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Rebuilding America's Military: Thinking About the Future

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About the Author

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This Special Report *is the first in a series from The Heritage Foundation's Center for National Defense that addresses the U.S. military's efforts to prepare for future challenges. This paper establishes the framework to be used by the papers that follow that will individually address each military service.*

This paper, in its entirety, can be found at:
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America's military—engaged beyond capacity and in need of rebuilding—is at a crucial juncture. Its current "big-leap" approach to preparing for future conflict carries great risk in searching for revolutionary capabilities through force-wide commitments to major single-solution programs. The Heritage Foundation's Rebuilding America's Military Project (RAMP) recommends that the U.S. military instead adopt an iterative, experimentation-heavy approach that can achieve revolutionary outcomes at less risk through evolutionary improvements that build on each other until transformative tipping points are reached. Critical to this is a military culture that is immersed in the study of war and a force of sufficient capacity to prepare for the future while also handling current operational commitments.

> [The] future is not preordained. This is the main reason why prediction is so difficult. There are decisions yet to be made, even about challenges that are well understood, along with chance events that will catch us unawares and developments already in train that have been inadequately appreciated.
>
> —Lawrence Freedman[1]

Introduction

On September 7, 2016, in a major speech outlining his views on national security, then-presidential nominee Donald J. Trump proposed rebuilding America's military, noting its small size and unreadiness to deal with the maturing challenges posed by major states like China and Russia and the ongoing threat to U.S. security interests posed by terrorist and international criminal groups.[2] Mr. Trump was not alone in noting worrisome trends and conditions. During the 2016 election cycle, nearly every major presidential candidate voiced similar concerns and policy objectives.

Since that time, leaders from both political parties in both chambers of Congress, as well as senior civilian and military officials in the Department of Defense (DOD), have noted the military's deteriorated readiness, capacity, and modernity to shoulder the tasks of defending national security interests. Such tasks could include missions conducted under a broad range of circumstances, from conventional war between major powers to various forms of irregular warfare involving sub-state aggressors or terrorist groups to security operations conducted in partnership with like-minded states.

If the military truly has significant shortcomings in its ability to secure the country and its interests and must therefore be rebuilt, what should rebuilding mean? To answer that question, The Heritage Foundation suggests an approach to rebuilding America's military power that holds the best prospects for success in the years ahead.

Analysts and defense pundits consistently say that the future cannot be known, yet they attempt to forecast the future based on observable trends,

projecting those trends decades into the future in order to speculate on likely future conditions. In turn, the military services use those forecasts to inform modernization plans and related efforts meant to prepare them for future missions.

The Heritage Foundation's Rebuilding America's Military Project (RAMP) will provide a practical approach not only to reconstituting U.S. military power, but also to preparing the military for future conflict in a way that accounts most effectively for things that can and cannot be known. Included in the first category are advances in technology; the realities of defense acquisition; military service histories in experimentation and force development; the nature of competitions involving states, nonstate entities, and affected populations; and historically rooted aspects of military affairs. The second category involves the specifics of all of these factors as they interact over time, invariably leading to outcomes and conditions that are impossible to know before they occur.

RAMP will be published in a series of five papers. This first paper sets the stage for the papers that follow with an overview of Heritage's approach to dealing with "futures." We begin by examining the critical importance of replacing the current "big-leap" approach to military preparedness with an iterative, incremental approach based on experimentation that would have a much greater likelihood of ensuring that the armed forces of the United States are properly prepared for the future than are those of America's competitors.

Subsequent papers will address how such an approach would pertain specifically to each service and what opportunities exist for the U.S. Army, Navy, Air Force, and Marine Corps to develop and integrate new capabilities even as they execute current programs of record such as the F-35 fighter, B-21 bomber, *Ford*-class aircraft carrier, and *Columbia*-class ballistic missile submarine and undertake reorganization of their operational units and formations.

Importantly, RAMP does not attempt to predict specific outcomes, nor does it presume to know the pace at which adjustments to the force might occur. It also does not predict how competitors might change their forces and approaches to conflict. Rather, this approach recognizes that warfare—preparation for war as well as actual combat—is an interactive and highly volatile condition involving an unpredictable number of participants who act, react, and counteract in ways and for reasons that are unique to specific circumstances at any given moment. It is this dynamic nature of conflict and competition that makes preparing for war years in advance of its outbreak such a challenge.

Through RAMP, we propose a different paradigm for force preparation and modernization, a paradigm that involves an investment strategy for rebuilding America's military that allocates taxpayer dollars to efforts with the greatest potential to generate meaningful combat power that is relevant to the world in which the military must operate. RAMP urges the military establishment to adopt a different way of thinking about its approach to ensuring that the Joint Force is able to defeat any adversary—not only today or next year, but on the battlefields that inevitably will materialize 20 or 30 years from now. RAMP calls on the U.S. military to shift its thinking from the 20-year leap approach—in constant pursuit of the next transformative moment—to a more iterative and evolutionary approach that will result in a force that is more consistently modern, mentally agile, spiritually resilient, and culturally confident, regardless of the nature of the enemy or the circumstances of combat.

Challenges to Rebuilding

During the past few years, a chorus of voices—voices from across the government and the military services and including national security analysts and commentators—has noted the deteriorated state of the U.S. military's readiness for conventional war against a major adversary. The U.S. military is smaller, older, and less ready for large-scale operations today than at any other time in nearly 80 years or more, while challenges to U.S. security interests have grown in number and severity since the end of the Cold War.[3]

The military's weakened condition is due in large measure to more than 16 years of unremitting combat operations in the Middle East and South Asia, a series of high-profile and very expensive modernization program failures during the 1990s and early 2000s, generally flat or reduced budgets since the end of the Cold War, severe cuts in defense funding imposed by the Budget Control Act of 2011, and general budget volatility over the past several years. At the same time, China and Russia have committed to updating and expanding their military capabilities and using their enhanced power to pursue objectives antithetical to U.S. interests globally, and Iran and North Korea have taken bold steps to exert dominant influence in their respective regions, working to overturn security arrangements long underwritten by the U.S.

To correct this situation, U.S. political leaders have committed to "rebuilding the military." But this raises fundamental questions: Rebuild it to do what, with what capabilities, in what form, and with what capacity?

Finding answers to such questions means trying to anticipate the conditions for which the military must prepare. Assumptions must be made about potential adversaries, the circumstances that lead to war, the nature of conflict, and its scale and scope. Counterinsurgency operations against an enemy that lacks artillery, armor, aircraft, and ships is far different from large-scale conventional operations against a fully equipped major state. The military must assess whether various emerging technologies, such as artificial intelligence (AI) and robotics, enable it to conduct major combat actions with a smaller force than previously needed or whether capacity will remain an issue in spite of new capabilities.

Forecasting the nature, location, and context of battles that may be fought 20 or 30 years in the future might seem a fool's errand, but one cannot prepare for a war after the fact. If only from a material standpoint, the services must purchase new equipment to replace items nearing the end of their planned service life. With ships, aircraft, and tanks lasting 20 to 40 years or more, military leaders are compelled to make the most informed decision possible before committing vast sums of money to programs that must remain relevant in as many settings as possible for as long as possible.

That the future is unknowable in its details is true, but it is also true that facets of the future can be glimpsed because some elements that will comprise it (for example, demographic trends) can be seen today and are difficult to change. This is likewise true for the military, largely because it already has or is in the process of acquiring many of the tools it will use 20 years from now. The "known unknowns," to borrow from Donald Rumsfeld, that frustrate serious planners comprise those things that are known to be highly volatile, the things that are so variable that even though one knows about them, one cannot predict what will become of them a year from now, much less 20 or 30 years from now.[4] Technology and specific human behaviors fall into this latter group.

When dealing with these "known unknowns," two critically important factors, seldom addressed in service documents, come into play: nonlinearity and capacity. In *The Future of War: A History*, Lawrence Freedman sensibly observes that "the future is not preordained" and cannot be predicted because it evolves from the interaction of people with events.[5] While history and statistical modeling can point to reasonable probabilities, they cannot state with certainty that a specific condition *will* arise. Because specific individuals will occupy key positions in the future and public reactions to future events and conditions will be determined by the specific individuals who comprise society at that time, the ability to prepare for the future depends on the ability to adapt to changing conditions as awareness of them evolves.

The surest way for a military to keep pace with changing conditions is to experiment constantly to see what "new" means in practice and to maintain competence in the warfighting skills that history has shown to have enduring value. So too must the

military remain routinely engaged with the world to know what and how conditions are changing and to be in a position to shape events favorably along the way.

Nonlinearity. Analyzing observable trends and using methodologies that explore possible alternative futures are useful in trying to peer into the future. The military establishment regularly attempts to understand trends in and their implications for everything from potential causes and likely locations of conflict to the progress of various technologies and how they may affect the conduct of military operations. Defense planners know that however good any weapon, sensor, or platform (ship, plane, or vehicle) may be, new technologies will alter conditions so that targets are harder to find, systems are easier to detect, opposing forces are separated by greater distances, and advanced capabilities are more affordable and more widely available. Given finite resources and the time it takes to develop, field, and become proficient with new tools, the military services emphasize understanding where trends may lead so that the tools of war are relevant and effective for as long as possible.

