrop Grumman Aerospace Systems from 1999 to 2009. Prior to its acquisition in 1999 by Northrop Grumman, Mr. Mitchell served as president of Teledyne Ryan Aeronautical. Under his leadership, Teledyne Ryan Aeronautical captured and developed the Global Hawk high altitude, long endurance, unmanned aircraft system.

MR. BEN RILEY is senior research associate at Georgia Tech Research Institute. He previously served at the principal deputy, deputy assistant secretary of defense, emerging capability and prototyping in the Office of the Assistant Secretary of Defense, Research and Engineering. Prior to assuming his position in September 2009, Mr. Riley served as the director of the USD (AT&L) sponsored Rapid Reaction Technology Office and Chairman Combating Terrorism Technology Task Force.

DR. JOEL SERCEL is president, chief engineer, and founder of both ICS Associates, Inc., and Trans Astronautica Corporation (TransAstra) with more than 30 years of technical experience. Dr. Sercel spent 14 years at the Jet Propulsion Laboratory and 2 years as a senior program manager for the Air Force, where he ran a team of more than 120 systems engineers architecting a $20 billion-class classified satellite network.

MR. DANIEL WARD is consultant with Dan Ward Consulting, LLC. Prior to launching Dan Ward Consulting, he served for more than 20 years as an acquisition officer in the Air Force, where he specialized in leading high-speed, low-cost technology development programs, and retired at the rank of Lieutenant Colonel. While on active duty, he helped establish the Air Force Research Laboratory's rapid innovation process.

C

Workshop Agenda

JANUARY 27-29, 2016

Day 1: January 27, 2016

Closed Session

8:30 a.m. Co-Chairs Lead Discussion

Open Session

9:30 Sponsor Remarks
Col. Chuck Ormsby, USAF, SAF/AQR

10:00 What the RCO Does That More of the Air Force Should Consider Doing?
David Hamilton

11:00 Global Hawk: ACTD Case Study on Successes and Obstacles
Mr. Robert Andrew Kirk Mitchell, NAE

12:00 p.m. Break

1:00 24th Air Force: Quick Reaction Effort to Provide an Air-enabled Cyber Capability
Mr. Chet Wall, 90th IOS Technical Advisor

2:00 Committee Discussion

2:45 Break

3:00 Motiv Space Systems—A “New Space” Company
Brett Lindenfeld, Vice President, Operations

Closed Session

4:00 Committee Observations from Day 1 Presentations

5:00 Adjourn

Day 2: January 28, 2016

Closed Session

8:00 a.m. Co-Chairs Lead Discussion

Open Session

9:00 LCMC Perspective on Barriers to AF Innovation Through Experimentation
Lt. Gen. (ret.) C.D. Moore

10:00 Committee Discussion

10:45 Break

11:00 TransAstra—Experimentation Efforts Focused on Asteroid Mining
Joel C. Sercel, Ph.D., Founder and Principal Engineer

12:00 p.m. Break

1:00 Venture Capital Perspective on Innovation
Arif Janmohamed, Partner, LightSpeed Venture Partners, Silicon Valley, California

2:00 Acquisition Perspective on Barriers to Innovation/Experimentation
Dr. Camron Gorguinpour, SES, SAF/AQ

3:00 Making "Experimentation" a Part of the Culture in Air Force Developments
Lt. Gen. Steve Kwast, Commander & President, Air University, Maxwell AFB

4:00 Break

Closed Session

4:15 Committee Observations from Day 2 Presentations

5:15 Adjourn

Day 3: January 29, 2016

Closed Session

8:30 a.m. Co-Chairs Lead Discussion

Open Session

9:30 Perspective from U.S. Air Force Acquisition Leaders (Present & Past)
Gen. Ellen Pawlikowski, Commander, Air Force Materiel Command

Gen. (ret.) Lester Lyles, Experimentation Study Co-Chair

10:30 Joint Q & A
Gen. Pawlikowski and Gen. Lyles

11:45 Break

1:00 p.m. Making Experimentation and Innovation a Part of Air Force Acquisition Culture
Dr. William LaPlante, MITRE Corporation

