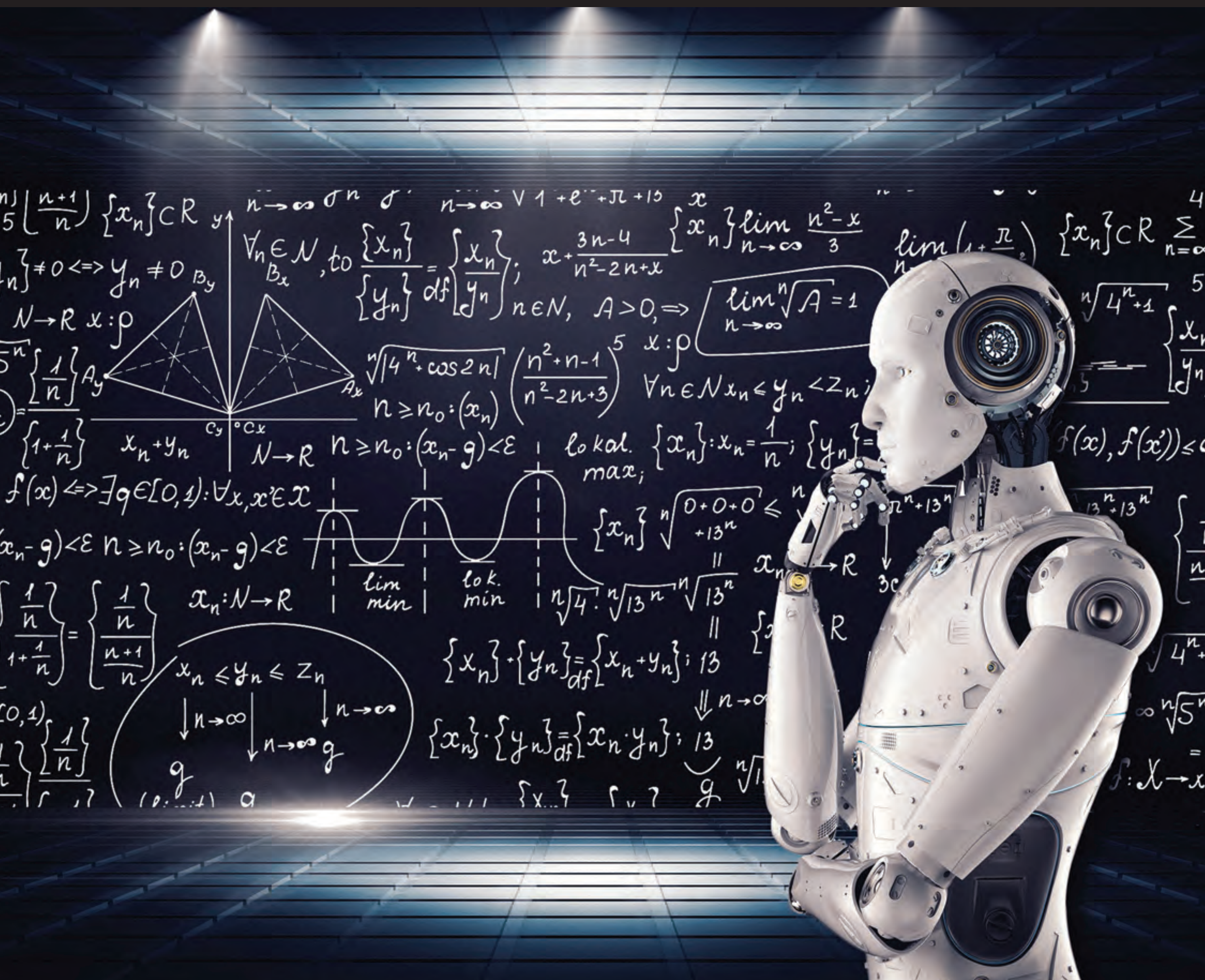

Artificial Intelligence and Machine Learning are changing future of war.
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AI is Shaping the Future of War

By Amir Husain

Several years ago, before many were talking about artificial intelligence (AI) and its practical applications to the field of battle, retired United States Marine Corps General John Allen, and I began a journey to not only investigate the art of the possible with AI, but also to identify its likely implications on the character and conduct of war. We wrote about how developments in AI could lead to what we referred to as "Hyperwar" — a type of conflict and competition so automated that it would collapse the decision action loop, eventually minimizing human control over most decisions. Since then, my goal has been to encourage the organizational transformation necessary to adopt safer, more explainable AI systems to maintain our competitive edge, now that the technical transformation is at our doorstep.