Such efforts often create new problems, however. In the attempt to ensure that major defense programs cover as many potential challenges as possible, equipment requirements tend to become more expansive in scope and scale. This leads to complexity in design, greater challenges in development and production, extended time to field, and increased cost. Along the way, everyone involved in the process—from the services to manufacturers, supporters in Congress, and senior Administration defense officials—becomes heavily invested in the program. Ultimately, a major program accumulates so much momentum that canceling it is difficult even if conditions turn out to be very different from those that were originally anticipated.

A similar pattern of nonlinearity occurs in trend and threat analysis. Throughout the Cold War, for example, the Soviet Union remained a consistent pacing threat against which the U.S. military assessed challenges and developed capability and employment concept solutions.

During the 1990s, with the Soviet Union gone and states like China and Russia yet to emerge as serious challengers to the U.S., military planners adopted a capabilities-based approach to modernization rather than a threat-based approach. This method envisioned capabilities that would be desirable regardless of the opponent, which led to a host of programs premised on the promise of future technological advances that included comprehensive situational awareness and assured information exchange among highly distributed forces, widespread use of unmanned systems, and long-range munitions of great precision.

Unfortunately, many of these programs were overly aspirational and ended in cancellation. The technologies of the day were not sufficiently mature to produce usable capabilities within tolerable budgets and timelines.

The September 11, 2001, terrorist attacks refocused the military on counterterrorism and, a few years later, counterinsurgency operations. Real-world problems such as detecting, protecting against, and neutralizing improvised explosive devices (roadside bombs) and identifying militants and their support networks within large civilian populations demanded the full attention of the U.S. defense establishment, overriding concerns about and preparation for conventional war.

Within this strategic context—the immediate demands of counterinsurgency/counter-terrorist operations and the lack of a major state competitor as assessed by the defense/national security community—an entire body of work and futures forecasting arose that emphasized the nature, likelihood, and future challenges of conflict short of large-scale conventional war. Futurists predicted that war would involve some variation of irregular warfare, variously described as (among other descriptors) hybrid, gray zone, ambiguous, or asymmetric—anything but large-scale, conventional, state-vs.-state conflict akin to World War II or the Korean War. Or so the argument went.

To the frustration of many military futurists, competitor state powers have arisen while the U.S. has remained fixated on irregular wars. China, Russia, North Korea, and Iran have emerged as serious threats to U.S. interests in key regions, throwing the services' views of what future conflict would be like into disarray. This is especially true with respect to the Army and Marine Corps.

This new reality has been acknowledged by the Trump Administration's *National Security Strategy* and Secretary of Defense James Mattis' *National Defense Strategy*.[6] "The central challenge to U.S. prosperity and security," writes Secretary Mattis,

"is the *reemergence of long-term, strategic competition* by what the National Security Strategy classifies as revisionist powers. It is increasingly clear that China and Russia want to shape a world consistent with their authoritarian model...."[7]

History shows that security conditions do not remain static. Despite the best efforts of analysts to forecast future conditions, the behavior of individuals, societies, and groups cannot be predicted other than to say that people will not be content with the status quo and will take steps to change conditions in their favor. Present conflicts color one's vision, and forecasts nearly always project current experiences into the future, amplifying what is known rather than imagining how and why future conditions might be quite different.

Something similar occurs when projecting current trends in technology, culture, and society into the future. Analysts look at the history of phenomena and take cues from patterns of development and behavior to get an idea of where things seem likely to head.[8] The military services base their modernization and conceptual efforts on these trends, pegging their programs to an accepted view of forecasted future conditions. As programs mature in funding, effort, and institutional commitment, service views of future warfare solidify in organizations and formalized concepts, becoming harder to alter year after year, with just too many vested interests at stake.

The point here is that straight-line projections are appealing because they most easily accommodate available data and the pictures they paint are easily understood and thus compelling: They make sense. It is much harder to argue for future scenarios that diverge from observed trends. How does one make a compelling case when all of the evidence appears to point in a contrary direction? Small wonder that forecasts from a wide variety of agencies tend to mirror each other. Challenging prevailing opinions by asking "Why?" or "What if?" introduces variables that may run counter to current data, dramatically broadening the range of possible futures and making it all the more difficult to link modernization and preparation efforts to future conditions.

Capacity. If consistently maintained experimentation is key to understanding the nonlinearity of change as the present becomes the future, and if robust, iterative training and exercises are key to maintaining competence and incorporating new insights and capabilities revealed by experimentation, then the capacity of the force to do all of these while meeting operational demands becomes profoundly important.[9] Capacity is essential to ensuring that the force is able to engage the world (i.e., shoulder the daily operational load); educate, train, and exercise; and undertake the experimentation necessary to discover how advances in technology and practical employment translate into useful methods for solving real operational problems before competitors can discover them.

The smaller the force, the greater the risk it runs of not being able to meet current security demands while also preparing for the future. Risk, then, is perhaps the greatest driver shaping preparation of the force. If current challenges are grave and growing in severity and the force is comparatively small or has limited resources, the military must put off preparing for the future in order to meet the challenges of today. Conversely, if resourcing and capacity grow relative to operational demands, the military can commit more time and attention to preparing for the future, thereby decreasing risk in both the present and the future.

For 15 years or more, nearly all of the U.S. military, especially the land and air forces, has been needed to conduct sustained operations in the Middle East and South Asia. Restrictions on defense spending have forced the services to prioritize current readiness and operations over maintenance and preparation for the future—for example, by limiting the purchase of equipment to replace equipment rapidly worn out by such operations. As a result, the military simply has not had enough units and equipment to handle current operations; to take some people and units out of operational rotation for rest, training, and refitting; to engage in the full range of training necessary for competence in military operations beyond "stability and security ops"; and to undertake experimentation critical to assessing what might be useful in future conflicts. No wonder that Secretary of Defense Mattis, upon entering office, was shocked to find how deteriorated the military had become since his retirement only four years earlier and that current readiness is his top priority for the force.[10] In short, numbers matter.

Determining the Implications of New Technology

> [T]he world as a whole does not work in a mechanistic, deterministic fashion.... [C]omplex social interactions like military innovation or actual combat do not reduce to simple, linear processes.... However, human organizations in general and military cultures in particular seek to bring order and linearity to a world governed by chaotic complexity.
>
> —Williamson Murray[11]

People and organizations want to maximize dollars spent, protect and expand their position in a market, and ward off or prevail over competitors or dangers to their interests. The federal government (especially the executive branch) is no different. The intelligence community, fiscal policy offices, and the military establishment (departments, services, and agencies) in particular spend a great deal of effort analyzing evolving trends so that they can make better-informed decisions on policies and allocations of resources (money and manpower) that often require years to take effect.

For example, a particular technology, such as quantum computing, may have the potential to overturn long-held assumptions about the reliability of encryption or the speed with which detailed analysis of a competitor's weapon systems might be performed. Increasingly, unmanned systems will be seen on the battlefield (although in rather rudimentary forms) if one accepts projections of what they will be like in the future: able to operate without a person (a pilot or a driver) in the machine but requiring some form of human involvement to fire a weapon or adjust to an unexpected event.[12]

But what are the implications of unmanned systems coupled with advanced computer algorithms that allow for nearly instantaneous analysis of extraordinary amounts of data—that is, armed platforms equipped with artificial intelligence that enables them to make their own decisions—or with the ability to defeat any computer or network defense systems and thereby steal information, manipulate data, or simply observe an opponent without detection? How might these affect the conduct of war? Even if the United States—say, for ethical or risk-management reasons—were to limit the development and deployment of such capabilities, competitors likely would not similarly restrict themselves. Consequently, studying the development of a vast range of technologies and their underlying science is crucial to preparing the military for future operations.

Senior defense and military service officials cast a wide net to understand the implications of potential future conditions. Their efforts distill into a small number of key, formally accepted documents published by the U.S. defense, national security, and intelligence communities.[13] Recurring themes include:

- Major competitors;
- Significant conditions that will create violence-inducing frictions; and
- A pervading emphasis on speed, intensity, and complexity that will demand that U.S. military forces detect, understand, act, and reassess the disposition, condition, and activities of enemy forces—with extreme precision—more rapidly and effectively than they are currently capable of doing.

Identifying a trend is one thing; determining what it means going forward in the real world is quite another. In noting trends, the data usually speak for themselves in terms of changes occurring over time, patterns of relevant behavior, and expectations for how the trend may evolve based on what has been observed. When forecasting the future, assumptions have to be made, and many of them cast projections in extreme terms, whether optimistic or pessimistic. Forecasting, however, tends to ignore the fact that people and organizations respond to stimuli, in this case changing conditions. When conditions change slowly, challenges to interests may not be readily apparent, in which case responses are muted or absent altogether; but when core interests are clearly threatened, people react in alarm, and this can lead to dramatic shifts in the trajectory of the trend.

Reactions can also be counterintuitive. Old methods are sometimes readopted as effective counters to new capabilities. Intelligence collection efforts utilizing the most advanced surveillance tools have been stymied by the use of handwritten notes

carried by human couriers. People also find ways to leverage one technology against another or the same technology against itself—quantum computing used for both encryption and code breaking, for example. For all of the benefits that robots bring to the workplace—reduced costs, increased productivity, and the elimination of various hazards normally faced by people—humans may reject or limit their widespread use for a variety of reasons.

