

Science and Technology Investment

The key to timely modernization

by Maj Franz Gayl, USMC(Ret)

A robustly funded Marine Corps Science and Technology (S&T) program is critical to our effective and timely modernization. This requires increasing the Marine Corps' discretionary basic research, applied research, and advanced technology funding while expanding the size of both the Marine Corps Warfighting Lab (MCWL) and the S&T cadre. The alternative is the *status quo* practice of drafting the S&T investments of others. This frugality-based followership progressively undermines preparedness because time is lost in the development of Service-unique capabilities. In fact, it places Marines at risk when directed to execute Title 10 tasks in the future when they are technologically overmatched.

As the smallest Service, the Marine Corps has a commendable history of doing more with less. In past conflicts we have often prevailed despite inadequate weapons and equipment inherited *ad hoc* from other Services. Legendary Marine Corps conduct in Belleau Wood, Tarawa, Korea, and Iraq stand out. Despite the Corps' comparatively modest research, development, testing, and evaluation emphasis, the Marine rifleman was the lethal weapons platform that mattered most to combat outcomes in practice.

This will not be the case in the future. The autonomous platforms employed in Manned Unmanned Teaming (MUM-T) and by adversaries alike will soon come to possess the preponderance of battlefield lethality. The decisive role

>Maj Gayl enlisted in the Marine Corps in 1974, where he served as an Antitank Assaultman and attained the rank of sergeant. Later, he served as a Marine Corps Infantry Officer until his retirement in 2002. He has since served as a civilian Science and Technology Advisor in Headquarters Marine Corps.

of the Marine armed with a personal or crew-served weapon is giving way to equally demanding, yet indirect, operator and maintainer contributions in support of remote platforms. The shift from manual human to machine warfighting is sure to accelerate.

The *Commandant's Planning Guidance* (CPG) states, "This is the force that will always adapt and overcome no matter what the circumstances are."¹ Going forward, our ability to adapt and overcome will be challenged by our growing technological dependence. Our role in the *National Defense Strategy* calls for specialized weapons and equipment. Joint collaboration should be pursued for material efficiencies and interoperability when interests align in accordance with the CPG's stress on partnering with others to share risks. But when developmental paths do not serve our unique naval expeditionary needs, we must retain the capacity to determine our own technological destiny. Considering the relentless modernization of the pacing threat, the lost time associated with followership will be unrecoverable.

The feasibility of littoral operations in a contested environment (LOCE), expeditionary advanced base operations (EABO), Marine rifle squad reorganization, and amphibious operations require

many new Service-specific capabilities. Since combat development begins with S&T, S&T should thus constitute a larger fraction of the Marine Corps' discretionary total obligation authority (TOA).

However, the Marine Corps' percentage of TOA dedicated to S&T has historically been far less than that of other Services. Figure 1 (on following page) graphically compares the Marine Corps' Fiscal Year 2019 S&T investments with those of other DOD Services and Agencies.²

Some may suggest that the comparisons in Figure 1 are misleading, as the Marine Corps benefits from hundreds of millions per year in additional S&T resources through its presence within the Office of Naval Research (ONR). They also might point out that the CG, MCWL is dual hatted as the Vice Chief of Naval Research (VCNR).

Furthermore, the de-emphasis on RDT&E investment in favor of readiness for current operations and responsiveness to combatant commander requirements has been a conscious Service decision. It is the Warfighter Investment Program Element Board that allocates resources to S&T based on its collective perception of Service priorities. In Fiscal Year 2019, the Marine Corps allocated approximately \$260 million in funding

