ARTICLE

Taking the Brakes off Uniformed Scientists and Engineers

Brian J. Fry

Policies intended to develop and utilize uniformed scientists and engineers are often misapplied and impede effective employment. Uniformed scientists and engineers are uniquely suited to link technical possibilities to operational realities; developing these capabilities will help uniformed scientists and engineers maximize their contributions to the acquisition community and to the combat power of the Air Force.

Acquisition management is vital to the future Air Force, but restricting uniformed scientists and engineers (S&Es) to that singular function blunts their potential contributions. This approach is not the consequence of some unexpected demand but an institutionalized misinterpretation of S&Es' roles and abilities. This article examines how S&Es are being developed and utilized today, identifies the bureaucratic restrictions placed upon them, and describes how to posture S&Es to maximize their contributions and the combat power of the Air Force. (Of note: "S&Es" refers only to active duty military officer S&Es.)

The Air Force has untapped science and engineering capabilities within its S&Es.[1] Their advanced education opportunities depreciate and their hard-won technical skills atrophy in duties that do not utilize these skills. Today's S&Es see minimal opportunity for future use of their skills within the Air Force but a plethora outside the service. They exercise more leadership and responsibility as captains in career-broadening assignments than they do in assignments at the ranks of major and lieutenant colonel.

Motivation

The optimal function of S&Es is to exploit "technology by linking technical possibilities to operational realities faster than an adversary."[2] This is a distinct role for which

1. George M. Williams, "An Analysis of the Problems Encountered by the United States Air Force in the Motivation and Retention of Military Scientists and Engineers" (master's thesis, George Washington University, February 1965), 63–71; James M. Thomas, *Retention of Scientists and Engineers in the Air Force: A Modified Model for Interpreting Correlates of Career Intent*, AFHRL-TR-70-27 (Lackland AFB, TX: Air Force Human Resources Laboratory, Air Force Systems Command, June 1970), 11–13, https://apps.dtic.mil/; Robert H. Cohn, *Scientist and Engineer Career Patterns for Air Force Civilians and Officers*, AU/ACSC/029/1999-04 (Maxwell AFB, AL: Air Command and Staff College [ACSC], April 1999), 34, https://apps.dtic.mil/; and Montgomery C. Hughson, "The Future Role of the USAF Technical Officer" (Maxwell AFB, AL: ACSC, April 2000), 5–6, 28, 32, https://apps.dtic.mil/.

2. Brian J. Fry, "Mobilizing Uniformed Scientists and Engineers," *Air & Space Power Journal* 35, no. 2 (Fall 2021): 70, https://www.airuniversity.af.edu/.

S&Es are ideally suited and one that has proven indispensable in the Air Force's past peer conflict (World War II) and competition (Cold War). To fulfill this role, an S&E must possess three attributes: 1) be technically proficient, 2) be operationally relevant, and 3) be able to lead others in identifying, maturing, and fielding new technologies.[3] By developing S&Es with these attributes, the Air Force will adapt to technological changes faster than a peer adversary.

Outwardly, the Air Force seems to develop its S&Es accordingly: The service sponsors graduate degrees in science and engineering; it offers operational broadening tours to S&Es; and the established career path for S&Es includes command positions up to colonel. Yet despite many initiatives available to develop S&Es in line with their optimal role, those initiatives are often misapplied, if at all, or exist in opposition to other initiatives. The result is a narrow or unclear S&E career identity.

While S&Es' overarching role of exploiting technology may be accepted already, its implementation has been interpreted as S&Es are expected to be "smart buyers."[4] In other words, they use their technical knowledge to ensure the Air Force buys appropriate technology. This expectation is enshrined in a career and assignment structure designed to use S&Es (and acquisition managers) in service of purchasing technology solutions.

This article envisions a role that infuses S&Es throughout operations rather than being limited to acquisitions environments. Given this broader role, S&Es will not only be smarter buyers, but they will also be able to satisfy technology needs and exploit opportunities sooner, better align technology development to operational needs, and develop future technical leaders more deliberately.

Historical Context

From the 1970s to the early 1990s, S&Es frequently utilized their technical skills as their primary function and were valued for those skills. A cursory survey of the S&E senior leaders commissioned and cultivated during this era show a large portion earned graduate degrees early in their career. Many had a string of technical assignments, and many held technical leadership positions early in their careers.[5]

Following the Cold War, the Department of Defense and the Air Force began a series of acquisition reforms from the mid-1990s through the early 2000s. One approach in particular, Total System Performance Responsibility, asserted that much of the government involvement in system development was nonvalue-added, and efficiencies could be

3. Fry, "Scientists and Engineers," 72.

4. William F. Ballhaus et al., "Science and Technology and the Air Force Vision: Achieving a More Effective S&T Program" (Washington, DC: US Air Force Scientific Advisory Board, May 2001), 8, https://apps.dtic.mil/.