Recent problems with social media companies like Facebook, which allowed user-provided data to be exploited for political purposes, have prompted some users to delete their accounts.[14] Something similarly difficult or impossible to predict could very well happen across societies as technological tools meant to be helpful come to be viewed as overly intrusive. It is not possible to predict how tools and capabilities will be used or whether they will be accepted or rejected until they enter the marketplace.

To further complicate the problem of forecasting, projections cannot account for the impact of something that has not yet been invented or even conceived. The claim of many forecasters that U.S. capability advances (which are known) will plateau while everyone else's catch up effectively ignores the potential for the U.S. to develop something entirely new that allows it to keep its advantage over competitors.[15] For example, many predict that U.S. submarines will eventually lose their ability to operate virtually undetected, but what if the U.S. Navy and its manufacturing partners continue to improve the ability of our submarines to operate with even less signature? In making forecasts, consideration should be given to discovering new things, experimenting with emerging tools, and incorporating items as they are determined to be useful. Perhaps the primary challenge for the current force is not a lack of new developments with military relevance, but a lack of institutional ability to understand and exploit a deficiency that comes from having too little time and too little capacity to devote to the task.

As noted, top-level documents like the 2017 *National Security Strategy* and 2018 *National Defense Strategy* identify four state actors—China, Russia, North Korea, and Iran—and the more generalized set of "transnational threat groups" and "jihadist terrorists" as the pacing challenges on which the U.S. national security and defense establishment should focus.[16] China and Russia are set apart as major powers with whom the U.S. will be in a "long-term, strategic competition."[17] Iran and North Korea are regimes that threaten U.S. security interests indirectly by supporting terrorist groups, for example, or directly by maturing their nuclear weapons and the means to deliver them. Non-state actors represent a more ambiguous (not unlike what the U.S. has been confronting since 9/11) but more lethal challenge as they acquire advanced tools like drones and cyber weapons.

Futures documents do not explicitly attempt to characterize the five threat challenges two or three decades from now, but they do not propose any other specific threat actors, leaving the military to focus efforts on these that are mentioned.

Current Forecast: Technology Trends

Our starting point for discussing how the U.S. military should approach preparing for the future must be to review *how the military currently thinks about the future*. Its view of themes and trends drives service modernization programs, the experimentation agenda, and force organization and training initiatives. The design of a fighter, destroyer, or armored combat vehicle is informed by conclusions the services reach about the capabilities they want their forces to have. So, too, are development of employment concepts, thinking about how large the military should be, and what readiness means.

Speed. One characterization of the future is common across all of the formally approved government literature: speed, an almost frenzied hurriedness, a crush of anticipation, a sense that the rapid pace of technological change will relentlessly drive change at ever-accelerating rates. Rapid and extreme change driven by technologies and human activity will shape everything from climate change and induced frictions among populations to the pace of combat engagements and the rate at which competitors dictate the tempo of crises, from states to sub-state and non-state actors to individuals. The primary drivers of this headlong rush, futures literature breathlessly claims, will be the digital and cyber worlds.

Unimpeded Technological Proliferation. Next is the idea that technologies in general will proliferate unimpeded, enabling everyone from states to individuals to catch up to the U.S.—the democratization of state-like power, as it were. In this scenario, the U.S. would find all domains contested and itself without many technology-based advantages.[18] Military advantage would go to the actor that is best able to employ technologies singularly or in novel arrangements and/or able to achieve awareness and decision superiority over competitors, much as the Germans drew upon experiences (from World War I) and technologies (radio, airplanes, tanks, machine guns, industrial-scale artillery) that were accessible to all and combined them in a form that gave them a tactical advantage from 1939 through 1940.

The literature suggests that everyone will have access to high-speed computing; artificial intelligence (or AI-enabled things); instantaneous global communications (via social media and/or advanced secure communications due to cryptography); advanced sensors (thus eroding stealth and other signature-reduction advantages); unmanned platforms (to include swarming capabilities); and even precision guided munitions. Thus, forecasters predict, the U.S. will have to fight its way in and do battle on a nearly equal footing with everyone from countries like China and Russia to well-funded criminal gangs.[19]

Cyber. All information travels through cyberspace at some point.[20] Even old-fashioned radio waves are processed by computers; information that includes voice, data, and imagery passes through and is processed by electronic systems, making it vulnerable to compromise by anyone able to access or deny access to the system. Potential points of entry are innumerable in practical terms. Computer and communication systems create vast networks and connect to power sources that are access points for hackers.[21] Computers are also operated by people—arguably the network element that is most likely to be compromised.[22]

Cyber attacks can include destruction or manipulation of data, operating system and application software, or the physical components of the system. Bad information can be fed into the system to deceive analysts and product consumers. An actor can also burrow into systems simply to monitor the flow of information and how it is used. The more a force is connected to and reliant on information systems, the more points of vulnerability of which the force has to be aware.

The advantage (and hence the danger) of cyber is that, unlike conventional military operations, cyber operations can be executed far from a physical battlefield and without exotic, expensive, hard-to-acquire combat platforms.

Artificial Intelligence. All of the major state powers—especially China—have committed substantial resources to the development of artificial intelligence capabilities.[23] China's massive investment, with some $2 billion in one AI technology park alone, is but the latest indicator that major powers view AI as the next strategically important capability. Russian President Vladimir Putin recently said, "Artificial intelligence is the future, not only for Russia but for all humankind. Whoever becomes the leader in this sphere will become the ruler of the world."[24]

AI promises the ability to collect, organize, analyze,

and extract meaning from huge amounts of data (structured and unstructured) and translate insights into action far faster than would be possible for an unassisted human. With AI incorporated into military operations, a force could quickly gain awareness and understanding of friendly and enemy dispositions and develop and rapidly sort through possible options to arrive at those most likely to achieve success, to include neutralizing or mitigating options available to the enemy. When AI is married to unmanned systems, according to U.S. military futures forecasting, autonomous weapons will be able to conduct tasks or even a full mission without human involvement.

AI also has defensive applications, helping to determine the optimal arrangement of units, sensors, and weapons to utilize the minimum amount of available resources most effectively while achieving maximum protection of the force.

In both applications, AI would be a powerful combat power multiplier by freeing valuable but limited manpower and manned systems for tasks that require direct human involvement. AI will also amplify the effectiveness of manned formations by extending awareness, increasing the accuracy of fire, and preserving combat power by minimizing the impact of enemy efforts.

Unmanned Systems. Military operations in South Asia and the Middle East have demonstrated the value of unmanned systems, particularly in the air. Advances in this area have dramatically expanded the scope and reach of military forces, improving understanding of the battlespace and the ability to achieve desired effects and creating opportunities or denying the same to the enemy. Success in the air has whetted the appetite for similar capabilities on land and at sea.

Directed Energy. Availability of ammunition has often proved to be decisive in military engagements. Once ammunition runs out, a force is unable to pursue its objectives or fend off enemy attacks. Historically, ammunition has been heavy, cumbersome to transport and store, and expensive. In the modern age, munitions like missiles and "smart bombs" are also quite technologically complex, which usually translates into difficult to manufacture.

Directed energy (DE) weapons like lasers promise to simplify this problem dramatically, providing a limitless magazine (as long as power is available), no logistical requirement to resupply rounds, and nearly instantaneous engagements even of multiple targets. If breakthroughs in energy management can be found to scale such weapons to various sizes, DE weapons promise to transform warfare by transforming everything from small ground units to ships, aviation, and space-based platforms.

Hypersonic and Hypervelocity. Hypersonic weapons and hypervelocity projectiles, which travel at five times the speed of sound or more, move faster than fielded defensive weapons can track and engage, giving the attacker an unbeatable offensive punch and enabling the defender to shoot down any attacking platform or non-hyper-speed weapon. "Hypersonic" generally describes weapons with a propulsion system that enables high speeds over long distances and maneuverability to evade intercept; "hypervelocity" typically refers to projectiles that are launched or propelled by external means, like a bullet fired from a gun.

The U.S., Russia, and China are all pursuing such capabilities. U.S. defense officials have expressed alarm at the progress made by China, in particular, which is outpacing U.S. efforts.[25]

Precision Guided Munitions. If there is one technology that captures the modern American way of war, it would be the routine use of precision guided munitions (PGMs) that enable extremely accurate attacks on enemy targets. A guided munition, whether it is a bomb, rocket, or round, has the ability to change its course in flight and hone in on a target using sensors integrated into the weapon itself or with guidance from an external source like a reflected laser or a GPS signal.

Guided munitions began to appear in the 1940s, came of age in the 1960s, and showed their revolutionary impact on warfare during the Gulf War in 1991.[26] Since then, the U.S. has relied on PGMs almost to the exclusion of unguided munitions (with the exception of basic ground weapons like rifles and machine guns, direct-fire vehicle-mounted weapons like those used by tanks, and indirect-fire weapons like mortars).

While much more expensive on a per-round basis, PGMs enable a platform like a plane or ship to engage targets successfully with single shots or a single pass instead of multiple sorties or volleys using unguided munitions. This speeds target engagement, reduces risk to the force by reducing exposure, and reduces the logistical burden of resupplying large amounts of ammunition.

To date, the U.S. is the only power with extensive

experience using PGMs, but Russia is quickly gaining experience in Syria and Ukraine. China, Russia, and other states are certainly investing in such capabilities. U.S. planners expect that in the future, American military forces will be on the receiving end of capabilities they have been using against others, unchallenged, for nearly three decades.

