CSIS BRIEFS

To Compete, Invest in People

Retaining the U.S. Defense Enterprise's Technical Workforce

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NOVEMBER 2020

THE ISSUE

The U.S. defense enterprise has an impressive history of science, engineering, and innovation; however, today, it struggles to retain its technical talent. U.S. defense organizations face issues onboarding technical talent, leveraging talent in support of defense missions, and developing and promoting technical talent within defense organizations. Without addressing these retention issues, the defense enterprise will continue operating largely as a set of industrial-age institutions that leverage technology ineffectively rather than as twenty-first century organizations where technology and technologists are managed like a strategic asset. Therefore, to modernize and compete, the defense enterprise must invest in people—including technical talent—by proactively addressing retention barriers and adopting a holistic approach to talent management.

INVESTING IN PEOPLE

Geopolitical competition and the nature of modern warfare are increasingly shaped by technology. Recent modernization efforts across the defense enterprise—which created technical centers of excellence within the Department of Defense (DOD), built stronger relationships with Silicon Valley and other tech hubs, and included DOD's largest investment in research and development in 70 years—embrace this technical future.[1] However, to fully modernize and compete effectively, the U.S. defense enterprise also needs to invest in people.

For the purposes of this brief, the people in the defense enterprise include both civil servants and members of the armed forces who are employed by the U.S. military branches (i.e., the Army, Navy, Air Force, Space Force, Marine Corps, and Coast Guard), defense agencies (e.g., the Missile Defense Agency and Defense Advanced Research Projects Agency), and defense headquarters (e.g., the Office of the Secretary of Defense and combatant commands). Although the defense ecosystem—including companies, universities, and federally funded research and development labs—makes essential contributions to national defense, this brief focuses on people directly employed by the federal government.

Recent recommendations, including those by the Future Defense Task Force, the Council on Foreign Relations (CFR), and the Reagan Foundation have discussed a broad requirement for professionals of all science, technology, engineering, and mathematics (STEM) backgrounds.[2] Others, however, including the Cyberspace Solarium Commission, the Defense Innovation Board, the National Security Commission on Artificial Intelligence (NSCAI), and the National Commission on Military, National, and Public Service have focused on specific skill sets, including digital, artificial intelligence, and cyber.[3]

This brief takes an expansive approach to STEM talent but notes that the defense enterprise currently lacks a common definition or requirements that specify why the federal government should employ STEM professionals. For

instance, the defense enterprise may wish to recruit and retain STEM professionals to:

- Leverage data to improve decision quality;
- Conduct basic science and technology research;
- Design and/or develop certain types of systems (e.g., reference architectures for major defense acquisition programs or prototypes);
- Buy and operate technology more effectively; and
- Enhance diversity of thought across organizations.

In filling these roles, for example, STEM professionals could be aerospace engineers who conduct basic research on hypersonic flight. They may also be software developers who support humanitarian assistance and disaster relief operations by writing the code for fire line mapping drones. Finally, they could also be mathematicians who support signals intelligence collection and analysis.

The importance of educating and recruiting STEM talent to support defense and national security missions was highlighted by several recent reports. For example, the Future Defense Task Force recommends that the U.S. government support primary education and that DOD improve "hiring pathways," increase pay, and shorten security clearance processes for STEM professionals.[4] Similarly, CFR recommends expanding the STEM talent pipeline through investments in national education initiatives, scholarships, and fellowships.[5] The Reagan Foundation recommends creating a "STEM Corps" in which STEM students would commit to a career in national security in exchange for tuition reimbursement.[6] The National Commission on Military, National, and Public Service, the Cyberspace Solarium Commission, and the NSCAI also recommend similar steps.

