Mobilizing Uniformed Scientists and Engineers

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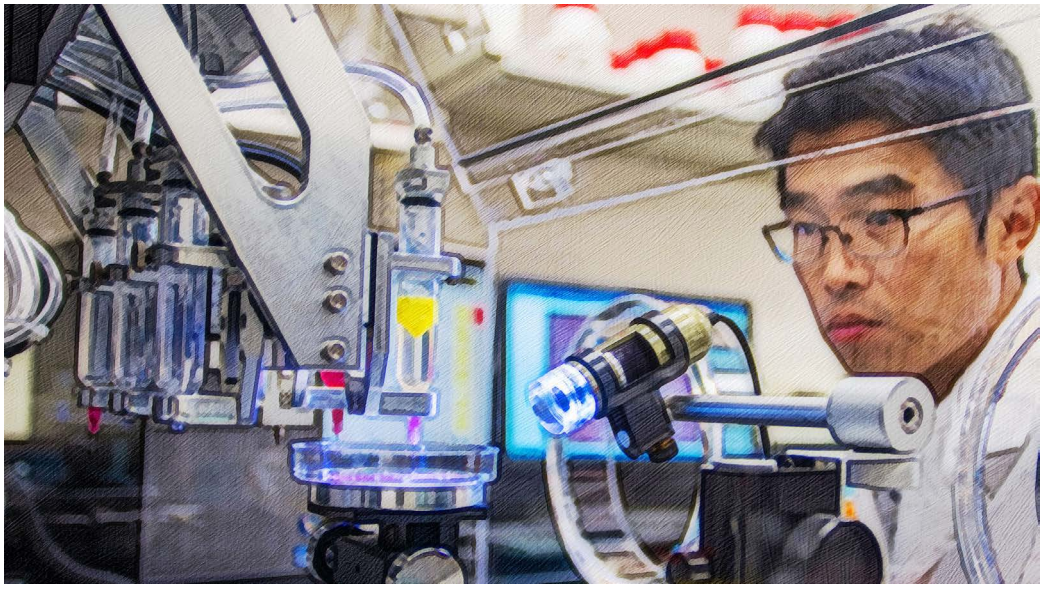

Connecting what combat forces need with what technology can provide has been an enduring problem, one that will become increasingly urgent to resolve.[1] Crossing this divide will require leaders with a deep understanding of science and engineering and the ingenuity to apply this understanding to operational problems. Here the Air Force has an opportunity to reassess the role of a talented mix of officers capable of making that technical-operational link, but whose utility often seems uncertain or hazy—uniformed scientists and engineers (S&Es). (Hereafter, "S&Es" refers only to uniformed military officer scientists and engineers.)

Background

The Air Force chief of staff has declared that accelerating change is the service's strategic imperative.[2] In part, this imperative applies to advancing technology the Air Force relies on heavily for dominance and is reminiscent of the technological challenges the US military faced at the dawn of World War II.[3] In that war, the US military and the US Office of Scientific Research and Development fielded a dazzling array of new technologies by mobilizing civilian scientists and engineers

from academia and industry. But doing the same for S&Es was much more problematic.[4] A 1948 Department of the Army study examined the utilization of S&Es during World War II and found that despite a wealth of uniformed scientific and engineering expertise, a significant portion—more than 36 percent—had been squandered in jobs poorly utilizing that expertise or in jobs that used none of it. In fact, less than 30 percent of S&Es were placed in billets in which their expertise was described as "well utilized."[5]

The study recognized the importance of S&Es within the military services, noting that "any future war will require within the Services a large group of technically trained officers of high skill to function in research, planning, and operations."[6] Yet in the decades since, numerous other studies have found the same issues and concerns voiced by S&Es in the 1940s remain true today: S&Es are not doing actual science and engineering, there is poor technical leadership, and advanced degrees are ignored or poorly utilized.[7]