5. "Major General Paul D. Nielsen," US Air Force (USAF) (website), August 2004, https://www.af.mil/; "Lieutenant General Ted F. Bowlds," USAF (website), August 2011, https://www.af.mil/; "General Ellen M. Pawlikowski," USAF (website), June 2015, https://www.af.mil/; and "Major General William N. McCasland," USAF (website), April 2013, https://www.af.mil/.

gained by transferring some government functions to the contractor (especially engineering functions).[6] Rather than provide program oversight, the assumption was the government could write sufficient requirements, establish metrics, reward or punish as needed, and simply maintain "insight" through program execution.[7]

Discussing the merits of this approach is beyond the scope of this article, but its impact is important: organic technical experience was gutted from Air Force acquisitions. Under Total System Performance Responsibility, this expertise was only necessary for writing requirements and metrics, and the initiative was used to justify downsizing the acquisition workforce with scientific and engineering expertise absorbing the brunt of the reductions.[8] Within Air Force Materiel Command from 1994 to 2005, the number of S&E authorizations dropped 48 percent; for comparison, the total Air Force officer authorizations decreased only 10 percent.[9]

In response, S&Es began a shift from technical functions to acquisition management or left the service. A retention bonus was briefly offered to S&Es from 2003 to 2005; however, the bonus has been authorized but unfunded since that time.[10] In addition, during the 2006–2008 reduction-in-force/force-shaping initiative, acquisition managers were retained at rates above the nonrated officer average, while S&Es' retention rates were at or below the average.[11]

From 1994 to 2020, Air Force active-duty-officer end strength decreased 21 percent.[12] In comparison during that period, scientists decreased 26 percent, engineers decreased 22 percent, while acquisition managers increased 42 percent.[13] These factors reinforce the notion that acquisition management and not technical skills are preferred by the Air Force. Moreover, this preference for acquisition management influences the development and employment of S&Es and instills an uncertainty in the role and value of S&Es.

---

6. National Research Council (NRC), *Owning the Technical Baseline for Acquisition Programs in the U.S. Air Force: A Workshop Report* (Washington, DC: The National Academies Press, 2015), 6, https://doi.org/.

7. Henry P. Pandes, "A Quest for Efficiencies: Total System Performance Responsibility," AU/ACSC/094/2001-04 (Maxwell AFB, AL: ACSC, April 2001), 5–10, https://apps.dtic.mil/.

8. NRC, *Technical Baseline*, 6–7.

9. NRC, *Examination of the U.S. Air Force's Science, Technology, Engineering, and Mathematics (STEM) Workforce Needs in the Future and Its Strategy to Meet Those Needs* (Washington, DC: The National Academies Press, 2010), 159–160, https://doi.org/.

10. *Department of Defense Appropriations for 2003: Hearings before the Subcommittee of the Committee on Appropriations*, 107th Cong., 2nd sess. (2002), 731, https://www.govinfo.gov/; and A. J. Bosker, "Scientists, Engineers Vital to Air Force Mission," *Air Force Print News*, April 1, 2003.

11. Courtney Knoth, "Air Force STEM Health" (Washington, DC: Air Force Studies and Analyses, Assessments and Lessons Learned, May 16, 2012), 33–37.

12. Defense Manpower Data Center, "DoD Personnel, Workforce Reports & Publications," accessed January 4, 2022, FY1994 Data, https://dwp.dmdc.osd.mil/; and FY2020 Data, https://dwp.dmdc.osd.mil/.

13. Christopher A. Wyckoff, "The Slippery Slope of Air Force Downsizing: A Strategy Connection" (Maxwell AFB, AL: Air War College, February 14, 2013), 31, https://apps.dtic.mil/; and Air Force Interactive Demographic Analysis System, FY 2005–20 datasets.

Building Technical Proficiency

Current Practices

The development of S&Es is determined by their inclusion within the acquisition career group, which includes six utilization fields: scientists, engineers, acquisition managers, contracting officers, and finance officers, with senior materiel leader-upper echelon for certain colonel positions.[14] This article focuses on the first three fields. Although the senior materiel leader-upper echelon field uses aspects of the other five fields, its qualifications and scope of responsibilities most closely match that of acquisition managers, so this article treats them as the same field.[15] Acquisition managers are responsible for managing acquisition programs and may possess any undergraduate degree. Only about 20 percent of new acquisition manager accessions possess a science/engineering degree.[16]

In contrast, all S&Es possess at least a technical baccalaureate degree, yet they face several obstacles to further developing and practicing their technical skills. The nature of military service—different assignments, duties, locations, and so forth—inhibits most S&Es from achieving the technical specialization and longevity on subjects like government civilians and contractors. This makes S&Es less desirable to participate in (or lead) technical projects, pushing S&Es into administrative and acquisition management duties. This push is further reinforced by reduced representation of S&Es but increased representation of acquisition manager authorizations at higher ranks (fig. 1).