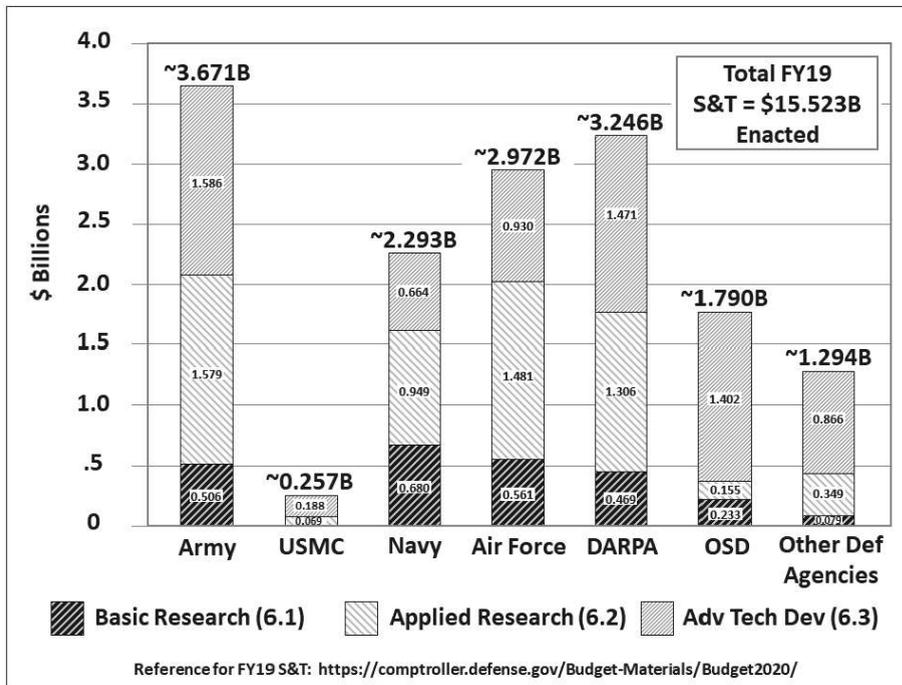


Figure 1. Side-by-side comparison of DOD S&T budgets in FY19.³ (Figure provided by author.)

toward S&T. Of that total, \$158 million went to ONR, with the remaining \$100 million in “green” S&T being shared between MCWL and the Joint Non-Lethal Weapons Directorate.⁴

To amplify the impact of its relatively small contribution to ONR, the Marine Corps S&T Program claims to “leverage” the Navy’s over \$2.2 billion S&T stake there.⁵ The program also claims to leverage the S&T investments of the intelligence community, Defense Advanced Research Projects Agency (DARPA), and the Strategic Capabilities Office—to name a few. This strategy has been described as “spending other people’s money” to satisfy many of the Marine Corps’ modernization needs.

However, the longer-term ONR commitment to the Marine Corps’ growing S&T needs is uncertain. The Marine Corps’ own Expeditionary Maneuver Warfare Department (Code 30) at ONR was eliminated in 2019. The Chief of Naval Research’s (CNR’s) intent was to have the remaining five ONR codes make up the difference by embracing the Marine Corps’ needs in an integrated naval S&T investment strategy. But this transformation has been difficult for the other codes as they, as well as their portfolio priorities, have

long been defined by a Navy-centric research culture. The internal reorganization has been met with some push-back, resulting in personnel turn-over. Adding to the uncertainty, until recently, it has been difficult for the Marine Corps to quantify to what extent its contributions to ONR have actually been spent on the Marine Corps’ needs and what leverage was actually gained.⁶ The success or failure of ONR’s reorganization will probably not be measurable for years; it remains an experiment. In the meantime, the Marine Corps’ EABO and LOCE challenges mount and demand guaranteed return on investment in the near term.

Also, the decision-making authorities of the VCNR are limited. With the rare exception of regulation-based actions as senior officer in the CNR’s absence, the dual-hatted CG of MCWL is primarily relegated to an advisory role at ONR.⁷ As VCNR, he has limited—if any—reprogramming discretion over “blue” Navy dollars, and the decision-making CNR is always a Navy flag officer.⁸ Likewise, the influential position of Director, Naval Research Laboratory (NRL) is consistently a Navy Captain, even though the NRL under ONR constitutes the Department of the Navy’s

(DoN’s) corporate lab for both Services. Neither the position of the colonel Director nor the NRL’s deputy director have ranked well in Marine Corps manpower staffing priorities.⁹

The value of any continuous uniformed Marine Corps presence at any level in defense research organizations, such as ONR and NRL, is potentially priceless. Still, even in the ONR headquarters of 900 Navy civilian and uniformed personnel, the Marine Corps has managed to maintain only four active uniformed billets. The situation is bleaker at NRL, with two Marine Corps reservists compared to hundreds of Navy civilians, at least a dozen Navy active duty personnel, and an NRL Navy reservist population of over 200—many being scientists and engineers.¹⁰

Presently, the CPG also states,

Given the pace and consequence of ongoing technological change, the Lab [MCWL] must continue to evolve to meet the demands of the future strategic and operational environment.¹¹