Throughout the history of the service, a common sentiment has maintained that the Air Force has untapped science and engineering expertise within its uniformed ranks. The difference today is that the US military no longer enjoys the enormous technological lead it once did, despite investing billions of dollars in research and development.[8] As detailed in the 2018 *National Defense Strategy*, increasingly rapid and diverse advancements in technology require the military to utilize its people (particularly S&Es) better in order to more effectively employ technology.[9]

Mobilizing Air Force S&Es

While there are examples of the Air Force successfully tapping into its uniformed technical talent during World War II (our last peer-level conflict) and the Cold War (our last peer-level competition), perhaps the strongest contemporary example of lucrative employment of S&Es is the Israeli Defense Forces' (IDF) Talpiot program.[10] This program trains participants in a rigorous science, technology, engineering, and mathematics curriculum in addition to a broad spectrum of training with operational forces.[11] Before graduation, participants complete a thesis project proposing a technical solution to a military need they identified during training.[12]

Despite a budget that is a fraction of the US military's, the IDF, through the Talpiot program, fields technology that is impressive in terms of quality, timeliness, and combat effectiveness (for example, the Iron Dome and Trophy defense systems).[13] The Talpiot program's successes were possible in part because of the program's ability to provide operational experiences complemented by a rich, technical understanding—with the expectation that technical expertise will be applied therein—directed toward creating a cadre of military innovation leaders.

Against a peer adversary, the United States must field and employ new technologies faster and more effectively than the opponent. One expert recently noted the divide "between academic scientists, national research labs, industrial research labs, and the military" and the historic impacts of the military failing to identify and field game-changing technologies.[14] To address this deficiency, he advocated for servicemembers with the unique "ability to translate and mediate between the creators of new technologies and the users of those technologies."[15] Within the Air Force, S&Es with operational expertise are already poised to fill this role.

Air Force scientists—biologists, chemists, physicists—and engineers—aeronautical, computer, electrical, mechanical, flight test—are responsible for analyzing, researching, developing, and testing new technologies and are also tasked with supporting highly technical operations and intelligence.[16] Entry into these career fields requires a science or engineering baccalaureate degree. These academic credentials combined with their career field responsibilities, operational experience tours, and their status as uniformed officers, provide S&Es the foundational elements to build the rapid technology transition capability enjoyed by the IDF and advocated for by experts in the field.[17]

Although the building blocks are there, the Air Force's current employment of S&Es is ripe for improvement. Some S&Es are assigned to billets that utilize their technical expertise but only at the junior ranks, typically before they obtain graduate degrees that would enable greater participation in and contributions to technical activities.[18]

Ideally, an S&E would earn an advanced technical degree early in their career. But this pursuit often receives lukewarm encouragement, and few senior command opportunities are designated for S&Es with these credentials.[19] From a career field management perspective, many S&Es are viewed as interchangeable with acquisition managers. They often serve in system program offices as part of an integrated product team responsible for tracking the cost, schedule, and performance aspects of a research and development contract.[20]

Placing S&Es in these positions has value, but due to the delay in obtaining graduate degrees, lack of promotion incentives for advanced technical degrees, and mismatches between specialty and assignment, frequently S&Es lack sufficient technical depth/specialization to hold defense contractors technically accountable.[21] Consequentially, S&Es are utilized in nontechnical activities, further obfuscating the role (and likely hindering the development) of S&Es.[22] Furthermore, from a service-level view, even the existence of S&Es in the Air Force often seems unnecessary: why employ S&Es when government civilian and contractor scientists and engineers have more technical depth and specialization?

This combination of issues aggravates the decades-old challenge of fielding new technologies at the speed of relevance, which is crucial to maintaining a technological edge against peer adversaries. Untangling how S&Es can best be employed to maximize their potential and that of the Air Force requires answering two fundamental questions: (1) How can S&Es be utilized to maximize their and the larger acquisition community's contributions to delivering technology and improving the combat effectiveness of the US military? and (2) What attributes and development do S&Es need to maximize their potential?