Advanced Sensors. As with many electronics technologies, the sensitivity and capability of sensors of all types have improved rapidly while their cost has decreased just as rapidly. During the Cold War, military and scientific requirements drove sensor improvements; more recently, commercial market demand has encouraged the development and production of advanced sensors that collect information across the energy spectrum, thus making numerous technologies of military relevance available to a growing array of actors at an affordable cost. The proliferation of advanced intelligence, surveillance, and reconnaissance (ISR) sensing systems, especially in the commercial space sensing sector, provides global coverage and capabilities even to non-state actors like terrorist and criminal groups.

Commercial space-based ISR systems now include electro-optical/infra-red (EO/IR); synthetic aperture radar; and electronic intelligence (ELINT) collection capabilities, among others.[27] Since most companies in this field now focus on providing analytic services rather than imagery alone, they are heavily investing in machine learning algorithms, resulting in rapid advances.

The Third Offset. Advances in various technologies like computational and materials sciences have given the military a better ability to understand and act more effectively than at any other time in history. DOD's Third Offset Strategy—driven by recognition of the tactical and operational challenges posed by the maturing anti-access and area-denial (A2/AD) capacities being fielded by China and Russia in particular—was initiated to connect the military more directly with cutting-edge developments in the commercial sector that can provide new options to offset enemy advantages, whether of geography, improved weapons, or sheer numbers of forces.[28] The program endeavored to explore options in several categories:

- Deep learning,
- Human–machine collaboration,
- Human–machine combat teaming,
- Assisted human operations, and
- Network-enabled, cyber-hardened weapons.[29]

The Future Operating Environment

Beyond technological trends, studies of the future also address conditions that forecasters believe will arise 20 or more years from now, characterizing the environment within which U.S. military forces will be expected to operate.

Urbanization. This leads the list in nearly all futures documents. According to studies, by 2035, 60 percent or more of humanity will live in congested megacities (cities with populations greater than 10 million) typically located near coasts.[30] Increasing global disorder will be brought on by growing competition for government services and resources such as potable water, arable land, and energy. Societal cleavages driven by religion, ideology, or economic stratification (haves vs. have-nots) will also spur conflict. The literature on future conditions predicts that these three trends will combine to create highly problematic and more hostile settings for the military.

Global Disorder and Societal Cleavages. Cities attract people. They provide employment opportunities, access to commercial goods and government services, concentrations of social, civic, and religious entities, proximity to power centers, and close connection to sources of information. Analysts have noted the increase in the size and number of large cities and have projected that this trend will continue, with the number of megacities growing from two in 1950 and over 20 in 2010 to perhaps 41 by 2030.[31]

It is natural to assume that frictions generated by concentrations of people would overburden the ability of governments to provide services, maintain order, and manage expectations for employment. Consequently, military planners forecast, urban warfare will be more likely in the future and will place extraordinary demands on U.S. forces conducting operations in congested, complicated, civilian-dense settings.[32]

Is it reasonable, however, to presume that this trend will continue as projected? America's own history with urbanization indicates that as cities grow in size and density, crime rates climb, the cost of living increases, and employment opportunities become problematic, leading to an exodus. It could just as well be the case that governments restrain the growth of cities and businesses develop more effective and affordable ways to serve outlying markets, leading people to shun the urban jungles anticipated by futurists. The U.S. military may instead find itself fighting in sprawling neighborhoods surrounding urban centers, with significant implications for equipment, concepts, and unit organizational designs involved.

Demographic Trends. Demographic trends do not change easily. Once on a path to increase or decrease in size, populations tend to stick to that line absent a major disruption like disease, war, or government policy.[33] Increases, decreases, the underlying cause of change, and surrounding conditions exert different pressures on a society.

In a rapidly growing population, the demand for jobs is high. In a decline, the population generally ages, with the older cohort of adults outnumbering the young, putting pressure on government services absent the robust tax base normally provided by working-age adults. A population affected by war generally loses males, while China, after imposing a one-child policy for approximately 35 years, has an overabundance of males. Wealthy advanced countries like the U.S., France, Germany, Japan, and China typically have low birthrates, calling into question their ability to generate large numbers of military forces, while emerging countries like India, Pakistan, and Indonesia have growing populations, even if they are poor.[34] This can cause clashes between countries as governments compete for resources.

Forecasters look at such trends for indications of potential causes of conflict and the ability of countries to initiate and sustain war, but there is scant evidence that analysis of demographic trend data has helped to predict the likelihood, condition, or duration of wars imminent or wars to come.

What Futures Forecasting Overlooks

This collection of trends and projected conditions serves as the basis for military service efforts to prepare for future combat conditions. *According to service perspectives*, all domains will be contested. All major competitors will have capabilities similar to (if not better in some areas than) those of the U.S. Non-state entities like terrorist groups, criminal organizations, militias, and even some individuals will be able to pose state-like problems for U.S. forces, especially in the cyber domain. Conflicts will likely occur in congested, densely populated urban environments and be more numerous, lethal, complex, and difficult to resolve, placing extraordinary demands on U.S. forces.

In this future world, the advantage will go to the force that can see its opponent first and hide its own posture and activities for as long as possible. Engagements will likely be initiated at extreme ranges and depend heavily on unmanned systems and AI-supported awareness and decision-making capabilities. Combat formations will likely be dispersed because massing increases a force's signature, making targeting easier and significant losses more likely due to the proliferation of precision guided munitions delivered at high speed by unmanned platforms. Future combat would seem to be platform-centric, with humans involved only in tightly defined circumstances where special capability is needed that machines cannot provide.

What if, however, much of this is wrong or key aspects are exaggerated? What if, as Freedman suggests, "chance events...and developments already in train that have been inadequately appreciated" lead to a substantially different future?[35] Perhaps the technologies used by one combatant will effectively balance those of the other, or perhaps the technologies themselves will prove too difficult to realize or turn out to be cost-prohibitive, resulting in program delays and cancellations. This is far from unlikely, given the U.S. military's experience on numerous occasions.[36]

It could be that decisive advantages are maintained by the force that has the best history of using emerging technologies to solve real-world combat problems, is best trained and competent in its skills, and is best able to support operations across time and space thanks to a robust, redundant, and responsive logistical support system.

Certain discussions are notably absent in any of the leading predictions: for example, a discussion of why forecasted conditions might not come about or a consideration of ways people could react that might alter the presumed trajectory of trends. The literature readily acknowledges the challenge of forecasting the future and admits that the future is unknowable in its detail and eventuality, but it then projects trends 20 to 30 years out and muses about likely scenarios and their implications.

This is what scenario work is all about, and it is helpful in assisting organizations to think about possible futures so that investments are made to ensure that the organization has a hedging strategy for the "unknown but possible." But "military cultures... seek to bring order and linearity" to their efforts and thus tend to view *possible futures as probable*.[37]

Future Innovations. In addition, although it is impossible to say what their impact might be, new things are discovered or invented all the time. That is the whole point of technological progress. With that in mind, it is quite possible that the U.S. military will find ways to negate competitor advances and maintain tactical advantages in combat through as-yet-uninvented technologies. This is entirely dependent, of course, on the extent to which the U.S. invests in research and development (R&D), experimentation, and getting things into the hands of users to find out what the art of the possible is. Doing so implies capacity: in funding, availability of personnel and units, institutional attention, supporting industries, and intellectual curiosity. If the force is so small and pressed by workload and funding deficits or stretched budgets that it can handle only current operational demands, it will not be able to discover what it needs to succeed in the future.

In a world in which all have access to advanced capabilities and situational awareness and sensors level the notional playing field, core competencies in combat skills and time invested in discovering artful combinations of capabilities that confer tactical advantage will make the difference.

Enduring Enablers. Also unaddressed by any of the documents—surprisingly, even by those produced by the military services—are the key enablers that history has shown are essential to winning wars: sustainable theater logistics, modern training facilities and ranges, an educated and experienced

force, capable maintenance and supply structures, and a transportation system that enables provisioning a force with all of the critical classes of supply and a global command and control system that orchestrates everything.[38] The force has to be able to execute and sustain operations over time and in the face of combat losses. Very few countries, and perhaps none but the U.S. today, have the ability to do this at any distance from home.

Since most scenarios envision wars far from the U.S. proper, it is essential for the U.S. to maintain this capability. In fact, it is likely to be decisive. Without the experience of U.S. forces in extended operations, especially distributed across substantial areas, competitors will have little understanding of the complexity involved or of the systems needed.

Domain Control. Then there are the capabilities essential to denying an enemy the ability to use a domain.[39] For example, attack submarines can deny the enemy use of the underwater domain and, as a result, of the surface ocean. Undersea capabilities are therefore a national asset that any major power, much less any lesser state and certainly no sub-state actor, will find it difficult to match. Limiting enemy operations to certain domains increases both the importance of forces that operate in those domains and the ability of those forces to leverage domains denied to the enemy (in this example, the underwater domain) to support operations in the contested domain (the surface ocean).

Dictating Tempo. Perhaps the greatest shortfall in defense predictions about the future is the implied sense that the military can only react to conditions dictated by others. Military theorists and practitioners place great value on knowing and understanding what opponents are up to; this is the point of intelligence and surveillance efforts. But defense futures documents and the program justification and operational concept papers they engender carry a subtle message that the future is shaped by others and the best the U.S. can do is understand the nature of that future and respond accordingly.

