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Chairman Gallagher, Ranking Member Khanna, and members of the House Armed Services Subcommittee on Cyber, Information Technologies, and Innovation, thank you for allowing me to testify today on the critical importance of defense innovation and how history should inform investments in defense technologies. I am honored to provide perspectives from my experience in the defense policy and force planning communities.

We are in a decisive decade: one that demands urgent action to regain our military technological advantage over the pacing threat. China's rapid military modernization has eroded the United States' ability to deter and, if necessary, defeat aggression in the Western Pacific. While no rapid, easy fixes exist to redress these circumstances, rebalancing America's military capabilities and capacity to reduce risk created by a decades-long failure to modernize our forces demands new foundational principles. Toward that end, I spotlight six lessons from history that should shape the planning for, and continuous modernization of, our nation's military forces.

1. Maintaining the technological advantage is a marathon, not a destination.
Treat defense innovation as a series of sustained competitions.

Meeting present and foreseeable national security challenges will demand a long-term, sustained focus on military innovation and modernization. I could argue that we are in a conflict today—or at least an intense competition for military advantage, with peer and near-peer adversaries. History teaches us that competitors constantly seek to displace the leader, as is the case in any race.

In the case of national defense, it is a mistake to think that a single technological breakthrough will provide a permanent advantage. Eventually, useful ideas and tools proliferate beyond their initial creator into the hands of other competitors. Consider that gunpowder was first invented in China as early as 142 AD. Other Asian and European powers gained access to the material and steadily learned how to advance and refine its employment. Over the next two thousand years, competitors developed new ways and means to use gunpowder that were increasingly cheaper, faster, accurate, and more lethal.

Similarly, the revolution in military technologies and operational concepts that the United States pioneered during the late Cold War period leapfrogged all other nations' warfighting prowess. The effectiveness of stealth, precision strike

systems, 4th generation aircraft technologies, and networks stunned the world during Operation Desert Storm in 1991 and set the stage for unrivalled U.S. military dominance in regional conflicts over the next two decades. At the same time, however, competitors studied these successes and sought to aggressively match and supersede the technologies and operating concepts that created them. China in particular has reshaped its military and warfighting strategy to defeat the "American way of war" and the U.S. military's aging capabilities. U.S. military inferiority is a very real possibility if we do not seek to advance our capabilities from the performance thresholds that were last set at the end of the Cold War.

2. Seek asymmetric advantages rather than parity. *Prioritize developing and acquiring <u>asymmetric capabilities</u> that will disrupt and impose costs on adversary forces instead of thinking in terms of fighting a better war of attrition.*

This approach is not new. It is exactly what American leaders in the 1970s and 1980s pursued as they faced a Warsaw Pact with more combat capacity in Europe than NATO. These leaders realized they needed to out-think the Soviets, which led to DOD's Assault Breaker initiative, which yielded the reconnaissance-strike complex that matched enhanced battlespace information awareness with precision strike technologies and stealthy aircraft.

Today, facing similar challenges, the United States must prioritize new technologies like 5th and 6th generation stealthy aircraft for both air-to-air and air-to-ground missions; uncrewed collaborative combat aircraft (CCA) to augment these highly capable crewed aircraft with affordable yet capable mass; a new generation of munitions that are both mission-effective and cost-effective; and new systems that will harness the attributes of directed energy, artificial intelligence, and quantum computing.

However, there is a risk that new technologies will initially be used in mass-on-mass approaches to warfare, in which each side seeks to land more punches on the other. That risks U.S. forces engaging in a tactical "whack-a-mole" operation. We need a strategic approach that pursues breakthrough technology that fundamentally *changes* the rules of the game. Otherwise, we risk simply repeating the stalemate and slaughter we saw during the First World War. In a more modern example, the attrition-dominant warfighting approach underway in Ukraine is not how the United States should ever seek to fight.

Instead, we need to emulate lessons learned about how new technologies like mechanized armored forces restored maneuver to armies in the first half of the 20th century and how long-range air forces enabled strikes deep into an enemy's heartland to impose costs and disrupt the adversary's means of sustaining an offensive. Efforts and resources must be focused on thinking in a smarter, more prudent fashion than the opponent, not just who can absorb the most losses over an extended period of time.