The form of evolution will be determined by leadership; however, at a minimum, it should include increases in both S&T funding for tangible investment and qualified personnel for S&T community participation. The disparity of at least nine-to-one between the discretionary S&T modernization resources available to two Services under the same Secretary continues to stand out.¹²

When it comes to force development action taken on gaps requiring S&T investment, the Marine Corps S&T Program must defer to the Capabilities Development Directorate (CDD) under the Deputy Commandant for Combat Development and Integration (CDI). The CDD is tasked with anticipating strategic challenges and opportunities, and this includes evaluating advocate and Fleet Marine Force (FMF) identified needs for combat development action. The CDD evaluates gaps identified through advocate prioritization and CMC direction, as well as deliberate and urgent universal need statements (D-UNS and U-UNS). In managing the Warfighter Investment Program Element Board, CDD must prioritize

investment based on available resources, and faced with a zero-sum game dilemma futuristic, S&T-dependent UNS fall below the funding line.

Some might contend that S&T equities scale proportionally with Service TOA, and that the Marine Corps, as a smaller Service, should logically have fewer S&T resource requirements. However, S&T is a fixed cost independent of Service size. We may be a smaller Service, but developing the many Service-unique capabilities driven by our EABO focus will carry the same risks and fixed developmental costs as they would for a larger Service or agency.

Additionally, the CPG encourages innovation but also stresses that “the Deputy Commandant for Combat Development and Integration has primary responsibility for all Marine Corps force development,”¹³ with all other advocates providing subject matter expertise, rather than development direction. Unfortunately, in the absence of S&T Program funding margins needed to build on success, many Supporting Establishment organizations have found it necessary to self-fund innovations using in-house funds outside of CDI and MCWL processes. These include, but are not limited to, DC, Installation and Logistics’ Next Generation Logistics experimentation, 55 separate artificial intelligence (AI)

initiatives across the Supporting Establishment, Marine Corps Systems Command’s AAV innovations, and Training and Education Command’s Brute Krulak Center for Innovation and Creativity. Each of these exceptionally worthy initiatives has the potential to accelerate the Marine Corps’ modernization efforts. Yet, they invariably lack fiscal sustainability and frequently fail to transition as operational capabilities. To achieve CPG-directed unity of effort and messaging, such innovations should logically come under the coordinated oversight of the Marine Corps S&T Program as well as receive tangible S&T Program transition support.

AI serves as a relevant S&T case study. As the animating force of autonomous machines during MUM-T, AI is one of, if not the most, important enabler of Marine Corps modernization. Over the years, HQMC advocates and FMF leaders have expressed numerous needs for AI-enabled capabilities by means of D-UNS and U-UNS submissions to the CDD. Each sought to accelerate the pace and direction of AI technologies maturing at DARPA, industry, universities, and in other Service labs. In every case early S&T investment was required, yet each fell below the funding line.

Some will counter that ONR is fulfilling all of the Marine Corps’ AI

research requirements. However, during a recent review of ONR’s AI basic research initiatives, it was difficult to see any connection to identified Marine Corps AI and data-related needs.¹⁴ Conceivably, Marine Corps influence over 6.1 basic research funding could prove critical to efficiently driving hopeful science toward the highest payoff technologies and capabilities for the future FMF. But the continued absence of any Marine Corps discretion over DoN’s \$600 million per year in 6.1 causes AI and other basic research to take non-operationally inspired, academic directions in line with the traditional ONR basic research culture.

Admittedly, much progress has been made elsewhere under the leadership of DC, Information as the Marine Corps’ lead for AI. An Information Investment Program Evaluation Board was established and a Marine Corps AI community of interest (COI) was formed. Under the co-oversight of the DC, CDI and DC, Information, the COI is assisting in the prioritization of AI investments, incentivizing AI innovation at the edge and supporting the transition of successful AI-enabled capabilities while mitigating unintended duplications of effort through COI transparency. Nevertheless, empowering the AI COI to tangibly act on the most salient AI and data-related challenges will require top-level, AI S&T-favoring TOA redistribution that includes 6.1 resource ownership.

To compensate, other DOD organizations are assisting with the Marine Corps’ AI operationalization ambitions. The Director of the Joint AI Center (JAIC) has offered to assist in the development of a tactical fires-related AI application important to the Marine Corps GCE.¹⁵ With PP&O sponsorship, the Naval Postgraduate School is also funding Marine Corps student research in AI to specifically address those GCE fires-related interests. The JAIC also offered to purchase several dozen game-changing, fully autonomous, UAS for FMF experimentation in response to a USMC UNS. However, the S&T Program at MCWL declined the offer due to an apparent lack of capacity causing the Marine



Some research is being done, but more is required. (Photo by author.)