In fact, the U.S. is the dominant actor on the global stage, capable of shaping events and dictating tempo if it has the confidence and willingness to do so. Warfare is an interactive affair in which combatants make moves and countermoves driven by their initial postures, interests at stake, opportunities seized or created, and reactions to attacks that were not effectively anticipated. With this in mind, preparing military forces for the future also means cultivating an offensive-minded, initiative-taking spirit throughout the force rather than in a small subset. This mindset can be instilled and reinforced by emphasizing aggressive, realistic training and focusing on intentional experimentation that engages much of the force, conveying purpose and seriousness about the profession of arms and the conduct of war.

Secretary of Defense James Mattis has testified that the U.S. military has fallen behind its major competitors in every area of warfighting competition: land, sea, air, space, and cyberspace.[40] Russia has made significant advances in air defense, multiple-launch rocket artillery, heavy armor, nuclear weapon delivery platforms, and various ballistic missile capabilities. China has invested heavily in anti-satellite weapons, medium-range and long-range missiles, hypersonic weapons, and cyber warfare capabilities; is rapidly developing modern "blue water" naval platforms to include modern aircraft carriers meant to rival the latest U.S. *Ford*-class carrier; and is testing ship-mounted rail-gun technologies.

It would be a lethal mistake to dismiss such developments. Advances *are* being made in the fields of cyber, robotics, artificial intelligence, materials sciences, sensors, and a host of other fields relevant to waging war. The United States and its competitors are certainly not ignoring the military potential of these technologies, but developing a potential capability and understanding its likely impact can only be assumed until the military develops a viable employment concept and tests it in real-world conditions. As insights are derived and practical applications are proven, the result may well be dramatic—even revolutionary—changes in military affairs that force all militaries to adapt to new ways of fighting.

Innovation and Competence. The previously cited case of Germany's success in combining advances in mobile armored firepower, aviation, and radio communications to gain the advantage in the early years of World War II is but one example of how revolutions in military affairs take place. Germany's dramatic competitive advantage was the result of a concerted 20-year effort to understand and solve problems encountered during World War I. Through the work of 57 committees established to explore the questions raised by that war, the German army set out to solve real-world problems, experimenting with various combinations of new technologies emerging at that time.[41]

The overwhelming success of U.S. forces against the Iraqi military in 1991 was also no fluke. Though Iraqi forces proved incompetent in modern warfare, the integrated and choreographed capabilities of the U.S. forces were as jaw-dropping to other major powers like China and Russia as was Germany's prowess in 1940.

To counter Soviet numerical and capability advantages along the NATO–Warsaw Pact line, the U.S. invested substantial resources in creating and improving satellite-enabled communications and weapon guidance systems and increasingly capable sensors throughout the 1960s, 1970s, and 1980s, bringing about the amplification of *blitzkrieg* that Soviet planners termed "reconnaissance strike complexes" and American theorists called "network-centric warfare."[42] Both Soviet and U.S. analysts noted the rise of precision guided munitions and the ability to coordinate precision attacks at increasing ranges on a global scale.

The very latest advances in an assortment of technologies today indicate that this capability for tightly orchestrated precision attack is on the verge of another leap forward. AI-enabled situational understanding and response, the proliferation of unmanned systems, extraordinarily sensitive sensors, and advances in materials sciences are amplifying the power of Air Force Colonel John Boyd's OODA loop (i.e., better situational awareness and understanding that orients efforts more effectively, allowing the actor to take action and reorient to the changed situation as quickly as possible), even in non-kinetic battles.[43]

Unfortunately, the allure of another revolution in military affairs has likely incentivized an approach to modernization that may undermine what advocates are seeking. Enchanted by the potential of AI, robots, and the rest, the Department of Defense has redoubled its commitment to the big-leap approach to modernization instead of adopting a consistent, iterative, evolutionary advancement of U.S. capabilities. The military community purportedly understands that the future cannot be predicted, yet it often mortgages its future on big bets, assuming that proposed solutions will be relevant when they are fielded a decade or two later. Such bets are further complicated by attempts to account for the unexpected, making programs as multifunctional as possible in order to account for the widest range of possible conditions and uses that may arise in the coming years. This consistently results in major acquisition programs burdened by vast lists of ambitious requirements that lead to technological delays, cost overruns, and schedule slippages while the fleet of equipment that the new program is meant to replace continues to age, especially in these days of relentless operational demand.

It might be inferred from this that Congress, senior military leaders, and executive oversight offices believe that history grants the U.S. strategic pauses between engagements to take risks without consequences and provides ample warning before a contest for the U.S. to get ready. The historical record shows otherwise, at least for the U.S. over the past century or more.

Reality of Conflict. The use of military force is normally a policy decision made by the executive branch, enabled by the legislative branch, and supported (even if passively) by the public. Whether such decisions are wise is always debated, but history clearly shows that the country calls upon its military not only routinely, but frequently.

Since 1991, U.S. forces have been employed nearly 270 times according to a tally maintained by the Congressional Research Service.[44] Tasks have ranged from rendering assistance in the wake of a natural disaster to evacuating Americans from dangerous settings, deposing regimes threatening vital U.S. interests, and rendering assistance to partner nations. Nor is this unique to the past quarter-century. In fact, for the past 120 years, the U.S. has involved itself every 15 years or so in a major war that required a substantial portion of its operational force:

- The Spanish–American War, 1898;
- World War I (U.S. entry), 1917 to 1918 (20 years after the previous war);
- World War II (U.S. entry), 1941 to 1945 (23 years later);
- The Korean War, 1950 to 1953 (five years later);
- The Vietnam War, 1962 to 1973 (nine years later);
- The Gulf War (U.S.–Iraq), 1990 to 1991 (17 years later); and

- The Iraq War (Gulf War II) (U.S.–Iraq), 2003 to 2011 (12 years later).

In addition, the U.S. has been engaged in sustained operations in Afghanistan since 2001 and has been engaged in combat operations in Syria since 2014, also reintroducing forces in Iraq at that time to combat the Islamic State.

Both between and during these major deployments, the military was also generally committed in smaller packages to:

- Signal U.S. interests in key regions;
- Work with other countries to improve their own capabilities and establish strong ties with the U.S.;
- Participate in exercises with one or more countries to emphasize U.S. commitments to security relations and to improve the ability of the U.S. to coordinate military operations effectively with diverse militaries; and
- Acquire important knowledge of and experience in key regions proven useful during times of crisis.

Back home, units both maintained equipment and conducted training and exercises to prepare for deployments and engaged in various forms of education in order to gain a better understanding of how the conduct of warfare might be changing and what such changes might imply for U.S. forces.

In both peace and war, the military is constantly at work (or should be) using its equipment and consuming resources. When operational tasks are high, equipment and supplies are used at an accelerated rate. When operational tasks are both high and sustained over a lengthy period of time, the usable life span for equipment is consumed much faster than originally planned when the equipment was fielded. Capacity and commensurate resourcing are essential to maintaining competence and effectiveness while meeting operational demand and preparing for future employment.

Big Bets, Big Risks. While it cannot and should not ignore the applicability to military affairs of various technological advances (robotics, artificial intelligence, human performance augmentation, cyber weapons, etc.), because such technologies are in the early stages of development and have not been used extensively in operational settings, the military lacks sufficient understanding to validate early conceptions of their utility (singly or in combination) or to know what their usefulness will be decades hence. Nevertheless, the services often formalize predictions in acquisition programs and commit to fielding entire classes of weapons and platforms that will not be realized for 10 to 15 years or longer, making big bets on big leaps in capability with a projected cost and projected lead time.

Big leaps run big risks. An entire capability set, like air power or armored land power, may be jeopardized if the big leap does not work out, and the result will be to endanger the nation's security—the antithesis of the military's reason for being. Boldness is essential in combat, in research, in experimentation, and in training, but caution should be the watchword when risking the nation's security on unproven claims of transformational capabilities that have yet to be seen in practical application.

The U.S. has had the luxury of pursuing big-leap programs since the 1970s because between the U.S. and its NATO allies, sufficient conventional capacity remained viable to deter Soviet aggression during the Cold War as did a more active and varied nuclear force that served as the ultimate reinforcement. Post–Cold War, no enemy force engaged by the U.S. posed a meaningful challenge. States like China, Russia, North Korea, and Iran had not yet evolved in capability and the behavior exhibited today. Today, however, U.S. military capabilities have been worn down by almost two decades of sustained use, and many platforms (representing critical capabilities) are nearing the end of their planned service life prior to the fielding of a replacement.[45]

For the U.S. in particular, because of the size of the force, single-solution big leaps in fleet modernization entail another sort of risk because it takes a long time to replace a capability force-wide. If the U.S. gets it wrong or finds that a major competitor has deployed a countermeasure that nullifies or supplants a presumed U.S. advantage, the cost and time needed to reequip the force could be substantial. Iterative improvements that field modernized increments of a capability type would mitigate such risk.

Redundancy and Resilience. Alongside the big-leap approach to modernization, the services have favored single-class multi-functional/multi-purpose platforms and have competed in

winner-take-all acquisition programs in order to pursue efficiency by reducing redundancy in capabilities. While this does generate efficiencies in production, supply and maintenance support systems, and training programs, it also creates single points of failure across the joint force and defense industrial base. A small set of major defense contractors compete to win the contract for the next tactical fighter, tank, or destroyer. Whoever wins locks in that program for 20 years or more. At present, single defense contractors are responsible for the latest versions of tactical fighters (F-35); bombers (B-21); aircraft carriers (*Ford*-class); and main battle tanks (M1 Abrams).