Through hundreds of interactions with defense professionals, policymakers, national leaders and defense industry executives, General Allen and I have taken this message to our defense community—that a great change is coming and one that might see us lose our pole position. During the course of these exchanges, one fact became increasingly clear; artificial intelligence and the effects it is capable of unleashing have been gravely misunderstood. On one hand, there are simplistic caricatures that go too far; the Terminator running amuck, an instantiation of artificial intelligence as a single computer system with a personality and a self-appointed goal, much like the fictionalized Skynet. Or an intelligent robot so powerful and skilled that it would render us humans useless. On the other hand, there are simplifications of AI as a feature; trivializations in the name of practicality by those who cannot see beyond today and misconstrue AI's holistic potential as the specific capabilities of one or two products they have used, or most likely, merely seen. I would hear from some that fully autonomous systems should (and more amusingly, *could*) be banned and this would somehow take care of the "problem." Others thought the proponents of artificial intelligence had overstated the case and there would never be synthetic intelligence superior to humans in the conduct of war.

But artificial intelligence is not like a nuclear weapon; a great big tangible thing that can be easily detected, monitored or banned. It is a science, much like physics or mathematics. Its applications will lead not merely to incremental enhancements in weapon systems capability but require a fundamental recalculation of

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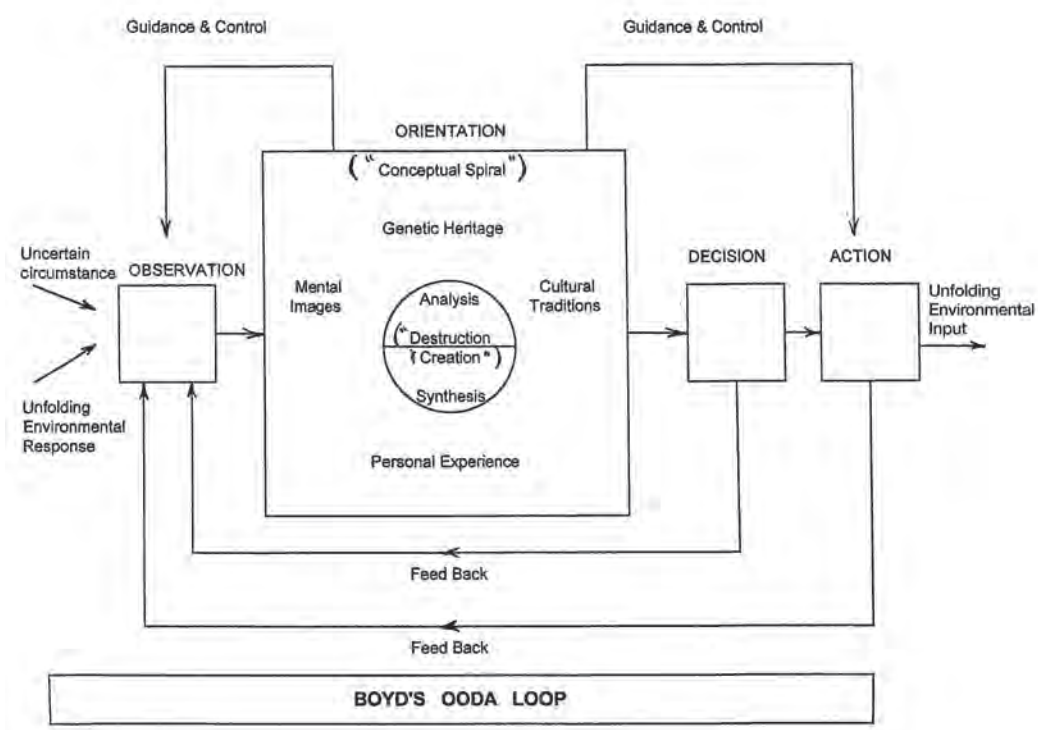
what constitutes deterrence and military strength. For example, the combination of AI elements—visual recognition, language analysis, the automated extraction of topical hierarchies (or ontologies), control of systems with reinforcement learning, simulation-based prediction, and advanced forms of search—with existing technologies and platforms, can rapidly yield entirely new and unforeseen capabilities. The integration of new AI into an existing platform represents a surprise in its own right. But the complex interactions of such platforms with others like them can create exponential, insurmountable surprise. Which current conventional system deters such an AI creation?