CSIS's research builds upon this work by focusing on a separate but related challenge: STEM talent retention. To identify potential retention barriers, the CSIS study team used a mix of qualitative and quantitative data. The team collected this data by conducting 27 interviews with stakeholders across the defense ecosystem, including the civil service, uniformed service, and the private sector. The team also convened a workshop with senior leaders and practitioners, leveraged publicly available information such as the Office of Personnel Management (OPM) Fedscope database, and used the history of civilian talent at a defense cyber organization as an illustrative vignette. Ultimately, the team concludes that the defense enterprise should invest in its people by proactively addressing retention barriers and adopting an enterprise approach to STEM talent management.

STEM TALENT TODAY

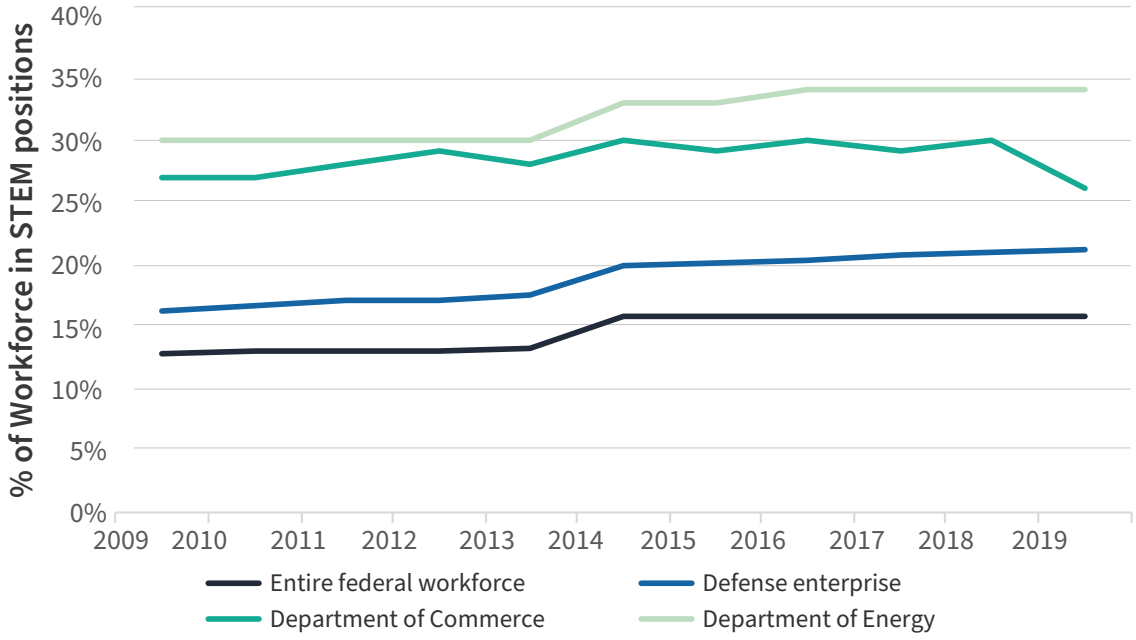
Before discussing STEM talent retention, it is useful to understand the size and scope of the STEM workforce today. Both civil servants and members of the armed services supply the defense enterprise with STEM talent. Although there are important differences between these two communities, there are also commonalities. As such, this brief discusses both workforces generally while noting challenges and opportunities that are unique to the civil service.

One unique opportunity is that civil service workforce data is publicly available through OPM.[7] According to OPM, in 2019, 16 percent of civilian positions across the federal workforce were classified as STEM; this number includes, for example, positions in information technology, electrical engineering, and computer science.[8] Importantly, there may be other positions across the government that are not formally classified as STEM but that work closely with technology (e.g., technology management, budgets, or policy). There may also be positions that are not classified as STEM but that are filled by professionals with STEM backgrounds. Finally, there are certainly STEM positions in the intelligence community; however, this data is not reported by OPM.[9]

Acknowledging these limitations, Figure 1 shows that the fraction of STEM positions across the federal government increased slightly over the last decade. Compared to the entire federal workforce, the defense enterprise contains a larger fraction of STEM professionals. Compared to departments of similar size and technical focus, however, the defense enterprise contains a smaller fraction—a result that is surprising in light of DOD's recent efforts to build-up its STEM workforce in key areas such as cyber.