3. Technology is only as effective as the way it is used. *Pair emerging technologies with novel concepts for their use in realistic threat environments. Stop doubling down on new technology just to do the same things better.*

Ground-breaking technologies are most effective when they are matched with insightful operational concepts that seek to optimize the ends, ways, and means of securing desired effects in the battlespace. Too often throughout history, nations have ceded the full potential of new technologies by harnessing them to legacy ways of fighting. Consider that during the First World War, the U.S. Army initially employed aircraft as artillery spotters—a linear interpretation of "better high ground" to provide support to surface forces. Over time, the use of airpower expanded to include new missions like close air support, strategic attack, and air superiority, as well as long-range reconnaissance and surveillance. Similarly, when uncrewed MQ-1 Predator drones were first developed and fielded in the 1990s, their role was restricted to intelligence, surveillance, and reconnaissance. Eventually, when combat circumstances demanded enhanced effects, they were weaponized. This led to an entirely new approach of using sensor-shooters for precision strikes in Afghanistan, Iraq, Syria, and beyond.

As new technologies like uncrewed CCAs are developed, there is a risk they will be used in ways that will linearly augment the Air Force's crewed aircraft and compensate for the service's combat air inventory shortfalls. While the Air Force needs more combat air capacity, it would be better to use CCAs in new ways to disrupt and degrade China's warfighting strategy in a Pacific conflict. Insights from recent wargames at Mitchell Institute for Aerospace Studies indicate uncrewed CCAs used in novel ways could be a means to disrupt China's air and missile defenses, opening the path for follow-on forces to gain the degree of air superiority needed to defeat a PLA offensive against Taiwan.

4. It still requires adequate capacity. *Recognize that force capacity still matters. Stop the caustic cycle of attempting to do more with a diminished force.*

Even as the United States invests in technology to offset China's combat mass advantage, it is crucial to remember that numbers still matter. An aircraft, ship, tank, or satellite can only be in one place at a time, and operations in a region as large as the Pacific will require a force that is sized to conduct multiple dispersed operations across thousands of square miles simultaneously.

The capacity multiplier effect afforded by new technology is undeniable. During the first night of Operation Desert Storm, 20 stealthy F-117 fighters used precision-guided munitions to strike 28 separate Iraqi targets. By comparison, it required 41 non-stealthy aircraft with non-guided "dumb" bombs to destroy a single target during the same time frame. However, many in DoD saw this revolution in effectiveness as a justification to slash force structure inventories in the 1990s and 2000s. Moreover, since the end of the Cold War the United States has yet to complete the full buy of a new manned combat aircraft. The B-2 was canceled at 21 aircraft delivered, not the 132 initial requirement. F-22 production was stopped at 187 fighters, not the 381 planned—and that number was already a reduction from the force of 781 aircraft originally envisioned. Force cuts and inadequate modernization have left U.S. combatant commanders without the capacity required to support their war plans. Given the need to deter and possibly respond to aggression in Europe, the Middle East, the Indo-Pacific, and in defense of the U.S. homeland, force structure numbers matter.

Consider basic combat aircraft mission rotation math—one-third of a deployed inventory of a combat aircraft will be executing missions while another third is returning to their airbases, and the remainder will be getting ready to launch on their next missions. Applying those numbers to the B-2 inventory illustrates how a U.S. combatant commander could have only a handful of stealthy bombers ready for missions at any given time—assuming the entire B-2 force is deployed, no bombers are down for maintenance, and there is no combat attrition. With roughly 100 combat-coded F-22s in the force, those numbers work out to approximately 30 F-22s on station in the battlespace at any given point in time—again, using unrealistically positive force planning assumptions. Stretch 30 F-22s across a region as vast as the Western Pacific, and it is clear that force capacity cuts in the past were far too radical.

The solution to these capacity shortfalls demands DOD acquire stealthy B-21s, F-35s, KC-46s, CCAs, NGAD systems, and other modernized capabilities at the scale needed to deter, and if necessary, defeat threats in multiple theaters. This will require sustained, predictable budget growth that balances the pace of modernization with increases in force capacity. The U.S. military simply cannot prepare for tomorrow's fight if it's forced to operate with yesterday's budget under a series of continuing resolutions.

5. Innovation only matters if you procure it. *It's not enough to innovate new technology, DoD and the services must also be empowered to surge acquisition and procurement with ample funding to meet operational requirements. Stop the practice of increasing research and development spending without follow-on aggressive procurement.*

It is important to recognize that military innovation is only worthwhile if it results in a leap-ahead in capabilities and sufficient force capacity. There is nothing more costly or inefficient than investing in research and development without following up with funding to acquire new technologies at the scale needed to make a difference in warfare. This problem has plagued the Department of Defense over the last 30 years and caused the services to extend many of their major weapon systems well past their original design lives, all at great expense to taxpayers and yielding only diminished returns.