These reactions were all telling. Rather than seeing artificial intelligence as a science, people were reacting to caricatures or linear projections based on the past. Specifically, the contention that since no AI has been built thus far that can exhibit long-term autonomy in battle, such an AI could never be built. Or that if it were, then it would take over the world of its own volition. These reactions would not be as problematic if they were coming from ordinary people playing the role of observers. But seeing people in positions of power and authority—*participants*—espouse such thinking was worrisome. Why? Simply because artificial intelligence will lead to the most important capabilities and technologies yet built by humankind, and a failure to understand the nature of artificial intelligence will cause us to fall behind in terms of taking advantage of all it has to offer in the near, medium, and long term. The stakes are high beyond description.

Hyperwar

Earlier in this piece, I described hyperwar to be a type of automated—potentially autonomous—conflict. But a deeper understanding of concepts



1st diagram incorporating Boyd's corrections, early 1993 (John R. Boyd Collection (COLL/2062) at the Marine Corps History Division, USMC Archives, Flickr.com Images.)

underpinning hyperwar requires exposure to the idea of the Observe-Orient-Decide-Act (OODA) loop; a cyclical process governing action both in the realm of war, and as many have recently pointed out, in commerce,[1] engineering,[2] and other peace-time pursuits.

Where did the idea of the OODA loop come from? While researchers in various fields throughout history have articulated the idea of a cognitive decision/action loop, the modern day conception of the OODA loop in a military context came from USAF Colonel John Boyd. Col. Boyd is famous both for the OODA loop and for his key role in developing the F-16 program. He is also remembered as that famed military strategist whose conceptual and doctrinal contributions, some would argue, quite directly led to the overwhelming U.S. victory in the first Gulf War. Acknowledging the impact of Boyd's work, then-commandant of the Marine Corps., General Charles Krulak said these words in Boyd's eulogy: "John Boyd was an architect of [the Gulf War] victory as surely as if he'd commanded a fighter wing or a maneuver division in the desert. His thinking, his theories, his larger than life influence were there with us in Desert Storm."

Of all Boyd's considerable contributions, perhaps the idea of the OODA loop is the most potent and long-lasting. OODA governs how a combatant directs energy to defeat an opposing force. Each phase of the OODA loop is itself a cycle; small OODA loops curled up within larger ones. As the OODA loop progresses, information processes feed decision processes that filter out irrelevant data and boil outputs down to those that are necessary and of the highest quality. In turn, these outputs become inputs to another mini OODA loop. Seen in this way, the macro OODA loop of war is a massively parallel collection of perception, decision, and action processes; exactly the types of tasks AI is so well suited to, running at a scale at which machines possess an inherent advantage.

AI in Perception, Decision, and Action

Just how good has AI become at these perception, decision, and action tasks? Take perception, an area where machines and the algorithms they host have made great strides over the past few years. AI systems can now beat Stanford radiologists in reading chest X-rays,[3] discern and read human handwriting faster than any human,[4] and detect extrasolar planets at scale, from murky data that would be a challenge for human astronomers to interpret.[5] The AI perception game is hard to beat, and operates at a scale and speed unfathomable to a human being.

The combined effect of millions of sensors deployed in space, in the air, on land, on the surface of the sea and under it, all being routed to a scalable AI perception system will be transformative. We are beginning to see shades of what this will feel like to military commanders. When the Russian military conducted a test of 80 UAVs simultaneously flying over Syrian battlefields[6] with unified visualization, Russian Defense Minister Sergei Shoigu commented that the experience was like a "semi-fantastic film" and that "they saw all the targets, saw the launches and tracked the trajectory." This, of course, is just the beginning.

What about decisionmaking? How would AI fare in that domain? Today, planners use tools such as "Correlation of Forces" (COF) calculators[7] to determine the outcome of a confrontation based on the calculated capability of a blue force versus a red force. They use these calculations and projections to make logistical and strategic decisions. If you divide the battlespace into a grid that constrains both space and time, in some sense the only COF calculation that matters inside each cell is the COF calculation for the cell itself, not for the entire grid. Taking this idea further, given the presence of assets in each cell, one could calculate their area of impact, under the constraint of a time bound. Obviously, a hypersonic missile will have a larger area of impact with a smaller time bound in comparison to a tank. An

AI trying to solve this problem would use sensors to identify assets present in each grid, calculate COF coefficients for each cell for a given time bound, and then seek to generate and optimize a plan of action that results in the smallest own-force maneuvering most efficiently to inflict maximum attrition on the enemy. All while suffering the least damage itself. A proxy for determining how much damage you could inflict while minimizing own-losses is the COF coefficient itself. The larger your advantage over the enemy, the greater the chances of a swift victory. An AI could also play this per-cell "COF" optimization game with itself millions of times to learn better ways of calculating COF coefficients.