2:00 Panel: Develop 10-12 Actionable Questions to Focus the Rest of the Study[1]
Prof. Alex Miller, University of Tennessee , Experimentation Study Co-Chair

3:30 Break

Closed Session

4:00 Committee Observations from Day 2 Presentations

Plan Remainder of Study

5:00 Adjourn

[1] Panel discussion originally planned was replaced by committee discussion at the behest of the co-chairs. Discussion of common themes is reflected in Chapter 2.

D

Workshop Attendees

COMMITTEE MEMBERS

Lester L. Lyles (Gen., USAF Ret.), Independent Consultant, *Co-Chair*
Alex Miller, University of Tennessee, *Co-Chair*
Ted Bowlds (Lt. Gen., USAF, Ret.), The Spectrum Group
Charles R. "CR" Davis (Lt. Gen.,USAF, Ret.), Seabury Aerospace & Defense
Blaise J. Durante, U.S. Air Force (retired)
Antonio L. Elias, Orbital Sciences Corporation
Ivy Estabrooke, Utah Science, Technology and Research Agency
David E. Hamilton, Jr., Eagle Aerie Inc.
Bernadette Johnson, Massachusetts Institute of Technology Lincoln Laboratory
William Johnson, WMJ Associates LLC
Joseph Lawrence, National Defense University
Robert Andrew Kirk Mitchell, Independent Consultant
Benjamin P. Riley, Georgia Tech Research Institute
Joel Sercel, ICS Associates Inc.
Daniel Ward, Dan Ward Consulting, LLC

ACADEMIES STAFF

Dr. Joan Fuller, Director, Air Force Studies Board
Dr. George Coyle, Senior Program Officer, Air Force Studies Board
Mr. Steven Darbes, Research Assistant, Air Force Studies Board
Ms. Marguerite E. Schneider, Administrative Coordinator, Air Force Studies Board
Ms. Dionna Ali, Research Assistant, Air Force Studies Board

SPEAKERS

Dr. Camron Gorguinpour, Director of Transformational Innovation to the Assistant Secretary of the Air Force for Acquisitions (SAF/AQ)
David Hamilton, CEO at Eagle Aerie, Inc., and former Director of the Rapid Capabilities Office
Arif Janmohamed, Partner, Lightspeed Venture Partners
Lt. Gen. Steven Kwast, Commander and President, Air University, Maxwell Air Force Base
Dr. William LaPlante, Former Assistant Secretary of Air Force for Acquisition, SAF/AQ
Brett Lindenfeld, Vice President of Operations, Motiv Space Systems
Robert Mitchell, Consultant, Former Vice President for Northrop Grumman Aerospace Systems

Lt. Gen. General C.D. Moore (Ret.), Executive Vice President, Dayton Aerospace, Former Commander Air Force Life Cycle Management Center (AFLCMC)
Colonel Charles Ormsby, Ph.D., Military Deputy, SAF/AQR
General Ellen Pawlikowski, Commander, Air Force Materiel Command (AFMC)
Joel Sercel, Founder and Principal Engineer, Trans Astra
Chet Wall, 90th COS Technical Advisor, 24th AF, 688th CW, 318th COG

GUESTS

Lt. Col. Elaine Bryant, Directed Energy Experimentation Campaign Lead/PEM, SAF/AQR
Mr. Harry Foster, Director, USAF Blue Horizons
Ms. Jen Hebert, Associate Project Leader, The MITRE Corporation
Ms. Betsy Jones, Project Leader/Systems Engineer, The MITRE Corporation
Mr. Jerry Lautenschlager, Development Planning PEM, SAF/AQR
Mr. Chris Leak, Program Manager, USAF
Mr. Dave Prochnow, Principle Simulation Modeling Engineer, The MITRE Corporation
Maj. Steve Trnka, Next Generation Air Dominance PEM