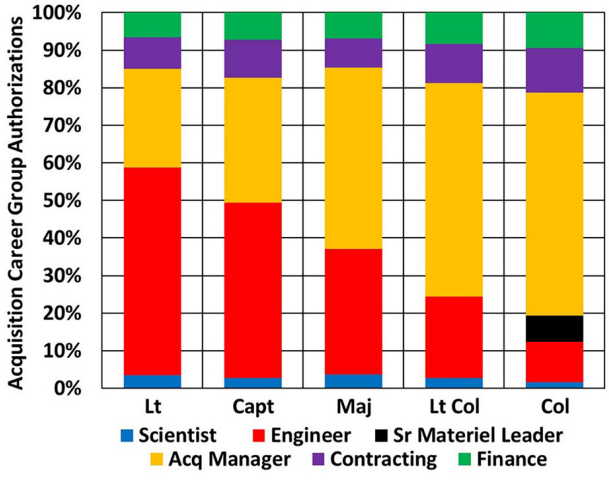

Figure 1. Composition of the acquisition career group by rank (adapted from Air Force Personnel Center, Data Reports and Retrieval Branch, September 2020 manpower file)

14. Headquarters Air Force Personnel Center (HQ AFPC), "Air Force Officer Classification Directory (AFOCD)," April 30, 2020, 207–26.

15. HQ AFPC, AFOCD, 208–26.

16. HQ AFPC, AFOCD, 267–69.

An S&E with a career goal of promotion to colonel will likely deduce their opportunities are greater in an acquisition manager position, with its ancillary technical prerequisite. Collectively, these conditions produce an organizational disincentive for S&Es to invest in deeper technical skills.

Scientists, engineers, and acquisition managers all attend the same initial skills training—a 14-day course focused almost entirely on the acquisition infrastructure and administering contracts.[17] Some coursework includes test and evaluation, but the focus of the course is on test planning and administration not execution. Using science and engineering to support operations and intelligence activities is left entirely to on-the-job training despite the officer classification guide specifically including these activities as a part of S&E duties.[18]

Throughout their careers, S&Es are required to obtain acquisition certifications, such as program management, science and technology management, and engineering management.[19] But as with initial skills training, the certification requirements are primarily focused on program management and contract administration with little supplementary technical training; the educational requirements for certifications, including the highest certifications (Level III), are a technical baccalaureate degree.[20] By receiving identical training to acquisition managers focused almost completely on contract management with minimal supplementary technical or operational connection, S&Es are trained to buy things in peacetime not exploit technology in wartime.

Like acquisition manager careers, assignments for S&Es sample the system life cycle (laboratory, center, depot) to allow them to observe the cradle-to-grave system progression. While a life-cycle pathway may be useful for acquisition managers to experience the various contract arrangements at each stage, this arrangement contains little to no technical connective tissue. Even if S&Es are placed in technical positions, any technical knowledge they gain in one assignment may be, and often is, superfluous in their next assignment.

The intent may be to develop technology generalists, but because of frequent moves, the current pathway makes S&Es technical spectators instead of participants. Yet the latter element is essential to developing the deep knowledge necessary to rapidly link technical options to operational applications. This lack of subject-matter depth diminishes the appeal of assigning S&Es to lead technical efforts. They are instead steered toward worker-bee tasks, acquisition management, and administrative duties where technical skills are less essential.

The assignment process for S&Es further limits their technical contributions. These officers are usually assigned to positions based first on what is open, then career field (just

17. Air Force Institute of Technology School of Systems and Logistics, "FAM 104: Air Force Fundamentals of Acquisition Management," n.d., accessed January 13, 2021, https://www.afit.edu/.

18. HQ AFPC, AFOCD, 209–12.

19. Defense Acquisition University (DAU), "DAWIA Certification & Core Plus Development Guides," accessed January 13, 2021, https://icatalog.dau.edu/.

20. DAU, "DAWIA Certification."

the broad category, for example, "physicist"), followed by rank, the position's fill priority, and lastly specialization (for example "laser and optics") and desires.

Although an S&E's specialty is considered somewhere in that process, a best-fit position may mean little after passing through all the other filters. One officer, upon graduating with a PhD in astrophysics, could have applied for 11 available physicist positions, but only one position included any mention of "space" and that was only a part of the position's scope. The Air Force has many applications for an astrophysics PhD, but unless those positions are open when an officer is available for a new assignment, the fact is irrelevant.[21]

By limiting assignments to open slots only and placing technical specialty at the bottom of precedence, double-billeting is treated as a greater sin than squandering technical expertise. S&E expertise and positions are generally treated as homogenous; this Industrial-Age practice regards people as interchangeable parts and variations from the standard as superfluous.[22]

While earning a master's degree is considered a criterion for promotion to the field-grade ranks (approximately 22,000 officers), the Air Force regards additional graduate education as an extravagance: only 402 field-grade authorizations require a doctoral degree and only 285 require a PhD in a science, technology, engineering, and math (STEM) field.[23]

Additionally, a substantial portion of these doctoral authorizations are faculty positions; just 74 of those field-grade STEM PhDs reside within Air Force Materiel Command. A STEM PhD signifies the recipient has expanded the frontiers of science or engineering. But only 3 percent of acquisition colonel positions require STEM PhD degrees, decidedly insufficient in Information-Age warfare where a networked variety of experts is essential to swiftly adapting to change.[24]

In recent years an Air Force PhD management office was created, but its efforts have been directed toward better identifying and utilizing existing PhD expertise, and it has not shifted the Air Force's view on the value of an expanded PhD cadre. For the last five years, yearly PhD quotas available to scientists and engineers were about 9 (3 percent of the total career field) and 21 (less than 1 percent of the total career field), respectively.[25]

While not every S&E needs a PhD, the requirement is likely underresourced and underrated, especially considering almost half of those quotas were for faculty positions, not operations-, intelligence-, or acquisitions-sponsored slots. Furthermore, graduate

---

21. Neil deGrasse Tyson and Avis Lang, *Accessory to War: The Unspoken Alliance between Astrophysics and the Military* (New York: W. W. Norton & Company, September 11, 2018).