Figure 2 shows that the barriers to retaining STEM talent may not be obvious or intuitive. For example, federal STEM professionals on average have higher salaries than other civil servants. Even though STEM professionals may leave for higher-paying jobs, they fare better than the government's other public servants. Furthermore, the average length of service is longer for STEM professionals than for other types of civil servants.

Figure 1: Percent of Federal Civil Servants in STEM



Source: "Fedscope," Office of Personnel Management, https://www.fedscope.opm.gov.

Figure 2: Additional Statistics on the 2019 Federal Civilian Workforce

Breakdown of the federal workforce	Civilian workforce in the defense enterprise	36.0%
	Civilian workforce in STEM positions	15.8%
	STEM positions in the defense enterprise	21.1%
Leadership breakdown of the federal workforce	Civilian workforce in the senior executive service (SES)	0.4%
	Defense enterprise civilian workforce in SES positions	0.6%
	Civilian STEM workforce in SES positions	0.6%
	Defense enterprise civilian STEM workforce in SES positions	0.3%
Average length of service	Federal civilian workforce	12.4 years
	Federal civilian workforce in STEM positions	14.0 years
	Defense enterprise civilian workforce*	11.9 years
	Defense enterprise civilian workforce in STEM positions*	12.8 years
Average salary	Federal civilian workforce	$74,402
	Federal civilian workforce in STEM positions	$100,481
	Defense enterprise civilian workforce	$79,161
	Defense enterprise civilian workforce in STEM positions	$98,201

**Does not include Coast Guard civilians*

Source: "Fedscope," Office of Personnel Management, Fedscope, https://www.fedscope.opm.gov.

Clearly, more information is required to understand potential barriers to civilian STEM talent retention. Additional data on members of the armed services—some of which may be available in the non-public Defense Readiness Reporting System database—is also required. In lieu of such data, the study team investigated retention issues by interviewing stakeholders from across the defense enterprise. We also used interviews and open-source data to explore how a defense cyber organization encountered and solved retention problems. From this analysis, we conclude that other defense organizations should learn from our cyber vignette and proactively plan for retention. We also observe that the defense enterprise's current approach to STEM talent management, which assigns professionals to stovepipes such as cyber, can exacerbate the retention issues described below.

CHALLENGES TO ONBOARDING STEM TALENT

The defense enterprise begins facing retention challenges after STEM professionals receive conditional offers and begin the onboarding process. After receiving a job offer, STEM professionals face a lengthy and opaque onboarding process that can take over eight months and that is slowed down by security clearance investigations. Further, interviewees report that during this process, sometimes—due to no fault of the candidate—billets are reallocated and offers are rescinded. Compared to the private sector, where hiring is quick, open, and transparent, STEM professionals may view the defense enterprise's onboarding process as a deterrent.[10] As a result, STEM professionals can leak out of the defense enterprise pipeline before they are even fully onboard.

In some instances, the defense enterprise successfully stops these leaks by starting the onboarding process early. For example, cyber organizations start security clearance investigations while recruits are still in college by using internship programs to identify promising candidates.[11] While this workaround does allow recruits to complete their degrees and security clearance process in parallel, it applies only to a fraction of the total STEM talent pool. The defense enterprise continues struggling to recruit mid-career talent or to create opportunities for STEM professionals to rotate between government organizations or the private sector.

BARRIERS TO LEVERAGING STEM TALENT

After onboarding is complete, barriers prevent the defense enterprise from fully leveraging new STEM talent. First, because job descriptions poorly specify technical skills, the defense enterprise sometimes struggles to assign STEM professionals to problems that can leverage their specific capabilities. For example, nearly all civilian cyber positions are classified as a single occupational series even though the actual skills required (e.g., network architecting, software development) are different and distinct.