Answering these questions will lead to a coherent vision for the S&Es' role and framework for their development, provide unique contributions to the acquisition community, and increase the combat effectiveness of the Air Force. The proposed solutions are not an attempt to cure all that ails Air Force acquisitions. Rather, the article explains the most effective way to employ one component—S&Es—of that apparatus. If the call to action is to "accelerate change," then the Air Force should ensure S&Es are in a position to do so.[23]

The Role of S&Es

In determining how best to utilize S&Es, it is important to consider the attributes of the various professions delivering technology to the Air Force—S&Es, uniformed acquisition managers, and government civilian and contractor scientists and engineers—so the result will excite each of their strengths yet minimize overlap.

Uniformed scientists and engineers are part of the acquisition career group that includes six utilization fields [their two-digit specialty code]: (1) scientific [61], (2) developmental engineering [62], (3) acquisition management [63], (4) contracting [64], (5) finance [65], and (6) senior materiel leader-upper echelon [60] (only for certain colonel positions).[24] This discussion focuses on the first three fields.

Within their respective disciplines, scientists "build understanding" (~350 total officers), engineers "build and test things" (~3,200 total officers), and acquisition managers "buy things" (~2,500 total officers).[25] As a consequence, S&Es are more technically-oriented than acquisition managers: while S&Es must earn a science or engineering degree for entry into their career fields, acquisition managers may possess any undergraduate degree—approximately 20 percent of new entrants possess a science or engineering degree.[26] Additional technical education is also considerably different across the career fields: for instance, roughly 25 percent of scientists and 10 percent of engineers have doctorates (mostly in technical fields), while about 1 percent of acquisition managers possess doctorates.[27]

Government civilian and contractor counterparts to S&Es generally have more specialization in and longevity on technical subjects—sometimes decades—than S&Es who often have just two- to four-year assignments. But while government

civilians and contractors can deploy (for example, the Air Force Engineering and Technical Services program), it is not a guaranteed capability or requirement.[28] Moreover, civilians necessitate special considerations, and deploying contractors normally incur significant costs.[29]

Also, while government civilian and contractor scientists and engineers often have or can gain operational expertise, the process is usually via proximity or repeated exposure over a long time period rather than by first-hand experience. Moreover, civilian education institutions seldom include military applications of scientific principles in their curricula.

A distinguishing characteristic of uniformed military service is the implicit expectation to command and to deploy to combat theaters. These S&Es, as well as uniformed acquisition managers, can fill operational career-broadening positions—intelligence, cyber, or maintenance officer tours—that give them first-hand operational experiences they can apply in conjunction with their technical expertise.

Although several professions in the military are charged with providing new technologies, S&Es are the only professions that combine technical expertise, an operational perspective, and the implied expectation to deploy and command. As a result, S&Es can link technical possibilities to operational realities and exploit that connection faster than an adversary. The primacy of linking technical possibilities to operational and command realities (particularly in a combat theater) is what makes the roles of S&Es unique in comparison to uniformed acquisition managers, government civilians, and contractors.

This distinction profits from the S&E's technical expertise compared to the education expected of typical acquisition managers but does not duplicate the specialization of government civilians and contractors. Instead, S&Es use their technical expertise to integrate the expertise of government civilians and contractors, incorporate that knowledge into operational situations, and capitalize on opportunities with timely and impactful technology.

The optimal settings for utilizing S&Es would enable them to apply their technical skills to take advantage of technology through tasks such as conducting research, development, testing, and evaluation of new technology; designing, prototyping, and manufacturing equipment with new technology; facilitating technology transition to field units; adapting existing technology to new uses; analyzing, reverse-engineering, and countering adversary technology; or simply "MacGyver"-ing together something with duct tape and a Swiss Army knife in theater when the adversary has compromised first-line systems.

Exploiting technology *could* include managing a contract developing a new device (status quo for most S&Es today), but that should not be the only method, nor should it be assumed to be the primary method. This entire menu of tasks

should be available to S&Es and focused at creating operational advantages. While S&Es could perform these tasks in a variety of locations, making the most of technology in a combat theater is critical.