Corps to pass on the opportunity to lead in the tactical operationalization of AI. Separately, industry partners have helped by augmenting other Marine Corps AI projects in execution. This includes providing internal research and development and personnel contributions to ensure contracted project deliverables well-exceed expectations because Marine Corps S&T resource scarcity is widely recognized. While external support is greatly appreciated, its necessity serves to further illuminate S&T resource shortcomings.

Then again, some might observe that AI is the most revolutionary field currently being explored, and because of its exceptionality, it cannot be used to generalize Marine Corps S&T investment behaviors. Still, before AI, directed energy weapons (DEW) served as an illustrative Marine Corps S&T case study.

For two decades, HQMC advocates and FMF leaders have expressed needs for DEW-enabled capabilities. Each sought to accelerate the pace and direction of DEW technologies maturing in Service labs, DARPA, and industry. As with AI, the DEW-dependent D-UNS and U-UNS were submitted to the CDD based on prior knowledge of specific S&T projects in DOD and industry that could accelerate if given a committed Marine Corps S&T partner. The UNSs also defined Marine Corps user-suitable tactical configurations that could—given Marine Corps cost-sharing—steer prototyping efficiently for earlier fielding.

Unfortunately, like AI, DEWs were considered futuristic and immature, and failed to initiate S&T new-starts in the face of higher Service funding priorities. Many years were lost, and S&T cost-sharing opportunities with DARPA, other DOD labs, and industry were missed. Meanwhile, the relevance of DEWs to the modern battlefield continues to grow.

The AI and DEW cases illustrate the need for early Marine Corps S&T “skin-in-the-game” investment accompanied by a transition bridge to guarantee timely capability fielding. Each Service is responsible for independently researching, developing, and

outfitting forces when Service needs and requirements are not suited to joint commonality. This responsibility spans the spectrum from basic research through operational capability, and there are many DOD precedents for independent paths. For example, the Marine Corps prefers Light Armored Vehicles, while Army prefers Strykers. We employ CH-53s, V-22s, and Cobras, while Army employs CH-47s, Blackhawks, and Apaches. As a more current example, the Marine Corps is considering the innovative adaptation of Service-unique legacy systems to serve as risk-worthy stand in forces in the conduct of EABO.¹⁶ Such weapons and equipment differences do not always make sense to Congress, the Office of the Secretary of Defense, or auditors focused on commonality and interoperability. But we must make the case for and invest in Service-unique capabilities when appropriate.

Some may ask why the Marine Corps needs to steer 6.1 basic or 6.2 applied research investments in pursuit of modernization. After all, ONR consistently expends over \$600 million in 6.1 and over \$900 million in 6.2 per year in a programmatically responsible fashion, and that alone should render any Marine Corps direction superfluous. However, purposeful research must be guided by military operational expertise and vision from the start (i.e., contain a seed of utility at the outset). With the exception of the Marine Corps, all DOD Services and agencies recognize this necessity, and each routinely receives 6.1 and 6.2 resources to that end. As an industry example, the first primitive semiconductor was not discovered by accident or luck. The now-celebrated practical utility of the physical phenomenology was first predicted in thought experiments in the minds of the semiconductor’s co-inventors.¹⁷ What the Marine Corps needs to present researchers are sufficiently detailed thought experiments articulated by Marine subject matter experts who embrace the operational logic of envisioned capability use cases without dictating technological paths forward. Scientists and engineers treasure such early operational guidance as it enables them to work

toward useful prototypes at lower cost and a faster pace.

Some will say that the Marine Corps merely needs to be a savvy customer, observing which technology investments by other Services pan out and only then execute its own well-timed investments. Many contend that followership presents a better business case for the commitment of scarce resources. In fact, fast followership is the better choice when Marine Corps technology applications align with respect to joint or multi-Service interests. However, history contains many examples where the Marine Corps’ risk and cost-tolerant human and technology leadership was preferred to un-invested, non-influential followership.