This disconnect—between job description and required skills—makes it hard for hiring managers to assess how well-suited applicants are for tackling their organization's unique problems. Furthermore, hiring processes in the defense enterprise frequently do not incorporate the advice of current STEM professionals, forcing hiring managers to rely on checklists of required skills and limiting their ability to assess candidates' overall technical proficiency and potential. By comparison, the private sector often includes STEM professionals in hiring processes and assesses candidates not only for specific technical skills but also for their general aptitude for technical problem-solving.[12]

Furthermore, after onboarding, STEM professionals sometimes lack access to technical tools. Computing hardware is often underpowered and outdated. Software packages, system permissions, and data access authorities are tightly controlled. And in the cyber community, the DOD Inspector General reported that as recently as 2015, STEM professionals "lacked adequate capabilities and facilities to perform missions."[13]

Interviewees further reported that not only is access to tools limited but that approval processes to buy new computers and install new software is also onerous and discouraging.[14] Although overcoming these barriers is possible, interviewees suggested that it requires a management champion who is willing to advocate for STEM professionals, has the authority to drive change, and is willing to elevate approvals and cut through bureaucracy. Without a management champion, STEM professionals may find themselves unable to do their jobs efficiently or effectively and may become frustrated by their inability to obtain basic technical tools.

MISSED OPPORTUNITIES TO DEVELOP AND PROMOTE STEM TALENT

Management champions may also be critical for developing and promoting STEM talent in a bureaucracy where STEM-focused career paths are non-standard and may go unrewarded. The defense enterprise is notorious for over-promoting certain operational career paths; for example, the Air Force prioritizes the promotion of fighter pilots to senior leadership over nearly all other specialties.[15] And while the defense enterprise's cultural affinity for certain roles affects promotions in all other fields, it may affect STEM professionals disproportionately.

For example, recent research found that military personnel with unique digital skills (e.g., data scientists, software developers) are disincentivized from accepting technical assignments because they fall outside of established career paths and may put future promotions at risk.[16] Another study similarly concluded that many military members do not believe that they can have successful careers that focus on technology or that technical skills are rewarded during promotions.[17] Additionally, antiquated divisions between officers and enlisted personnel disproportionately disadvantage

non-commissioned officers by failing to prioritize their continuing education or participation in formal degree programs.[18] Interviewees further reported that in order to have a successful career trajectory in STEM, members of the armed forces require management champions who are willing to overrule bureaucratic processes and assign them to STEM-focused positions. Management champions are similarly necessary to serve as advocates on promotion boards, which tend to reward operational and management experience over technical skills.

Civilian STEM professionals may face similar challenges. For example, civil servants lack formal training and development programs, and the availability of billets limits their opportunities to rotate across assignments and organizations. Another limitation is the availability of senior billets to which civilian STEM professionals can be promoted; indeed, interviewees noted that civilians seeking promotions frequently must leave their home organizations, or the government altogether. Figure 3 shows that this problem is not entirely unique to the STEM workforce; indeed, most "senior" civil service roles are classified between a general service (GS)-11 and GS-13. Figure 2, however, shows that in the defense enterprise, the fraction of STEM civilians promoted into senior executive service (SES) positions is smaller than the fraction promoted across the entire federal government, although, notably, the numbers are small in both cases.

Perhaps more concerning, however, was that interviewees perceived that STEM professionals were often disqualified from seeking promotions into STEM-adjacent positions (i.e., positions that focus on technology management, budgets, or policy) that do not explicitly require STEM backgrounds. Even though many senior positions in the defense enterprise are STEM-adjacent, interviewees noted that STEM professionals were often perceived as being too technical or specialized to merit promotion into leadership roles where other skills, such as general management experience or process and operational expertise.

The end result is that STEM professionals struggle to be promoted into positions of leadership where they can serve as management champions for the STEM workforce. As described above, it is those management champions who are required to overcome barriers and to advocate for STEM professionals' development and promotion. Yet with too few STEM professionals in management positions themselves, the defense enterprise finds itself in a vicious circle where few management champions exist, and opportunities are missed to develop and promote STEM professionals.