22. James M. Dubik and Gordon R. Sullivan, *War in the Information Age* (Fort Belvoir, VA: US Army War College Press, 1994), 8, https://press.armywarcollege.edu/.

23. Air Force Personnel Center/Data Reports and Retrieval Branch, "MPW Manpower File" (September 2020).

24. Dubik and Sullivan, *Information Age*, 12.

25. HQ AFPC, "2017 Advanced Academic Degree (AAD) and Special Experience Exchange Duties (SPEED) Selection Process Guide," June 28, 2016, 24–34; HQ AFPC, "2018 AAD and SPEED Selection Process Guide," April 10, 2017, 10–17; HQ AFPC, "2019 AAD and SPEED Selection Process Guide," April 4, 2018, 13–19; and HQ AFPC, "2020 AAD and SPEED Selection Process Guide," April 25, 2019, 13–22.

education is not considered "in-specialty" for S&Es. This means an S&E assigned to a full-time science or engineering graduate program is not regarded as performing S&E duties while an S&E on a headquarters staff is. As a consequence, up to four and a half years (18 months for a master's degree plus three years for a PhD) of Air Force-sponsored graduate education yields no experience credit toward being considered a senior- or master-level S&E in the Air Force.

Additionally, most S&Es have two options for graduate school: principally the Air Force Institute of Technology (AFIT) and sometimes the Naval Postgraduate School (AFIT holds 79 percent of advanced academic degree slots for S&Es).[26] Although an outstanding institution, the Air Force's policy of preferential AFIT attendance is detrimental. The practice of discouraging civilian institution attendance to mandating AFIT attendance is based on a perceived cost savings or yielding a thesis/dissertation topic that is more overtly military in focus.

Neither reason is valid: numerous civilian institutions offer tuition waivers applicable to military students, and AFIT's curriculum is centered around topics with known military applications. By relaxing the Air Force's predilection for AFIT graduate school attendance, its PhD cadre will avoid group-think, gain opportunities for interaction and collaboration with some of the leading experts in emerging technologies, and expand the diversity of experience available to solve the Air Force's problems.

Recommendations

The development of S&Es should begin with an initial skills training that covers the acquisition infrastructure and the operations, logistics, and intelligence infrastructures these officers will be expected to support. If S&Es are to be a technical-operational link, this training will begin to forge that connection. These officers should practice conducting operational and developmental tests not just planning them. They should receive instruction in performing "field" and "hasty" tests they may need to conduct in deployed locations without the benefit of formal test facilities.

Also, new S&Es should receive instruction in wargaming techniques; as S&Es develop new technology, they must understand how best to employ it and wargaming will give them a means to explore that. This training would be the foundation giving S&Es the tools they need to connect the theoretical technical knowledge of their degree programs with the practical technical knowledge they will use in an operational context.

To continue to hone technical skills after initial skills training, S&E assignments should prioritize technical cohesion. These assignments should be made to the genuine best-fit position based on an S&E's expertise and development rather than choosing the best-available position at a set point in time. This can be accomplished by expanding the traditional six-month assignment window to two years and varying tour length more. The service should encourage and capitalize on the variety of specialized S&Es.

26. HQ AFPC, "2021 AAD and SPEED Selection Process Guide," April 1, 2020, iv–ix.

In the long term, more S&E careers should be subject-matter oriented rather than life-cycle oriented. For example, a space-focused scientist would attain a graduate degree(s) in astrophysics and serve in a range of assignments including at a space operations squadron, the Air Force Research Laboratory Space Vehicles Directorate, the Space Systems Command, and the National Reconnaissance Office. Each assignment would allow the S&E to expand and apply their technical specialty in new ways instead of shelving their acquired knowledge in subsequent assignments.

The Air Force cannot overestimate the volume of knowledge that can be brought to bear either for or against it; a master's degree is no longer sufficient. Graduate education is absolutely an example of "S&E duties." Rather than focusing on a discipline's foundational knowledge, a PhD program is a supervised endeavor that extends the bounds of what is currently understood or possible within a discipline. This is a skill essential to the growth and progress of the scientific and engineering disciplines and is an imperative to ensure technological overmatch of an adversary. The intent behind creating uniformed PhDs is to develop the research independence to create this overmatch, integrate (not duplicate) the government civilian and contractor expertise during wartime and enable S&Es to assume a relationship as a collaborator.