DoD's 1992 decision to cap B-2 procurement at only 21 aircraft rather than the 132 planned resulted in what is now the oldest and smallest bomber force in the Air Force's history. That is also why the aircraft is often cited as the most expensive aircraft ever procured at $2 billion per unit. Similarly, slashed purchases of the Zumwalt class destroyer resulted in the program's $12 billion of research and development costs being spread across just three ships. As a result, the Zumwalt now has a per-unit cost of $9 billion rather than the initial 1998 estimate of $1.2 billion. Consider what would happen if private industry adopted this approach: how much would a Tesla EV cost if they stopped production at only 21 vehicles? It would obviously be a disastrous course of action, yet it is one that U.S. leaders have pursed repeatedly across the defense modernization portfolio over the past three decades. If the need for a new technology remains valid, the most effective, efficient path available to defense leaders is to procure it in large quantities to meet their operational requirements.

6. New technologies still require training experienced people in volume to use them. *DoD must ensure it has enough personnel with adequate levels of training to fully exploit the advantages of new technologies in the capacity required for major theater combat operations.*

Finally, it is crucial to remember that a high-tech military needs highly trained service members in sufficient numbers to meet requirements and anticipate realistic attrition factors in warfighting operations. The Air Force has been carrying an annual 2,000 fighter pilot shortfall for many years. That is placing tremendous strain on operational units, depriving headquarters staff of essential expertise, and drives overtaxed pilots and their families to separate from the service. This peacetime shortfall would spiral out of control in a peer conflict that results in significant losses. It takes at least five years to train a moderately experienced fighter pilot, and far longer to give crews the depth of experience needed to maintain a combat edge over a competent adversary. That means that even if a solution is implemented today, it would take five years for the problem to diminish. The Air Force lacks such a solution, so the risk compounds. This is not the only shortfall—maintainers and other experts are likewise spread thin across the force.

Further personnel complications are arising as the Air Force sunsets worn out airframes like the E-3 JSTARS and the E-3 AWACS without operational follow-on systems due to excessive modernization delays. Air battle managers—the experts on those platforms—take years to cultivate and will be the key actors with the new Joint All Domain Command and Control (JADC2) enterprise. Extreme risk exists that these experts will depart the service for want of the tools to do their job. The Air Force, Department of Defense, and Congress must pay particular attention to stewarding these career fields through these difficult transitions. Regenerating this talent from scratch would take years—and regenerating truly seasoned experts even longer. Consider the challenges the Air Force faces in the electronic warfare field. It cut systems and personnel too aggressively in the 1990s as a budget savings measure and is now struggling to grow capacity for this mission area at a time when the threat is expanding.

Learn from history or risk losing. *We know what needs to be done to ensure our nation's security. It is time to stop admiring the problem and implement solutions.*

As U.S. leaders seek to address the threat posed by China, it is especially important to recognize that defense innovation and modernization at scale is needed now, not in some distant 2030s future. U.S. leaders learned this as they anticipated the onset of the Second World War, with Secretary of War Harry Woodring writing to President Roosevelt in 1938 that, "We are not prepared for conflict. Billions appropriated today cannot be converted into preparedness tomorrow." Woodring was right: of course money is crucial, but so is time. Despite an overwhelming surge after Pearl Harbor to boost wartime production and training, it took nearly all of 1942 and 1943 to ramp materiel production and personnel training to meet wartime demand. It was not until 1944 that the United States could fight the war decisively.

China will not afford us that time. They have too much at risk to consider any other course of action aside from achieving rapid knock-out blows and then prepare for an extended conflict if necessary to attrit U.S. forces to a point of insolvency. Avoiding that fate requires U.S. leaders to develop new technologies and procure them in operationally viable quantities that anticipate attrition, the scale of the Indo-Pacific theater, and concurrent operational demand in multiple theaters. It is time to be realistic about owning the problem we face, acknowledge where capacity gaps exist, and play a smart, long-term plan to net future success. Those who question the expense should consider the lessons from history presented here. Ignoring them will risk incurring far greater costs that result from suffering a major defeat.