Such practices make it hard for contractors to remain in business in the years between contract awards. For the military, strategic risk is substantial if the program does not proceed as anticipated, and combat risk is high if the single-solution platform proves to have a design flaw or operational performance shortcoming.

DOD's cancellation of the alternate engine program (the GE/Rolls-Royce F136) for the Joint Strike Fighter (F-35) in 2011 is an example of near-term budget challenges and high confidence in single solutions overriding longer-term operational and strategic interests in having more than one option. A number of studies informed strong congressional support for two engine programs that would have strengthened the associated defense industrial base and mitigated operational risk for U.S. airpower should the single engine program develop problems.[46] In spite of this, the U.S. Air Force and Secretary of Defense Ashton Carter cancelled the alternate program in order to shift funding to other programs.[47] Consequently, the United States' single program representing the vast majority of future airpower and the only new fighter jet currently in production relies on a single engine produced by a single manufacturer.[48]

In some measure, the success of U.S. forces in battle is increasingly critically dependent on big-leap bets made every 15 to 20 years that produce single-solution capabilities manufactured by single companies. All of this is predicated on capability requirements that may or may not be relevant 20 to 30 years in the future. This seems a risky way to do business when the security of the United States and its interests is at stake.

A Better Way to Prepare for the Future

> In most cases such innovation is evolutionary rather than revolutionary in nature...[taking] place over extended periods during which tactics, equipment, and conceptions change on a gradual basis.
>
> —Williamson Murray[49]

Despite the fact that the myriad events that will make up the future are still unknown, efforts must nevertheless be made in the present to shape that future in a favorable manner. Military planners assess the actions of current and prospective adversaries and the current and potential impact of technology and societal behaviors and then, taking these into account, take steps to give U.S. forces as many advantages as possible. Adversaries do the same thing (whether poorly or well), and events occur that catch everyone by surprise.

Add to this the fact that no one can have perfect knowledge of what the reactions of others to one's efforts will be, and it should be no surprise that some measure of uncertainty accompanies all preparations for the future. Hence the importance of adopting an approach that not only allows for the unexpected, but also leverages the power of continuous adaptation and sustained competence in capabilities that history has shown to have enduring value regardless of change.

History's Lessons. Murray and Millett's collection of essays assessing the efforts of the major military powers to account for changes that took place during World War I provides a number of insights into approaches that led to success or failure for the major actors who would fight again in World War II.[50] From their analysis of seven major areas of warfighting capability, the authors derive critical insights that differentiate successful innovation (i.e., preparing military forces for success on future battlefields) from failure. These include:[51]

1. Experimentation must occur and testing of equipment, concepts, and organization design must happen within a realistic framework of real (named) opponents, real capabilities, and real objectives to be obtained. Efforts lacking this focus drifted, resulting in capabilities that were effectively irrelevant in real-world applications.

2. Institutional commitments to innovation must account for the availability of forces in sufficient number to derive meaningful results and ensure both that exercises are intentionally designed to validate or invalidate otherwise hypothetical capabilities and that analysis of those exercises is rigorous and data-driven.

3. Developing realistic, quantifiable measures of effectiveness is critical because it forces intellectual rigor into the process. Without this, forces cannot really know whether they are developing capabilities and approaches that will accomplish desired objectives against a thinking, reactive opponent.

4. Education of the force, the officer corps in particular, must be linked to the operational world in order to avoid purely academic or theoretical conclusions that, when put into practice, are irrelevant to solving real-world problems.

5. Exploration of warfare must account for the fact that war and preparation for it are nonlinear; that is, war, by its nature, is volatile and unpredictable, and it evolves in ways that surprise all participants.[52] Similarly, experimentation may or may not result in expected outcomes—but that is the point: to reveal the unexpected. Military leaders who believe they can discern assured cause-and-effect relationships prior to validation or who think that a specific weapon or employment concept will result in a desired outcome regardless of the enemy's actions and reactions run the risk of catastrophic failure.

Murray, paying specific attention to the overwhelming success achieved by the Germans in the opening battles of World War I, noted that the highly disciplined process established by General Hans von Seeckt, chief of the General Staff, for reviewing war experiences was ruthlessly honest in evaluating all factors, paid particular attention to defining and understanding tactical and operational problems, and was methodical and intentional in experimenting with new tools, methods, and organizations to solve identified problems.[53] This approach resulted in an iterative evolution of the force by proposing,

testing, and validating tools, methods, organizations, and training programs.

Interestingly, Barry Watts and Williamson Murray observed in 1996 that "there does not appear to be *any* precedent in the entire history of the American military for subjecting past combat experiences to the kind of merciless institutional scrutiny manifest in the German examination of World War I under Seeckt...."[54] This deficit separates service experience from efforts to anticipate the future. The U.S. military habitually leaves its past behind as it leaps forward into the future, unable to know the circumstances in which it will find itself but filled with confidence that its conclusions regarding future needs will be accurate.

That U.S. forces were as dramatically successful against the Iraqi military in 1991 (or in other operations since the Gulf War) as the Germans were against the French in 1940 does not invalidate the assessment of Watts and Murray. U.S. conventional victories against Iraq (twice) and militia forces fielded in Afghanistan, Iraq, Syria, or elsewhere are hardly surprising given the disparity in capability and capacity between the U.S. military, built to win against the Soviet Union, and the militaries it eventually engaged.

As seen in service modernization efforts—i.e., big leaps to singular ends that take place every couple of decades—the U.S. military approaches preparing for the future in relatively short bursts of energy. This is typically spurred by a new service chief taking the helm and directing the service's doctrine, training, and "capability requirements" leads to characterize the future operating environment (usually 20 years ahead), followed by development of a comprehensive service concept that describes how the service will dominate in all domains against any opponent.

This is the exact prescription for failure against which analysts like Williamson Murray, Allan Millett, Barry Watts, Lawrence Freedman, and Eliot Cohen have warned. These analysts, all of whom have studied the history of military innovation, have argued consistently for iterative improvements of military forces driven by the practical lessons that emerge from experimentation and tightly focused efforts to solve identifiable tactical and operational problems.[55]

New commands or innovation offices are established. Technical requirements are generated and passed to industry. Liaison is initiated with leading businesses in the commercial sector to assess what "best practices" might be applied to military affairs. New technologies are hailed as combat multipliers that will make a smaller force more effective than its larger predecessor. Recent combat experiences are relegated to service history projects with the presumption that a new age is dawning that supplants conflict as it has been known to date. And all of this with little time, intellectual effort, or resources invested *in a sustained commitment over many years to test hypotheses before moving out on force-wide solutions.*

The actions of the U.S. military of the 1920s are in stark contrast to today's approach. Watts' and Murray's criticism notwithstanding, the U.S. Army, Navy, and Marine Corps fully embraced the challenge of assessing the implications of new technologies that emerged during World War I and thinking through what they might mean in various specific applications against clearly identified potential opponents in a future conflict.

Although the U.S. was on the winning team during World War I and might easily have concluded that U.S. forces would be similarly victorious on future battlefields with little need for continued evolution, military leaders at the time were realistic in assessing the potential for changes driven by the rise of new competitors (e.g., Japan in Asia and the Western Pacific); the emergence of new technologies and capabilities (e.g., aircraft, rudimentary tanks, and wireless communications); and practical battlefield problems (trenches, barbed wire, broken terrain) encountered across Europe that inhibited mobility and mitigated the presumed value of massed fires (World War I saw the largest concentrations of artillery and automatic weapons fire ever employed on any battlefield until that time).

Value was placed on intellectual exercises to keep the officer corps sharp—a reflection of its professionalism, regardless of an officially designated competitor. For example, the U.S. Naval War College conducted 318 war-games during the 1920s and 1930s that drove 21 fleet exercises to test various concepts developed by the war-games.[56] The Marine Corps, in conjunction with the Navy, embarked on seven fleet landing exercises between 1935 and 1941, each approximately two months long and involving numerous iterations to test various aspects of amphibious landings.[57] To be clear, both services were mindful of the potential challenge of a rising Japan in the Western Pacific, which simply validates

the notion that defining specific actors and operational problems is key to successful innovation.

The Army harnessed its War College to explore an extraordinary range of war plans, initially known as "color plans" (the U.S. pitted against a single opponent) and later "rainbow plans" (the U.S. acting as part of a coalition against one or more enemies), as early as 1919 but mostly between 1934 and 1940.[58] Such efforts were appreciated for their value in exercising planning skills, preparing future leaders, stretching the minds of planners, and generating and updating starting points in case war actually did break out with another power. As events unfolded in Europe with Hitler's rise to power, Army War College and Army War Plans Division efforts easily leveraged the foundation laid in earlier years.

The primary insight to draw from the interwar period is the commitment made by each of the U.S. military services and the whole of the German military to solve known problems and to explore the potential of new technologies and operational concepts. This commitment was sustained over two decades and involved repeated iterations of experimentation, prototyping, organization redesign, and concept validation that ultimately led to the forces used so effectively during the largest, most complex war in human history.