Developing Operational Relevance

Current Practices

Like opportunities for building technical skills, avenues for S&Es to gain operational experience are also limited. Most science and engineering organizations are not colocated with their mission-related operational units (flight test units are a notable exception), requiring S&Es to travel to their technology's eventual customers. This obstructed shared experience between operations and technical development can impair the quality and timeliness of acquired technology.

A career-broadening tour that cross-trains S&Es into operational career fields is one avenue to gain first-hand operational experience and includes two options: operational experience (OPEX, first assignment for new second lieutenants) and special experience exchange duties (SPEED, usually for captains).[27] But OPEX assignments are almost entirely filled by acquisition managers. Few S&Es are in OPEX tours; this was not always the case, but it is the current practice.

Excluding S&Es from the program reflects a priority on infusing the latest science and engineering practices into the acquisition community and the view the Air Force must get its money's worth from new S&Es, since many of them are Air Force Reserve Officer Training Corps scholarship or Air Force Academy graduates. As a result, more than 15

27. HQ AFPC, "2021," 16–23.

percent of new acquisition managers are in some operational assignment, while less than 4 percent of new S&Es participate in such assignments.[28]

While S&Es can apply for SPEED later in their career, positions are limited by the operational career field and competition within the acquisition career group: just under 10 percent of acquisition manager captains serve in operational assignments while less than 4 percent of S&E captains attend.[29] Expecting S&Es to field operationally-relevant technology without the benefit of first-hand operational experiences is a tenuous proposition.

Technical deployments are another source of operational experience for S&Es that has been barely employed. Most deployments available to S&Es are noncareer-field-specific deployments and do not utilize technical skills.[30] The supposition governing S&E deployments is that new technology will be employed like the F-22 (i.e., full operational capability then combat) rather than JSTARS (i.e., combat with prototypes).[31]

Recommendations

With S&Es composing roughly half of new accessions into the acquisition career group, their near-absence from operational assignments is an obvious basis for adjustment. One option would be to make an OPEX/SPEED assignment more accessible to S&Es. In providing an operational context for technical know-how, the program certainly gives the Air Force its money's worth in the long run. But care should be taken in deciding OPEX/SPEED participation as acquisition managers benefit from the experience as much as S&Es. Ideally, the program should be expanded rather than simply reallocated.

Ultimately, the number of OPEX/SPEED positions will be limited because of internal requirements within the operations career fields. Given that constraint, a tighter connection between operations, science, and engineering is needed. This deeper connection can be forged by assigning S&Es directly to operational organizations, either individually or in units. On an individual basis, operationally trained S&Es would have duties that are a mixture of operations and science and engineering, analogous to the existing pilot-physician program, influential in finally solving the F-22 hypoxia problems. The OPEX/SPEED programs could serve as the gateway for an S&E-operations pipeline.[32]

---

28. Air Force IDEAS, September 2020 dataset.

29. Air Force IDEAS, September 2020 dataset.

30. Derek W. Beck, "An Analysis of Retention Issues of Scientists, Engineers, and Program Managers in the U.S. Air Force" (master's thesis, Massachusetts Institute of Technology, February 2005), 46, https://dspace.mit.edu/.

31. David Hopper, "F-22s at Langley Receive FOC Status," Air Combat Command Public Affairs, December 12, 2007, https://www.af.mil/; Brian Everstine, "F-22's Role, Impact in Inherent Resolve Increasing," *Air Force Times*, February 12, 2015, https://www.airforcetimes.com/; and Lori Tagg, "JSTARS Plays Critical Role in Operation Desert Storm," US Army Public Affairs, January 16, 2015, https://www.army.mil/.

32. Jay Flottmann, "The USAF Pilot-Physician Program," *Go Flight Medicine*, January 27, 2015, https://goflightmedicine.com/.

In unit-size teams, S&Es would be attached to operational wings or deltas. The existing AFWERX Spark Cells were formed to create pathways between operational units and "experts from industry, academia, and the government" for innovation and new technologies."[33] But these cells are staffed by part-time or additional duty personnel whose expertise is not science, engineering, or acquisitions. Assigning S&Es directly to operational units (e.g., via Spark Cells) would allow them to leverage their technical expertise and proximity to operations to deliver technology directly to the end user.

This arrangement might be perceived as removing S&Es from acquisitions, but quite the opposite is true. These officers would still need to understand requirements, choose the best solution, and monitor the quality of the solution delivered—everything a smart buyer is expected to do but in a manner more comparable to the S&Es' wartime role for rapid adaptation. A peer adversary will introduce technological surprises our systems were not prepared for. In theater, S&E teams would enable adapting equipment and reprogramming systems to work through such surprises.

The advantage of this arrangement is that S&Es would be performing technical actions at the operational level, gaining operational experience in the process and bound to the operational impact of their efforts. Because the Spark Cells' interests tend to be local, the technical specialization and infrastructure needs for most problems will be less intensive, allowing S&Es to solve problems using their own technical expertise or by organizing and leading small teams.