Countering Peer Adversaries

In order to guarantee decisive advantages on the battlefield, the Air Force must create, field, and employ technologies more effectively than an adapting adversary. The transformative impacts from the introduction of aircraft to warfare in the early twentieth century are a testament to the importance of creating new technologies. Likewise, today's innovative technologies must be contracted, produced, and placed into service—consider the United States' delay in fielding radar systems and Germany's inability to field enough jet aircraft during World War II.[30]

Employing that technology effectively, however, is equally important. Doctrinal frameworks like that produced by the Air Corps Tactical School and eventually the Cold-War-era AirLand Battle allowed aircraft to be viewed not simply as a novelty but as an integrated component necessary to the success of an operational campaign.[31]

To address these operational imperatives, S&Es' war-fighting obligations are:

- **Creating:** S&Es are the source of new war-fighting domains. Air, space, electronic, and cyber warfare began as science and engineering pursuits. These officers seek out technologies that expand on what is possible within existing domains and pursue transformative technologies that extend beyond the limitations of these domains.
- **Fielding**: S&Es are fighting current and future conflicts simultaneously. Essentially S&Es are waging a long-term logistics battle to field new technologies.
- **Employing:** S&Es fight using information. Just as operations researchers use data and analysis and weather officers use their knowledge of the weather, S&Es use their knowledge to discover new information previously hidden and create tools that take advantage of their knowledge. S&Es understand how new technology works and how it can influence the operational environment.

In great power competition, it is insufficient to focus solely on creating and purchasing new technology (where the capabilities of uniformed acquisition managers and government civilian/contractor scientists and engineers may be more advantageous than S&Es). In conjunction with these efforts, the US military must quickly identify those technologies and means of employment that will

produce the greatest advantage; the S&Es' blend of technical and operational expertise can accelerate this identification.

If S&Es are to fulfill their war-fighting obligations and their role of exploiting technology faster than an adversary by connecting the technical to the operational, then skilled S&Es should be:

- **Technically proficient**. These officers should have a deep knowledge of their discipline and specialty. Technical proficiency includes an in-depth theoretical understanding—primarily through academic degrees—and practical understanding developed through hands-on experience applying technical skills to practical problems via research and testing. Theory provides the tools S&Es need; practice gives them the opportunities to use those tools. Both elements are needed to provide a well-rounded understanding of their disciplines.
- **Operationally relevant**. These officers should be able to understand and apply technical knowledge in operational and command contexts. Knowledge of the operational environment is necessary for S&Es to fully grasp the constraints such an environment will impose upon their technology. This insight could be gained through discussions with operational units, but working directly with operational units or having first-hand experiences in operations would give S&Es a much more comprehensive understanding of those constraints.
- **Leaders**. These officers should have skills in the following areas: (1) directing a research or test effort; (2) developing doctrine for new technology with operators; (3) advising senior leaders on the relative importance of detailed analyses and requirements; and (4) sharing their knowledge to cultivate junior S&Es, enrich their peers' expertise, and collectively enhance the technical aptitude of the total force. Uniformed scientists and engineers must be able to direct other scientists and engineers toward a technical mission and develop and mentor junior officers to one day succeed them. In this way, S&Es will enable accelerating the technological and doctrinal change necessary for the Air Force to maintain its dominance.

Conclusion

During a conflict with a peer adversary, S&Es can create, adapt, and employ technology to seize opportunities and counter the adversary's efforts, particularly in theater. Developing leaders with deep technical understanding and with experiences applying that technical knowledge to operations has been extremely ben-

eficial for the IDF. The Air Force could similarly benefit from developing its S&Es along the same philosophy.

The union of technical and operational expertise within an officer is a role for which S&Es are educated and professionally developed. Empowering S&Es to be technically capable and operationally relevant will ensure they identify and exploit technical opportunities over our competitors much earlier, infuse an operational mindset in acquisition organizations from the ground up, lead those acquisition organizations with a war-fighting perspective, and perpetuate and accelerate the change necessary to keep the Air Force at the forefront of technology. ✪

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Notes

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