Even for STEM professionals not seeking promotions, development opportunities may be limited. Interviewees noted that in order to stay current on technology, STEM professionals should rotate between the government, private sector, and training. However, as discussed above, barriers to onboarding mid-career STEM talent may disincentivize civil servants from pursuing external assignments and then returning to the federal workforce later.

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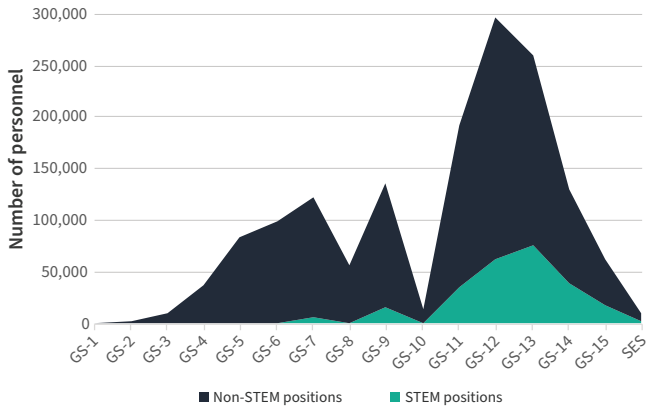
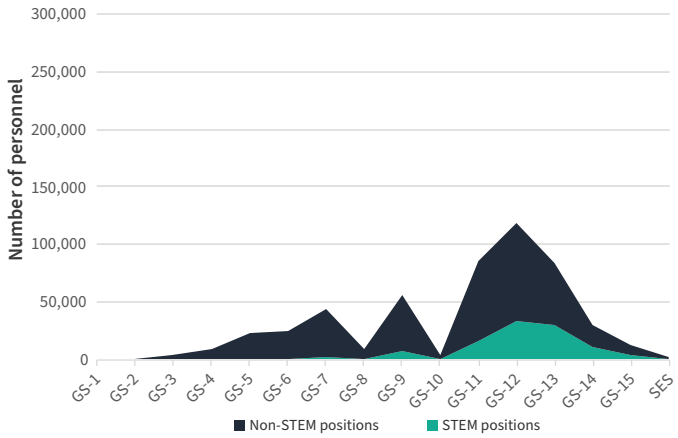
Figure 3: Number of STEM Civil Servants by General Service (GS) Position

All Federal Government Civilian Employees (2019)



Defense Enterprise Civilian Employees (2019)



Source: "Fedscope," Office of Personnel Management, https://www.fedscope.opm.gov.

Other barriers, such as significant service commitments in exchange for education or training, might dissuade both civil servants and members of the armed services from pursuing degrees or professional certifications while also retaining their federal jobs. Finally, opportunities to upskill the current workforce do exist; however, again, they require management champions who are willing to advocate for funding, time, and adjustments to work roles and assignments. As above, absent STEM workforce champions, the defense community may miss opportunities to develop and promote STEM talent and overall retention may suffer.

BARRIERS TO RETAINING STEM TALENT IN THE DEFENSE ENTERPRISE

The study team found that the defense enterprise faces many barriers to retaining STEM talent, including challenges onboarding STEM talent, barriers leveraging STEM talent, and missed opportunities developing and promoting STEM talent. Yet many data-driven questions remain: How many and what type of STEM professionals does the enterprise require? What talent already resides within the enterprise but is underutilized? And at what rate and why does talent leave?

Answering these questions is critical to managing the STEM talent pipeline holistically, from education to recruitment, retention, and promotion. Unfortunately, today, data resources are often siloed and incomplete. For example, billet and employment data still reside within separate personnel systems, and as described above, civil servant and armed service data are managed separately.