This arrangement frees the laboratories and centers to focus on the large-scale, resource-intensive research and acquisition efforts for which they are better configured, leaving these operational cells to focus on the smaller-scale efforts that alleviate friction within operations. The acquisition community will then be better postured to address the entire spectrum of the Air Force's technology needs. These officers would become technology scouts and sherpas more than simply liaisons. They would communicate new concepts to the laboratories and centers in a technical language, emphasizing what is really needed and communicating to operational organizations—in an operational language—what is possible.

This concept is not new. General James Doolittle, while commanding the 8th Air Force during World War II, created the Operational Engineering Section to "assist [in] the solution of minor problems, and to act generally as the intermediate link between the combat units and the established engineering activities of the Material [*sic*] and Service Commands."[34] This unit identified P-38J engine and fuel issues, modified B-24 bombers to improve survivability, and helped develop tactics utilizing a new ground-mapping radar.[35]

More recently, the 99th Reconnaissance Squadron effectively created its own federal laboratory in order to field technology for the squadron after being frustrated with a lack

33. "Spark," AFWERX (website), accessed November 14, 2021, https://afwerx.com/.

34. Benjamin W. Bishop, "Jimmy Doolittle: Cincinnatus of the Air" (dissertation, School of Advanced Air and Space Studies, July 2016), 103, https://apps.dtic.mil/.

35. Bishop, "Jimmy Doolittle," 103–20.

of progress via the traditional acquisition structure.[36] By spring 2019, the laboratory included 81 full-time civilian personnel across 25 career fields, including a technical director with a PhD in engineering (but no S&Es).[37] Adding full-time S&Es to operational units would dramatically increase the units' organic research, test, and acquisition capabilities supporting innovation. Additionally, S&Es could reach back to the laboratories and centers for more specialized knowledge.

Recent S&E deployments can serve as archetypes for expanding S&Es' contributions: the US Special Operations Command Ghost program, the Air Force Research Laboratory Center for Rapid Innovation program, and battalion electronic warfare officers.[38]

In the early years of the Global War on Terrorism, the Army fielded vehicle-mounted jamming equipment to counter remote-controlled roadside bombs. Since the Army's organic electronic warfare expertise had evaporated after the Cold War, Navy and Air Force electronic warfare officers—rated aircrew officers—were attached to Army units to help rebuild that knowledge. Eventually, Air Force S&Es were added since they were deployable and could quickly absorb the technical aspects of the new equipment.

Attached at the battalion and brigade level, they installed and maintained the jammers, trained soldiers in equipment operation, fielded new equipment, and used on-hand resources to adapt to the adversary. Most importantly from an acquisition standpoint, they provided specific, technical feedback on the equipment. Their technical background allowed them to understand why a technical design choice was made and articulate why that choice was not suitable for a particular operational environment. Furthermore, their proximity to operations allowed them to understand the demands on soldiers and to teach soldiers why the equipment required operating in certain ways. These S&Es' contributions had life-saving impacts against a relatively low-tech adversary; against a more advanced adversary, such contributions would be imperative.

Growing Technical Leaders

Current Practices

The best S&Es should serve as leaders and commanders. Unfortunately, leadership positions for S&Es are few as are opportunities for junior S&Es to develop their leadership skills before reaching those senior leadership positions. Often the only way an S&E

36. Francesca Gino, Jeff Huizinga, and Nicole Keller, "The United States Air Force: 'Chaos' in the 99th Reconnaissance Squadron," Harvard Business School Case 919-047, May 2019, 9, https://www.hbs.edu/.

37. Gino, Huizinga, and Keller, " 'Chaos' " 9–11.

38. Jason Rathje, "RATPAC: How a Network of Junior Acquirers is Changing the Air Force," Acquisition News & Gazette, December 12, 2014, https://www.transform.af.mil/; Whitney Wetsig, "AFRL, AFSOC Launch Palletized Weapons from Cargo Plane," Air Force Research Laboratory (AFRL) Public Affairs, June 5, 2020, https://www.wpafb.af.mil/; and Jacqueline M. Hames, "Electronic Warfare: A New Way of Fighting," US Army Public Affairs, August 21, 2009, https://www.army.mil/.

can attain leadership experience early in their career is in an operational career-broadening assignment: leading in an entirely different career field.

Frequently, junior S&Es are told they must choose between a technical track and a leadership track. This is a false dilemma—the choice is between one focused on technical competence and one focused on contract and acquisition management. The unfortunate reality is that the acquisition management track has most leadership positions at the end of it. Of 231 acquisition command positions theoretically available to lieutenant colonel S&Es, only 34 are coded for engineering and 3 are coded for science; the rest are acquisition management-type positions. At the colonel rank, of 124 positions, only 2 are designated for engineering, and none are designated for science. Although about 18 percent of acquisition colonels possess PhDs, a distinct variation exists between those in noncommand positions and those in command positions and on a presumptive general officer track (fig 2).[39]