It is our cultural character and gift to be willing to take technological risks and lead from the front. The 1st Marine Air Support Radar Team revolutionized close air support in Korea by using nascent computer technologies.¹⁸ Lt-Col Armond H. De-Lalio’s bold 1950s experimentation with rotary-wing jet-assisted take-off arguably helped reduce the risk for high pay-off C-130 jet-assisted take-off in the years that followed.¹⁹ The first aviator to land on a ship was a Marine, and the first American astronaut to orbit Earth was also a Marine. More recently, the potential of tilt-rotor aircraft to transform expeditionary operations was imagined by Marine Corps visionaries decades before it existed. Marines steered it throughout, absorbing costly and tragic setbacks, yet today we have the V-22—a symbol of Marine Corps and naval modernization.

Alternatively, if we choose to draft the S&T work of other Services, at a minimum, we let others define the limits of what we can and cannot do. This would provide ammunition to COL David Hackworth’s 1990s argument that our Title 10-empowered Service should be absorbed in the Army.²⁰ Worse yet, linear followership could very well place our Marines at risk of being technologically surprised by uninhibited adversaries who are well-adapted to and embrace exponential trends. To avoid such fates, robust, risk-tolerant, and early S&T-driven modernization is key to our Corps’ continued relevance

and self-determination. The following recommendations are presented for consideration.

The CPG directs us to

seek greater integration between the Navy and Marine Corps in our Program Objective Memorandum (POM) development process ... ensuring a common understanding and common baseline from which each Service can communicate.²¹

In transparent coordination with Navy, the Marine Corps should therefore use POM for greatly increased sums of 6.1 basic research, 6.2 applied research, and 6.3 advanced technology development S&T funding. This will provide MCWL the resources to evolve to “the focal point and integrating ground for new concepts, capabilities, and technologies that we develop, as well as a key enabler for accelerating the Service’s future force development efforts.”²² Also, for unity of modernization efforts, all Marine Corps “green” S&T resources should be overseen by MCWL and used at the discretion of the CG to reinforce and help transition successful Supporting Establishment and FMF innovations.

The position of CG, MCWL, currently dual hatted as the VCNR, should be elevated to a two-star billet. The billet of CNR at ONR should then regularly

alternate between a Navy flag officer and that elevated Marine Corps general officer. In line with naval integration, the assigned CNRs, whether Navy or Marine Corps, should have reprogramming authority over both blue and green S&T funds at ONR during their tours. This will imbue all FMF advanced capabilities with a fused, purposeful, naval focus from their inception. Over time, this will transform the culture of ONR into one that is truly naval in character. This improvement is especially timely now that the CNR billet reports directly to the Secretary of the Navy.

The Marine Corps should increase its Special Education Program (SEP) throughput while reducing war college attendance in favor of non-resident alternatives. The SEP emphasis should be overwhelmingly on science, technology, engineering, and mathematics as well as interdisciplinary tracks such as data science. The academic tradeoff should be a minimization of non-science, technology, engineering, and mathematics tracks such as program management. The larger operationally and technically bilingual SEP cadre should then come to populate every relevant DOD Agency and Federally Funded Research and Development Center. Marine Corps presence includes consistently assigning SEP graduates within every Code at

ONR—without gaps—and to DARPA in numbers proportionally comparable to the uniformed personnel provided by other Services. It should also include the assignment of SEP graduates to NRL Codes in numbers that consistently match those of uniformed Navy personnel. Concurrently, the assignment of SEP graduates to mature Marine Corps Systems Command’s programs should cease in favor of freeing their innovative expertise for billet assignments throughout the larger DOD S&T community.

The Marine Corps can also model the successful modernization efforts of other Services. For example, the Army has entered a cooperative agreement with Carnegie Mellon University to accelerate the research and development of Advanced Algorithms, Autonomy, and AI.²³

In 2019 the Air Force and the Massachusetts Institute of Technology (MIT) launched a similar program known as the MIT-Air Force AI Accelerator.

MIT recently proposed to CMC a separate partnership with the Marine Corps titled “Expeditionary AI and Robotics” (ExAIR).²⁴ MIT would work with Marine Corps operators to rapidly deliver prototypes of advanced AI, and robotics-enabled MUM-T capabilities for operational assessment. Every MIT project would have a Marine Corps-specific operational focus from initiation. ExAIR could also capture both USMC and Navy-focused needs to serve as the DoN’s elite partner in AI and robotics. Concurrently, ExAIR would mine the larger AI academic ecosystem and other Services’ progress when developments prove to be of joint or multi-Service utility. In all cases the naval ExAIR deliverables would overmatch our pacing threat as the Marine Corps and Navy hasten preparations to employ MUM-T and autonomy in support of LOCE and EABO.