Thankfully, several new efforts should improve data accessibility and robustness and allow agencies to determine skill gaps in critical areas, such as STEM. For instance, as of 2019, government agencies now provide an annual report to OPM on their "Work Roles of Critical Need" and on their progress mitigating skill shortages.[19] However, because this data is so new, the defense enterprise still lacks insights into employment trends and deeper analysis on STEM gaps. This lack of data, combined with the need to integrate disparate data sets, makes it challenging to adopt an enterprise approach to managing STEM talent across all organizations in the defense enterprise.

In lieu of better data, it is easy to conclude that the defense enterprise struggles to recruit and retain STEM talent because it does not pay well enough and cannot compete with private industry. However, nearly every interviewee firmly stated that "it's not the pay." Pay, including total compensation package, is certainly a factor in any professional decision. However, the study team's research suggests that STEM talent leaves the defense enterprise for reasons that are more complicated.

Like most professionals in the civil and armed services, technologists are motivated by a variety of factors, including mission and a drive to solve hard problems. This finding is consistent with talent management research which concludes that "purpose" is a key to retention.[20] STEM professionals, therefore, will leave the defense enterprise when they lack purpose, frequently because they do not have the necessary skills, tools, and opportunities to solve tough problems in support of defense missions.

Although more data—especially quantitative data on armed service members and detailed exit survey data—is required to understand the magnitude of retention barriers, the study team identified four factors as being critical detriments to STEM talent retention across the defense enterprise:

Lengthy **hiring timelines** and lack of **transparency** cause the defense enterprise to lose new STEM recruits before they are even onboarded. Although some workarounds exist (e.g., internships during college while the candidate is still a student), these solutions only address a fraction of the workforce that comes directly from universities and does not alleviate strain on mid-career hires.

Once STEM talent is onboarded, they frequently have insufficient or inappropriate **tools** to support their technical work.[21] Working in subpar conditions or with equipment that is poorly suited to address the mission, STEM professionals may become frustrated and choose to leave federal service, oftentimes to support defense missions from elsewhere in the ecosystem.

A lack of **career flexibility** prevents STEM talent from pursuing training and broadening assignments. Stakeholders agreed that over the course of a career, STEM talent (particularly digital talent) should refresh their skills every three to five years using rotations inside the federal government, tours in the private sector, and continuous training and education. Today, the barriers to pursuing such opportunities are high and can only be overcome through strong advocacy from technical champions in management.

Figure 4: Defense Cyber Organization Illustrative Vignette: Retention Problems and Solutions

APPROACH TO OVERCOMING KEY RETENTION BARRIERS	CONCRETE STEPS TAKEN AND ADDITIONAL ACTIONS RECOMMENDED
Shorten hiring timelines and increase transparency	• Leveraged cyber-specific scholarships and internships to shorten the hiring process for graduates • Recommended converting cyber civilians into excepted service positions so that onboarding could be centrally managed
Equip the workforce with technical tools	• Overcame obstacles, with the help of management champions, to get the workforce the tools they needed to do their jobs
Increase career flexibility	• Established unclassified workspaces for hires awaiting clearances • Recommended improving the technical criteria and assessment process used during hiring
Create development and promotion opportunities	• Flattened the organizational hierarchy to create more opportunities for upward mobility • Created a centralized civilian training program to advocate for and manage workforce development • Recommended adopting a "rank in person" model to promote civilians without requiring them to leave their jobs

Source: CSIS interview data.

STEM talent has insufficient opportunities for **development and promotion** within the defense enterprise. This may drive senior, highly skilled technical talent to leave the enterprise in order to reach their full potential. Over time, this may also result in a failure to utilize the entirety of the defense enterprise's human capital by failing to promote professionals of diverse backgrounds and skill sets into management roles.

This absence of technical leadership also sends a signal about the defense enterprise's values. Today, the enterprise's dominant culture is one that prioritizes operational experience, adherence to process, and general management skills over other professional experiences and capabilities. While pockets of technical excellence do exist, this culture hinders individual organization's ability to enact change.