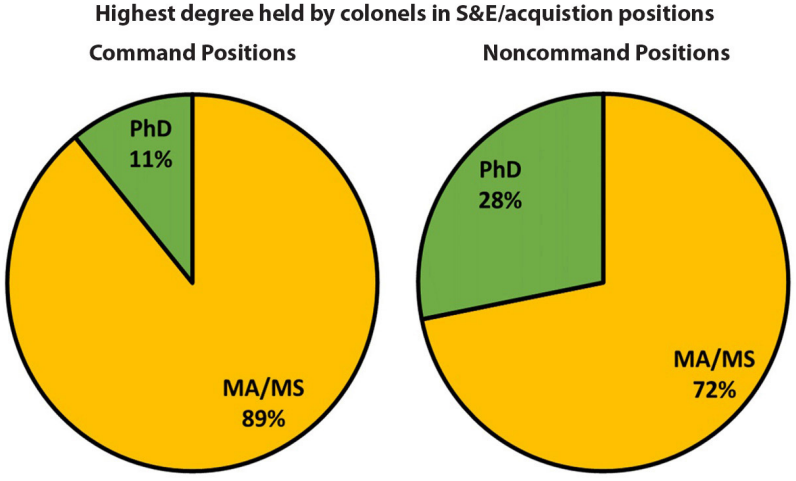

Figure 2. Comparison of highest educational degree earned by scientist, engineer, and acquisition manager colonels in commander and materiel leader positions and noncommand positions (adapted from Air Force IDEAS October 2020 dataset)

By forcing this false choice between technical and leadership, those that pursue deeper technical skills (called the subject-matter expert track) have their rank progression capped or leave the service because they see few appealing late-career options. Those that pursue acquisition management—the program management track—to remain competitive for promotions frequently do so by relegating their limited technical skills.

The well-worn remedy for a lack of technical depth in uniformed officers is to pair them with a civilian technical expert. But expecting an officer with limited technical background to fully employ the technical capabilities of their organization is unrealistic. What makes an effective senior technical leader is a robust background in technical

39. Air Force IDEAS, October 2020 dataset.

work—experience built by an S&E choosing, pursuing, and completing their own research and designs and tackling problems of increasing complexity. A properly developed S&E could utilize their civilian counterpart as a decision assistant, collaborator, and peer reviewer rather than as a blind safety net.

This disparity between technical and leadership skills did not exist to this scale in the past. Regardless of how well intentioned or successful Total System Performance Responsibility was, its legacy has steadily driven a wedge between leadership opportunities and those that pursue technical skills. Being a technically-focused officer is entirely compatible with military leadership and command; Generals Doolittle and Lew Allen Jr. are exemplars.[40] The union of a deep technical understanding and its application to operations in a single career specialty is still lacking at the senior military leadership levels.

Recommendations

The term technical track is often mistaken to mean functional track—what is known in the pilot-world as the fly-only track. But that is not what is advocated for here. A true technical track for S&Es engages their technical aptitude and its connection to operations and command decisions, and it empowers senior S&Es to direct and develop junior S&Es toward a technical mission. This bona fide technical track places equal importance on technical acumen, operational savvy, and leading technical efforts to gain advantages over adversaries.

The presence of a technical track need not detract from, nor block access to, an acquisition management track. Acquisition command positions are coded as acquisition management with good reason. Given the number of acquisition authorizations and promotion rates, the acquisition management track has an ample supply of S&Es and acquisition managers. But the existence of a path to senior leadership that prioritizes technical skill, harnessing it in an operational context, and leading others in those efforts would signify the Air Force values those skills and confers a mandate to pursue, advocate for, and employ them. Both the acquisition management and technical tracks need opportunities for S&Es to lead and command.

Creating S&E positions at operational units would be ideal settings for these officers to develop their leadership skills, as would creating units like Kessel Run but applicable to a range of technologies, not just software.[41] Additionally, as S&Es progress through their careers, they will apply their first-hand operational experiences in laboratory and center assignments, infusing an operational perspective from the ground up: a more fruitful alternative to placing operators (likely with limited technical expertise) in command of the

40. Bishop, "Jimmy Doolittle," 297–308; and "General Lew Allen Jr.," US Air Force (website), September 1981, https://www.af.mil/.

41. Lauren C. Williams, "Kessel Run Works through Growing Pains," Defense Systems, September 9, 2020, https://defensesystems.com/; and Mike Benitez, "Bring Back the Air Force Battle Lab," War on the Rocks, May 17, 2021, https://warontherocks.com/.

centers and trying to infuse an operational perspective from the top down. Uniformed scientists and engineers are fully capable of leadership if properly developed and would bring a robust background of technical work and operational insight to their commands.

Conclusion

Few of the problems and solutions presented in this article are new. For decades, studies and other articles have highlighted S&E issues and advocated remedies, but the Air Force has yet to fully embrace them.[42] With our peer competitors producing STEM PhDs at a rate twice that of the United States, planning to purchase the necessary expertise to maintain a technological lead is not a viable, long-term strategy.[43] With a shrinking technological lead, the Air Force must utilize its S&E personnel more effectively than our adversaries. "Our talent is our competitive advantage," and "people are . . . the reason we [will] prevail."[44]

It would be disingenuous to assert S&Es are not performing technical activities, gaining operational experiences, or leading technical efforts—many are. But the concern is how they are performing those actions and to what end-state. Some S&Es do science or engineering, but only for an assignment or two, frequently without any operational expertise, often without the benefit of an advanced technical degree, and likely in something other than their specialty.