With these historical insights in mind, the U.S. military would better prepare itself for the future by adopting the following practices.

Transformation: Evolution Leads to Revolution. As noted, the U.S. military prefers to develop comprehensive solutions to fulfill projected future capability requirements and then award a major contract to a single manufacturer tasked to field a multifunctional capability force-wide. With rare exceptions, these programs take an average of 15 years to move from concept to product, cost two to three times more than initial estimates, and deliver less capability than originally requested.[59] Once fielded over many years, the platform, weapon, or enabling capability remains in inventory for decades. The same thing occurs with operational concepts that tend to be generational in nature. Consequently, force modernization is reactive, episodic (and rare), capital intensive, disruptive, and risky and must overcome institutional equities and inertia that have accumulated for a quarter-century or longer.

Alternatively, an evolutionary approach to force transformation would institutionalize the very characteristic that is essential to ensuring that the services are relevant and effective regardless of time, competitor, technology, or specific context. This calls for the services to accept a fundamental change in their thinking about force modernization and combat relevance, embracing iterative, spiral development and an integrated relationship among experimentation, capability development and fielding, concept development, and education and training of their respective forces.

Absent such a shift in paradigm, the individual subsets of transformation that include experimentation, modernization, concept development, and training will remain disconnected and unfocused.

Experimentation. The point of experimentation is to explore the potential of a new idea to solve a problem, answer a question, or reveal something new. For military forces, experimentation is used to develop solutions to problems encountered on the battlefield; a challenge presented by the enemy that needs to be defeated or neutralized; or finding a way to defeat the enemy that is not currently possible. Limited experimentation provides a limited set of data with which to support decisions and few opportunities to test hypotheses. Obviously, more experimentation—more frequent, involving more participants, and over longer periods of time—yields more data and experience that in turn provide greater opportunity for learning and generate greater confidence in results and insights.

Organizations that embrace a culture of experimentation become institutionally comfortable with change, adaptation, and problem solving. They mature resilience against the unexpected. Because they are constantly updating their experience and understanding as they grapple with change, they are more consistently relevant to the world around them and are better able both to discern the implications of emerging changes and to adapt as circumstances evolve.

Alternatively, organizations that alternate between surging and pausing, system-wide change and long stretches of standardized stability, find themselves unsettled by and unprepared for change, especially disruptive conditions created by a major competitor. They become stale in their thinking and wedded to long-established procedures. Their processes and tools obsolesce as they accrue massive costs to modernize. They become institutionally brittle.

Methodical, sustained, and robust experimentation results in a constant refreshing of an organization's relevance and effectiveness. It validates possible options, transforming them into proven capabilities that can be passed on to industry for production at scale or to doctrine and training commands for further refinement and formalization and then promulgated as relevant to some or all of the force.

The services should amplify their experimentation efforts, not necessarily just by increasing the budget (helpful as that might be), but also by connecting those efforts more closely to operational, exercise, and modernization requirements efforts. A good example of such linking was the 2017 deployment of the 3rd Battalion, 5th Marines. This standard Marine infantry battalion was tasked not only with experimenting with a range of technologies and organizational designs, but also with taking the experimentation process into operational settings during its scheduled six-month deployment to the Western Pacific.[60] The initiative resulted in "41 separate recommendations, ranging from ideal squad size to what new gear and technology to buy."[61]

Such efforts expand awareness of potential capabilities, evolve experiments out of tightly controlled settings, and generate practical feedback on promising opportunities from actual users. Institutionalized, the value of experimentation could be multiplied many times over.

Modernization. An evolutionary model for force transformation implies that modernization would be consistent and regular rather than periodic, iterative rather than big leaps, and incremental rather than comprehensive. The current model for modernization defines desired capability requirements, locks in a design, and then commits a force-wide or fleet-wide capability to a single solution for two generations. Periodic updates to existing platforms and weapons do occur as technologies mature, but the basic system remains in play for decades.

The big-leap approach, with long gaps between new programs, stabilizes equipment inventories, supporting logistics, and common experience across the force, but it also reduces the opportunity for innovation in the defense industry and the military itself. Iterative updating—fielded in increments or batches—smooths the related cost curve, provides more frequent opportunities for industry players to compete, exposes operators to evolving capabilities, and provides force commanders with a variety of options and important redundancy in case any one option fails or is compromised.

Advocates of big-leap programs tout the ability to reduce costs by reducing the number of models and related repair parts and training for maintenance personnel. In addition, efficiencies gained in production lead to lower per-unit costs over time. Smaller batch, iterative updating that includes lots of prototyping to inform experimentation introduces complications that the big-leap approach attempts to avoid. Money spent on various prototypes is funding that could have been saved or invested in a preferred program, but at the risk of not discovering important insights that might prevent future problems.

A more complicated logistics, training, and experiential framework would likely cost more but would also have the benefit of mitigating risk, providing options to warfighting forces, and increasing the likelihood that the force will be more effective in future, hard-to-predict settings. Per-unit costs would likely be greater up front but might lead to reduced costs over time as a result of increased competition among a larger number of vendors. Costs are relative and should be assessed relative to national security interests and the ability of U.S. forces to prevail in combat.

Done well, an iterative, evolutionary approach would result in the transformational changes that revolutionaries want to see. It would also result in a force that is regularly updated, consistently adapting to its environment as changes occur.

The military already has or is in the process of acquiring much of what it will have 20 years from now. Aircraft typically remain in inventory for at least 20 years; the average age of today's fleet of fighters in the Air Force is 27 years. Averages are longer for ships, with vessels easily operating in the fleet for 30 years or more. Because advances in nuclear reactor design have doubled their life span, a nuclear-powered submarine will no longer have to undergo a major overhaul to replace its reactors halfway through its planned 42-year life span.[62]

Similar conditions apply to major ground combat systems. The Marine Corps' amphibious assault vehicle was introduced in 1972 and continues to be the primary Marine Corps assault vehicle some 46 years later. The Army's Abrams main battle tank was introduced 38 years ago, and the Army intends to use it until 2050, making it a 70-year-old weapons

platform, although upgraded over the years with new sights, power plant, communications equipment, self-defense capabilities, and main gun. (This last point—upgrades to platforms—implies that modularity can be a form of evolutionary transformation. If the basic hull or box of a platform or system proves to be enduringly relevant, then modernization can occur more routinely and affordably via updates to key components that include sensors, communications, weapons, and power plants or engines.)

Service adoption of regular modernization that replaces a portion of a capability set would break the cycle of multi-decade technological stasis. It would also ensure that at least a part of the force is equipped with the very latest capabilities, which is an important advantage since neither the timing nor the context of the next war can be predicted.

Education. Military education can be of two types: general education of tiers within the force (all captains, for example) or specialized education that is focused on subsets of a community. In both cases, introduction into a school can be open or merit-based (selection based on some competitive criteria). The former implies a general intent to expose the entire category of students to specific materials, with the performance of individual students of secondary importance. Examples include basic training or a "career level" school that all officers are expected to attend. The latter implies a completely different focus that prioritizes performance for a higher objective: ensuring that graduates are intensely prepared for specific jobs and that only the highest performers get those jobs.

Currently, a career-level school for field grade officers (majors and lieutenant colonels and their Navy counterparts) includes broad exposure to everything from cursory study of specific conflicts to defense budget matters and the byzantine defense acquisition system. Selection for these general-purpose schools is more a function of matching officers available to attend with available seats.

There is merit to this approach if the purpose is at least to afford an opportunity for all officers to be exposed to more elevated studies along their career path and, from the institution's perspective, to raise the general level of awareness of the entire officer population. Merit-based or competitively staffed schools admit a limited number of students by design and are rare in the sense that each service has only one such school and there is only one point in their careers at which officers can engage in such specialized, intense study of their profession.[63]

What is missing is a progression of increasingly competitive schools intended to produce the very best thinkers for assignment to billets affecting the preparation of the force for war. Such a system could have two tracks, one focused on assignments to operational forces and the other focused on higher staff assignments that shape the experimentation, modernization, and higher-order war-planning efforts of the force. In both cases, the imperative would be to sift the larger population to find the most dedicated and capable within their profession. This is currently not the case, and the services suffer from an institutional bias that favors a broad-based, generally higher average rather than being a more narrowly defined but highly skilled meritocracy-based profession.[64]

In addition, over time, the services have made a concerted effort to introduce a broader set of issues earlier in the career of junior officers. The argument made for this is that if young officers are exposed to more complex issues such as grand strategy, joint-interagency operations, and coalition warfare, they will understand the larger context within which tactical and operational-level events occur. It also prepares them for higher-level staff and command assignments later in their career rather than having senior officers take on responsibilities for which they have had no training.

However well-intended this may be, time spent studying such higher-order matters takes away from deep study of material that is more immediately relevant to the duties and responsibilities of a junior officer's current rank: tactics, operations, and perhaps campaign-level planning. There is enough material to keep a young student busy understanding the intricacies of combat at the tactical level. At this stage in an officer's career, time is decidedly *not* better spent pondering the mysteries of diplomacy and mobilizing a nation for war. The primary objective of military education programs, especially for officers, should be to prepare graduates to excel (at their respective levels of responsibility) in winning battles, operations, and wars and to understand how the tools and techniques of war can be applied most effectively in various settings.