This is one simple example of how a strategic hyperwar AI could seek advantage. There are others. The key point is that no human commander could even properly process thousands of fast-changing, per-cell COF calculations, much less act on them with the speed of a purpose-built machine running a rapidly improving algorithm.

Finally, let us come to action. In 2020, the Defense Advanced Research Projects Agency (DARPA) organized a dogfight competition[8] between human F-16 pilots and various AI algorithms, called "AlphaDogfight." The result was a landslide. AI won 5-1. There are many points of view about this competition and questions raised as to whether the rules of engagement were determined fairly. From my own personal experience applying AI to autonomous piloting applications, I know this: AI eventually wins. In 2017, SparkCognition, the AI company I founded, worked to develop technology to identify the conditions for an automated take off rejection. Using reinforcement learning, the AI we developed exceeded human performance both in timeliness of decision-making and accuracy of decisions made. The following year we worked on multi-ship defensive counter air (DCA) scenarios and found that, once again, AI performed amazingly well. In time, AI will win. Is someone making bets to the contrary? And if not, why aren't we moving faster to embrace the inevitable?

The fusion of distributed artificial intelligence with highly autonomous military systems has the potential to usher in a type of lightning-quick conflict that has never been seen before. The essential findings of my work in collaboration with General

"Screenshot of the DARPA AlphaDogfight Trial final round between a Heron Systems AI algorithm and a human pilot using a F-16 simulator" (DARPA)

Allen discussed above revealed that if artificial intelligence was aggressively applied to every element of the OODA loop, in essence, the OODA loop could collapse on itself. Artificially intelligent systems would enable massive concurrent coordination of forces and enable the application of force in optimized ways. As a result, a small, highly mobile force (e.g. drones) under the control of AI could always outmaneuver and outmass a much larger conventional force at critical points. Consequently, the effect of platforms under AI control would be multiplied many fold, ultimately making it impossible for an enemy executing a much slower OODA loop to contend or respond.

What, then, are the larger implications of AI's dominance in perception, decision, and action tasks? What happens when the OODA loop collapses? Let us examine a few implications.

Regional Powers and the "AI-Enabled Skirmish"

Previous work indicates that AI would provide a significant increase in the latitude of action available to both nation states and non-state actors. Smaller scale autonomous operations have an inherent quality of deniability in that there are no humans to capture or interrogate. And it is not just conventional, kinetic actions that AI can control but also cyber operations. The applications of AI to cyber are tremendous and range from automatic development of cyber weapons to the continuous, intelligent scanning of enemy targets to identifying pathways for exploitation, to the autonomous conduct of large scale, distributed cyber operations.

The onset of hyperwar type conflicts will have a great effect on almost all our current military planning and the calculations on which these plans are based. The most potent teeth to tail ratios sustainable by a human force will seem trivial when autonomous systems are widely deployed. The idea that training will always enable dominance will have to be questioned. And the already outdated notion of platform versus platform comparisons will become completely extinct.

Most of the scenarios described in "Hyperwar: Conflict and Competition in the AI Century," have already come to pass. In one conceptual vignette, we outlined how autonomous drones could be used to attack oil installations. Two years later, this actually happened against a Saudi oil facility in Abqaiq. We also highlighted how existing conventional aircraft would be reused as autonomous drones. The Chinese did exactly that with their J-6 and J-7 aircraft. Integrating AI into current systems presents the opportunity to build a potent capability at low cost and create significant complications for planners looking to counter these threats.

When kinetic or cyber effects can be employed over great distances, with great precision and with no human involvement, the likelihood that countries and groups will use these capabilities increases. And when autonomous systems begin to blunt the training-enabled human edge, the potency of such actions is amplified.

The Rest of the World is in on the Secret: the Future is Autonomous

Every day brings with it new announcements in military technology developments. And most of these are not taking place in the United States. Consider just the following recent news from around the world:

1. Russia announced that they deployed 80 drones simultaneously in Syria for ISR (Intelligence, Surveillance and Reconnaissance) coverage and were able to see "everywhere all at once."
2. The Russians have also tested the Mi-28N attack helicopter with a new drone launcher[9] that can be used to deploy ISR systems and intelligent loitering munitions. In January, 2021 Iranian media showed images of a similar system mounted on a helicopter.