Only a small percentage of S&Es gain operational experiences; the rest need a road trip to an operational unit for a brief spectator education. These officers sometimes lead efforts to field new technologies but only after a career prioritizing contract management skills with the objective of making them into smart buyers. Ironically, this situation provides them less technical experience upon which to base their technical judgments. Rather than creating multiple career paths promoting a range of valuable skills needed to exploit technology in war and all working in concert, the Air Force has promoted a single skill set (i.e., acquisition management) with an amalgamated starting line.

---

42. Lincoln R. Thiesmeyer and John E. Burchard, "Combat Scientists" (Boston: Little, Brown, and Co., 1947); J. Douglas Beason, "The Need for Technical Warriors," *Aerospace Power Journal* 14, no. 1 (Spring 2000), https://www.airuniversity.af.edu/; NRC 2012, *Assuring the U.S. Department of Defense a Strong Science, Technology, Engineering, and Mathematics (STEM) Workforce* (Washington, DC: National Academies Press, 2012), 58–59, 96–98, 116–119, https://www.nae.edu/. and Institute for Defense Analyses (IDA) Science and Technology Policy Institute, *Department of Defense Utilization of Military Scientists and Engineers*, IDA Paper P-5082 (Alexandria, VA: IDA, 2014), 27–40, https://www.ida.org/.

43. Katherine Stapleton, "China Now Produces Twice as Many Graduates a Year as the US," *World Economic Forum*, April 13, 2017, https://www.weforum.org/; Zhu Liu and Yong Geng, "Is China Producing Too Many Ph.D.s?" *Nature* 474 (June 22, 2011): 450, https://doi.org/; and *American Institute of Physics China*, "Rapid Rise of China's STEM Workforce Charted by National Science Board Report," January 31, 2018, https://www.aip.org/.

44. AFRL, "Human Capital Strategy 2021–2030," September 24, 2021, 4, https://www.afrl.af.mil/; and US Space Force, "The Guardian Ideal," September 17, 2021, 5, https://media.defense.gov/.

Forcing uniformed S&Es to choose between the extremes of either the functional- or subject-matter expert or program management tracks misses the role for which S&Es are ideally suited: finding and applying technical solutions to operational problems. Driving S&Es into a purely subject-matter-expert track puts them at a handicap in comparison to government civilian or contractor subject-matter experts. These individuals can devote decades to a niche subject, while uniformed S&Es may only get two- to four-year assignments. With limited promotion and effectively no command opportunities, S&Es have little organizational incentive to pursue the subject-matter expert track. In the program management track, S&Es are pulled in opposing directions between their identity as a technical officer and a role where technical skills are subordinate to program management skills.

Above all, S&Es are meant to link technical possibilities to operational realities in wartime faster than an adversary. The following principles and actions are essential to aid S&Es in fulfilling their role:

- S&Es must be trained to exploit technology in wartime against an adversary not simply buy things in peacetime
- the Air Force must foster and capitalize on the variety of S&Es' individual specialties
- the Air Force must offer S&Es a broad range of graduate programs at civilian institutions, in addition to AFIT and Naval Postgraduate School, to supply the service with a variety of expertise, gain opportunities for interaction and collaboration with some of the leading experts in emerging technologies, and expand the diversity of experience available to solve the Air Force's problems
- S&Es need to perform science and engineering—not just watch or manage it
- being a technically-focused officer is entirely compatible with military leadership and command
- both the acquisition management and technical tracks need opportunities for S&Es to lead and command

These recommendations are not a buffet of initiatives but a reset in how the Air Force envisions the role of its S&Es, reorienting a bureaucracy and culture that is failing to deliver technology faster than our adversaries. S&Es can contribute much more to the Air Force's combat power than they currently are, but today's S&E career structure is too restrictive and disaggregated to access their full capabilities.

This article advocates for more than simply relabeling some command positions from acquisition manager to engineer, rewarding STEM graduate degrees at promotion boards, creating a few more S&E generals, or once again funding an S&E bonus. The Air Force must reestablish a capability that proved invaluable in the last peer conflict and subsequent competition but has slowly declined in the decades since.

Extensive science and engineering skills once valued in positions up to the chief of staff of the Air Force, have now been relegated to quality control for what the Air Force

buys. Senior leader pleas for innovation and assertions of the value of STEM are essential but sound hollow to S&Es whose only avenues for innovation are what contract vehicle and type of money they are allowed to use. S&Es can drive the technological change the Air Force needs, but only if their brakes are taken off.

Lieutenant Colonel Brian J. Fry, PhD, USAF

Lieutenant Colonel Fry is an Air Force physicist and a Air Force Academy assistant professor. Dr. Fry is also a member of the Air Force Science and Technology 2030 Strategy Implementation Team.