Freeing up enough TOA to enable the effective evolution of MCWL and the S&T Program will require significant Marine Corps divestitures. But in a recent article Dakota Wood posed:

The Corps must ask whether a commitment of limited resources adds to its ability to prosecute a naval campaign



The Marine Corps can work more closely with the Navy to accelerate modernization efforts.
(Photo by Sgt Adam Dublinske.)



MCWL's Project Metropolis II, a limited operational experiment, combined robotics, sensors, and manned/unmanned vehicles. (Photo by Matt Lyman.)

and helps it to develop the capability to fight and win in the Indo-Pacific's contested littorals ... If the answer is "no" or "maybe," it should redirect those resources where they will be most useful.²⁵

In short, the Marine Corps is presented with a choice. We can continue to express satisfaction with status quo marginal improvements to a comparatively insignificant S&T program and entrust our modernization to the funding priorities of others; or we can commit to a large TOA redistribution—a pivot that favors S&T going forward. It is arguably better to have a smaller, thoroughly modernized FMF focused on overmatching the most relevant threats than a larger force promising all things to all combatant commanders with potentially obsolete weapons and equipment.

In conclusion, the Marine Corps S&T investment from the time of capability conception will avoid placing the future Marine Corps and Marines themselves at risk. With long-range shooting as an analogy, a gentle breeze that begins at the muzzle (early S&T investment) has greater influence on bullet path than a stiff wind only encountered at the target (late S&T investment). Modernization requires Service S&T skin-in-the-game throughout

to meaningfully affect technological outcomes. That is why the S&T Program and MCWL must receive a much larger slice of the Marine Corps TOA and structure to fulfill CMC's intent.

Notes

1. Gen David H. Berger, *Commandant's Planning Guidance*, (Washington, DC: July 2019).
2. DOD Comptroller, *Fiscal Year 2019 (FY19) DOD Research, Development, Testing and Evaluation*, (Washington, DC: June 2019).
3. Graphic depiction of FY 2019 Total Enacted Research, Development, Testing, and Evaluation available at <https://comptroller.defense.gov>.
4. ONR, *Overview for HQMC EAs and CoS*, (Washington, DC: September 2019).
5. Ibid.
6. Ibid.
7. Ibid.
8. General information regarding the CNR available at <https://en.wikipedia.org>.
9. *Overview for HQMC EAs and CoS*.
10. Ibid.
11. *Commandant's Planning Guidance*.

12. *Fiscal Year 2019 (FY19) DOD Research, Development, Testing and Evaluation*.

13. *Commandant's Planning Guidance*.

14. ONR, *Science of AI Performers*, (Washington, DC: June 2019).

15. Director JAIC Letter to DC, PP&O, (Washington, DC: April 2019).

16. Marine Corps Systems Command Program Manager, *Advanced Amphibious Assault, CMC Innovation Challenge Update*, (Quantico, VA: March 2019).

17. John Orton, *The Story of Semiconductors*, (Oxford, UK: Oxford University Press, November 2004).

18. Headquarters Marine Corps, "The Korean War Unit Records," (Quantico, VA: Marine Corps History Division, July 2019).

19. William Fails, *Marines and Helicopters, 1962-1973*, (Quantico, VA: Marine Corps History Division, 1978).

20. COL David Hackworth and Julie Sherman, *About Face*, (London, UK: Sidgwick & Jackson, April 1990).

21. *Commandant's Planning Guidance*.

22. Ibid.

23. Sean Kimmons, "In First Year, Futures Command Grows from 12 to 24,000 Personnel," *U.S. Army*, (August 2019), available at <https://www.army.mil>.

24. MIT LL Invitation to DC, CDI and CG, MCWL; Including ExAIR Proposal, (Cambridge, MA: August 2019).

25. Dakota Wood, "Rebuilding America's Military: The United States Marine Corps," The Heritage Foundation, (March 2019), available at <https://www.heritage.org>.

26. Naval Information Warfare Center Pacific, *Photo of Autonomous-Assault Amphibious Vehicle (A-AAV) collecting data from surf zone testing while training Marines how to program Autonomous Waypoints and Tele-operation*, (Camp Pendleton, CA: October 2019).