The professional military education system should not only reflect, but also be a critical component that emphasizes the seriousness with which

military personnel view their profession. Short-changing the study of war undermines a sense of its importance and an appreciation for the fact that a lost battle can mean a lost war. If the force means to be innovative, modern, relevant, and effective, it needs to devote as much effort in the schoolhouse as it does in the shooting house.

Military Culture. Extending directly from the discussion of education is the importance of military culture and the role it plays in innovation, preparation for the future, and sustaining core competencies in warfighting. Warfare is different from commercial and civilian affairs. While there are skills, tools, and methods that can be drawn from one and applied to the other, the worlds are not the same, and the military professional who thinks otherwise makes a fatal mistake. The 19th century Prussian military practitioner and war theorist Carl von Clausewitz warned "the statesmen and commander" never to mistake war for something "alien to its nature."[65] In other words, before embarking on a war, it is critically important to understand just what war *is*. In like manner, war, preparation for it, and the culture that attends it should never be confused with civilian pursuits.

The science and practice of war are cold and unforgiving. Militaries in every age have learned the hard truths of discipline, teamwork, preparedness, and realism and the awful consequences of failure in any of these areas. The military *must* maintain a culture that continually scans, tests, adopts, or discards methods and tools as conditions and technologies change.[66] It must be willing to analyze the implications of what it discovers for force effectiveness. In this effort, balance and restraint are perhaps more important than excitability and knee-jerk reactions. It is not a case of being overly cautious but rather of being intentional so that the integration of new and useful things is accomplished and limited resources are not frivolously wasted by repeatedly starting and stopping or betting everything on a major-leap capability only to find it harder to execute than originally envisioned. As in education, the military's culture must value a seriousness about the profession and about preparing for the future on a sustained basis.

Individual and unit competence often derive from confidence in hard-earned martial skills and the reliable effectiveness of tools that are germane to them more than they derive from the specific tools and technologies themselves. Lightly armed militias in Afghanistan, Iraq, and Syria have certainly proved this point by remaining viable and effective through nearly two decades of war against the most modern military force in world history.

Human will, perseverance, and courage have repeatedly been proven to be decisive elements in victory. In turn, forces that are vigorously trained and that embrace a culture of experimentation and adaptation have proven to be resilient and to have a critical edge over competitors who are static in their development, uncertain in their capabilities, psychologically brittle, and inexperienced in dealing with the fog and friction of war.

As today's military prepares for the future, it will be urged to change its nature to accommodate changes in the society from which it draws its recruits. The services should take great care and be cautious in doing so. While society provides the people the military uses to fight the nation's wars, it is the military that must do the fighting, not society. Competence in *war* should always be the priority, not calls for change from communities that do not experience the realities of battle.

Capacity. Capacity is a critical factor in preparing for the future. The ability of the military to do everything it is called upon to do depends on the amount of time, attention, people, units, and funding available to it. Capacity can come from expanding the military and its budget so that it can handle current operational tasks and still do everything else. It can also come from reducing operational tasks, thereby freeing resources for other efforts.

Capacity commensurate with requirements enables the military to experiment, educate, train, and exercise at meaningful levels while handling its daily operational workload. Too little capacity with no commensurate reduction in workload exhausts the force, leading to premature aging of equipment, reduced readiness, and damaged morale. This, in turn, increases both risk in the event a crisis arises while the force is compromised and the cost of rebuilding the force to the level necessary to defend national security interests.

However the services go about generating the capacity to prepare for the future—increasing force size or reducing operational workload—they should be wary of embracing the idea that new capabilities (i.e., technologies) are by default an adequate substitute for capacity. New capabilities typically extend and amplify the effectiveness of an individual or unit,

but people are still required to service and operate the new technology. Additionally, people and units can still be in only one place at a time, and a force must be able to replace combat losses if it means to sustain operations during the course of a conflict.

Capacity, along with readiness and capability, depends on the priority the nation places on national security when allocating taxpayer dollars each year. Rhetoric is important in making the case for national defense, but actual resources are more important because they make it possible to translate rhetoric into reality.

Finally, U.S. preparation for the future must acknowledge certain aspects of warfare and of U.S. success in combat in particular that have repeatedly proven to be of enormous value in the past and will likely remain critical to success in the future. As is the case with U.S. investments in global, theater, and tactical logistics, the U.S. military derives extraordinary advantages from being able to operate as a joint force with the ability to integrate capabilities provided by each of the services across all relevant domains of operations—land, sea, air, space, cyberspace,—and, for some analysts, the human domain—in ways that consistently defeat enemy forces.

For a number of reasons that include (among others) historical enmities, competition for domestic political power, and unmediated competition for resources, the militaries of most countries are parochial in their operations, more apt to deconflict missions so that they do not get in each other's way than to tightly orchestrate actions so that one capability enables and amplifies another. The U.S. military is the best manifestation of the latter, in stark contrast to competitor forces and even those of many partner countries. Experimentation, capability and concept development, and intellectual preparation for the future should keep this ability as a central factor in all efforts.

By extension, the ability to work in concert with allies and coalitions has proven to be essential to winning wars.[67] Consequently, the ability to share information, coordinate actions, and even integrate the reconnaissance-strike network capabilities of forces from contributing countries should be improved in efforts to prepare for the future.

Conclusion

All of these considerations are interrelated. A commitment to sustained, iterative experimentation is not possible unless the services are institutionally and culturally inclined toward it. Incremental or "batch" modernization implies a different mindset for how force capabilities evolve and what "modern" means as it relates to a military's technological and capability posture relative to competitors. The ability to do several things well simultaneously—operational tasks, training and exercising the force, educating personnel—implies that the force has the capacity to do so. Capacity comes from balancing tasks and/or sufficient resourcing to do everything at acceptable levels of risk.

Alternatively, more intentional connections can be made among these efforts: feedback loops between smaller-scale but aggressive experimentation and the operating forces cycling insights from one to the other, with spirals out to industry that drive development, acquisition, and fielding of new capabilities. All of this demands deliberateness; serious study of the warfighting profession; stability not only in leadership, but also in approach; a tolerance for uncertainty in forecasting that is underwritten by confidence that this sort of approach provides greater assurance that the force will be better prepared for the future—in a word, professionalism.

Preparation for the future works best when specific problems are identified and the services focus their efforts on solving them, employing an iterative approach over many years so that pieces of the problem are solved bit by bit and robust experimentation and force exercises discover what can (and cannot) be done, usually leading to revelations that could not have been known beforehand.

Revolutionary *leaps* are unproductively disruptive and risky, especially because the wager is the nation's security and the ability of the military to win in combat. Revolutionary *outcomes* are the objective and are achieved better and at less risk through evolutionary improvements that build on each other until transformative tipping points are reached. This is what history shows about military efforts to prepare for the future. Today's U.S. military would be wise to heed this lesson.

The papers that follow in this series will address each service, using this perspective to assess the efforts of the Army, Navy, Air Force, and Marine Corps to prepare for the future. Some capabilities do not lend themselves to small-batch iterative updating because of their cost, an intentionally limited inventory, or the nature of the environment or mission space within which the capability is used. Nuclear-powered ballistic missile submarines, for example, seem to be in this category.

Some communities routinely introduce and divest themselves of tools as new technologies emerge or old ways prove to be more effective in specific circumstances. The small size of the special operations forces, for example, and liberal authorities granted it to acquire systems and weapons are markedly different from those of the conventional forces. Nevertheless, a general application across the joint force as a whole, revising current approaches to preparing for the future in the ways outlined above, is sorely needed.

The objective of RAMP is to reframe discussions about rebuilding America's military power and to recommend an approach, applied as appropriate to specific efforts, that history has shown to have a greater likelihood of achieving the desired outcome. One of the very few obligations levied on and expected of the federal government—and one that only it can perform—is the defense of the United States and its national security interests.

Changing the current approach to ensuring that the U.S. military is best prepared for future conflicts will enable the government to fulfill this essential responsibility more effectively.

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35. Freedman, *The Future of War, p. 287.*
36. Examples include the A-12, FCS, EFV, F-22, B-2, LRLAP (for DDG-1000 AGS), and Excalibur, among others.
37. Murray, "Innovation: Past and Future," in *Military Innovation in the Interwar Period,* p. 303.
38. Remembering the basics has been a core strength that differentiates the U.S. from other powers, conferring a strategic competitive advantage. It is also critical to conducting operations away from home shores. Logistics and supporting establishment are often sacrificed in order to acquire weapons or fund current operations.
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66. See Murray, "Innovation: Past and Future," in *Innovation in the Interwar Period*, pp. 310 and 313. Today's equivalent must be serious thinkers and students of the profession. Ibid., p. 314. Critiques of military performance must not be diluted by pop-culture sensitivities or faddish social protocols, nor should they be hobbled by deference to the equities of various communities within the military such as the ever-present tensions between the Guard/Reserve and Active components, unmanned vs. manned communities, or the latest debates over kinetic vs. non-kinetic warfare.
67. Examples of coalition warfare stretch back to the earliest recordings of war. The wars between the Greek city states during the 5th century BC famously pitted the Delian League, led by Athens, against Sparta's Peloponnesian League. More modern examples include the Napoleonic Wars involving seven coalitions of European powers arrayed against France between 1803 and 1815, the grand coalitions of the World Wars, and recent coalitions marshalled by the U.S. to combat terrorist groups in South Asia and the Middle East, to name just a few.

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