Toward this end, the study team was frequently reminded that "People don't quit their job. They quit their managers." Indeed, many interviewees indicated that changing the culture, while difficult, was vital to ensuring that the defense enterprise can recruit and retain STEM talent in the future. Changing this culture, however, requires a shift from viewing the STEM workforce as a discrete cadre of "support" professionals to a more multifaceted, "operationally minded" workforce that is not only integral to successful operations across all missions but is also capable of leading them.

Cultural change, of course, is hard but not impossible. Indeed, the cyber organization that we studied experienced each of the key barriers outlined above. As shown in Figure 4, however, this organization also took concrete steps to overcome its retention barriers. It also identified additional actions that the entire defense enterprise can take to transform its approach to STEM talent management.

Changing this culture, however, requires a shift from viewing the STEM workforce as a discrete cadre of "support" professionals to a more multifaceted, "operationally minded" workforce that is not only integral to successful operations across all missions but is also capable of leading them.

RECOMMENDATIONS FOR TRANSFORMING THE DEFENSE ENTERPRISE

The defense enterprise has an impressive history of science, engineering, and innovation. The diversity of its workforce—including diversity in race, ethnicity, gender, and professional background—is its strategic advantage. However, while some organizations remain relatively tech-savvy, technology has outpaced many organizations in the defense enterprise,

which continue to struggle with digital transformation.[22] The result is that the enterprise today largely operates as a set of industrial-age organizations that leverage technology ineffectively rather than as twenty-first century organizations where technology and technologists are managed like a strategic asset.

Today, promotion processes insufficiently reward technical skills, and the technical tools, positions, and career trajectories that are available to STEM professionals are outdated. As a result, the defense enterprise's leadership ranks look much like they did in the past. And although these leaders hope to use technology, they may fail to serve as champions for their STEM workforce or as exemplars for technologists who hope to rise into the leadership ranks themselves.

To transform the defense enterprise from this current state to a future where it invests in technical people, we outline two lines of action below. First, in addition to recruiting more STEM talent, the defense enterprise should proactively address potential retention issues. Second, to help address those issues, the defense enterprise should manage STEM talent as a true enterprise, where technical skills are pooled and permeable not only across the federal government but across the broader defense ecosystem as well.

Address Retention Upfront

- **Collect more data to assess the current state of STEM talent recruitment and retention:** As recommended by others, the study team suggests that before setting requirements to recruit more STEM talent, the defense enterprise should use OPM and the armed services' personnel data to better understand its current STEM workforce, including geographic location, years of service, academic background, job responsibilities, and position type and level.[23] It should also collect new qualitative data—through intake, in-progress, and exit interviews—to better understand persistent gaps and workforce incentives. Although the armed services may already collect some of this interview data, the defense enterprise could benefit from a deeper understanding of its civil servants.
- **Define requirements for STEM talent across the defense ecosystem:** Armed with a better understanding of its current STEM workforce, the defense enterprise should define requirements for a STEM workforce of the future. To set meaningful requirements, the defense enterprise should define which functions STEM professionals should play and which specific skill sets and roles are necessary to execute those functions. It should also consider how functions should be allocated across the defense ecosystem, recognizing that some functions may be most effectively executed by upskilling the existing STEM workforce or by supplementing the federal workforce with contractors, federally funded research and development centers, and universities.
- **Include STEM professionals in the recruitment process:** In cases when new STEM talent is required inside the federal government, the defense enterprise should include members of its current STEM workforce in hiring processes. By including STEM professionals, the defense enterprise can more effectively evaluate applicants' technical skills and professional potential and avoid defaulting to assessments which use overly prescriptive lists of desired capabilities. One strategy for gaining more control of the STEM hiring process may be to convert STEM positions from the competitive to the excepted service.
- **Recruit and equip STEM talent at the same time:** While the defense enterprise prioritizes recruitment, it should also prioritize equipping its STEM workforce with technical tools in parallel. On day one, new STEM professionals should have the computers, software, and other equipment that are required to do their jobs.
- **Upskill the existing workforce and offer continued opportunities for training:** To reduce the recruitment burden, the defense enterprise should explore opportunities to upskill its existing workforce, enabling it to gain new technical skills. Going forward, the defense enterprise should also invest in continuous digital upskilling for its entire workforce, ensuring that their technical skills keep pace with rapidly evolving technologies.[24]
- **Flatten technical hierarchies:** The defense enterprise should flatten technical hierarchies by creating more opportunities for technical talent to serve in senior levels of the military or in GS-14 positions and above. One model for promoting civil servants may be converting their positions to "rank in person" rather than "rank in position." To offset the costs of more senior positions, the defense enterprise should recognize that with STEM talent, more is not always better. Investments in smaller, highly capable technical teams may offer better value to the government than larger, less experienced teams.
- **Prioritize STEM talent and literacy in defense enterprise leaders:** To retain the STEM talent that it recruits, the defense enterprise should develop leaders to be technical champions. New pathways should be created to allow STEM talent to join leadership ranks, where technical or

specialized experience should be viewed as an asset, not as a detriment to promotion. Similarly, the defense enterprise should expose non-STEM leaders to technical issues through training, rotations, and the assignment of advisers who can serve as technical champions.

Manage STEM Talent as a True Enterprise

- **Pool and centrally manage STEM talent:** Rather than managing STEM professionals in technical stovepipes, explore opportunities to pool and centrally manage STEM talent as a shared resource for organizations across the defense enterprise. Create opportunities and incentives for STEM professionals—especially civil servants—to join this talent pool and accept broadening assignments in different organizations. Initially, the defense enterprise can pilot this concept for civil servants, using demonstration authorities from OPM and drawing on lessons from the armed services. Similar technical talent pools already exist in exemplar communities, such as the Army's operations research/systems analysis functional area and have also been proposed for the Army's digital workforce.[25]
- **Create shared unclassified opportunities for pooled STEM talent:** By pooling and centrally managing STEM talent, especially civilians, the defense enterprise can also onboard new hires before their clearance process is complete. While awaiting clearances, pooled STEM talent can begin centralized training, support unclassified projects, and work in shared, unclassified workspaces.
- **Integrate STEM and non-STEM professionals on the same teams:** The defense enterprise must prioritize, incentivize, and provide opportunities for technologists and operators to convene and work together on system development. Technologists must understand their customers and users. Although the defense enterprise should consider centrally managing STEM talent, it must ensure that when STEM professionals are assigned to organizations, they work on integrated teams composed of both STEM and non-STEM professionals. Not only will such integration help close gaps between developers and operators, for example, but it will also help break down communication and cultural barriers between the defense enterprise's technical and non-technical communities.
- **Encourage permeability across the defense ecosystem:** Finally, the defense enterprise should encourage STEM professionals to gain experience outside of the government through internships, fellowships, and rotational assignments to labs, universities, and the private sector. Rotations across the defense ecosystem should be incentivized and serve as career advancement criteria in public, private, and academic sectors. The defense enterprise should support a "continuum of service" that enables personnel to reenter government service after serving in other roles.[26] Interviewees noted that career permeability can be further enabled by maintaining and cultivating alumni networks across the defense ecosystem.

To compete, the defense enterprise must fully leverage its workforce's potential by creating opportunities and incentives to retain all talent, especially in STEM. To achieve the fundamental shift necessary—from the industrial age to technical organizations that are positioned to innovate and compete in the twenty-first century—the defense enterprise must take a holistic enterprise approach to invest in and promote technical people. Importantly, the defense enterprise cannot undertake these steps alone; an integrative approach including Congress, industry, universities, and research and engineering hubs will ultimately drive the reforms needed to retain and grow STEM talent across the defense enterprise in the future. ■

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This brief is made possible by the generous support of the Pallas Foundation, Rebellion Defense, and Yubico, Inc.

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