3. During the Azerbaijan-Armenia conflict, Turkish TB2 drones were used to devastating effect in contested airspace. Mass deployment of these systems in combination with loitering munitions took out S-300 surface to air missile sites, armor, and infantry. TB2s are being produced at the rate of at least one per week at a cost that is a tenth, possibly a twentieth of U.S. MALE (Medium Altitude Long Endurance) drones.
4. Israeli Harop drones delivered to Azerbaijan are also being used—both kinetically and for propaganda. A recent Azerbaijani martial music video shows a convoy of Harop trucks, each equipped with nine launchers. One can literally see the Azerbaijani military showcase—in a music video, no less—the lethal capability to concurrently deploy a swarm of at least 36 drones.
5. Azerbaijan converted old soviet-era biplanes into DEAD (Destruction of Enemy Air Defense) drones by using them to both identify SAM sites and destroy them via kamikaze attacks.
6. Baykar Makina, the Turkish company that manufactures the Bayraktar TB2, has test flown the Akinci, a drone with a broader mission profile, greater capabilities, and lower cost in comparison to deployed U.S. drones. They have also announced an air-to-air mission capability for the same platform, potentially integrating the Turkish Gokdogan[10] and Bozdogan air to air missiles.
7. The Chinese, in the last few months of 2020, announced and tested two drones; a 100kg payload twin rotor aircraft that can supply troops at high altitude,[11] and a high-speed drone designed for ISR, electronic warfare, and ground strike.
8. Iranian drone production, by all accounts, has ramped up tremendously and a huge range of designs are being produced,[12] including a MALE system. Iran recently demonstrated a combination of small, high speed boats with an autonomous drone, raising the possibility of (UCAV) drones being deployed from (USV) drones.[13]
9. Ukraine has formed a joint venture company with Turkey to manufacture a modified version of the TB2. The initial plan is to produce at least 48 aircraft.[14]
10. The variety and scope of Chinese drone developments is incredibly impressive, and unmanned systems now address every application, from low-end tactical to high-end strategic.

There is also a considerable amount of work going on in Pakistan, India, Israel, South Korea, Brazil, and elsewhere. The list truly goes on and on. In a world where strategic competition between near-peers is once again at the fore, the pace of military innovation is skyrocketing.

While the volume and pace of these developments is impressive, nothing in the list above should be truly surprising. For years, General John Allen, former Deputy Secretary of Defense, Robert O. Work, and others have been pointing to the potential of autonomous technologies, inexpensive sensors, and fast spreading technical knowledge combining to yield potent and inexpensive capabilities.

Cost is a Competitive Advantage

Countries across the globe are leveraging low-cost frameworks for innovation, combining open source software and systems with inexpensive, commercial grade electronics, domestic software prowess and a willingness to experiment and rapidly iterate using methodologies often referred to as "Agile." Not only does this result in lower development costs, it also leads to speed of innovation.

In contrast, in the United States we spend large sums of money on incredibly expensive platforms that work well when they are maintained at great cost, and that perform when they are piloted or controlled by humans in whom we have invested millions of additional dollars of training time. Is this the best strategy? Or are we doing to ourselves what we did to the Soviet Union in the 1960s and 1970s… encouraging military spending into broader economic oblivion?

Our opponents will increasingly use inexpensive technologies that are easily produced, employable in large quantities, and that continue to deliver results even when they are left to their own devices without any need for a highly trained human operator.

While the United States is the richest nation on earth, too great a disparity in cost-per-capability cannot be sustained even by the world's apex military power. We are walking a dangerous path if we continue to provide lip service to emerging, disruptive technologies while making the real, significant investments in legacy platforms. It is not enough to talk about technological disruption, we must actually disrupt our funding and spending patterns.

Let us apply the cost-per-capability lens to just a few of our high-end platforms that have traditionally been force multipliers and differentiators for our forces. U.S. attack helicopters are the most potent in the world. But recent export orders show that they now cost between $100-125 million per aircraft.[15] While capabilities vary based on platform, in general, these helicopters carry anywhere between 8 and 16 anti-tank guided missiles (ATGMs), enjoy a loiter time of about 2.5 hours, and carry two pilots on board. In contrast, the Bayraktar TB2 currently being used in Libya and Nagorno-Karabakh has a loiter time of 24 hours, carries 2 ATGMs, requires zero on-board pilots, and costs about $2M[16]. It's quite apparent that armor is vulnerable to these drones, much as it is to attack helicopters. But have we considered how these drones can be employed in swarms as an alternative to the expensive attack helicopter? How many TB2s can be delivered via a single transport aircraft? How many conventional attack helicopters? How much training is required for on-board pilots versus for an autonomous system complemented by a remote operator? A new, distributed lethality alternative to attack helicopters has advantages beyond the obvious lower cost.

It might be tempting to look at tactical drones and dismiss them as relatively simple systems that were bound to proliferate. Of course, I agree with both those points; many are simple systems and they have indeed proliferated. However, the drones now being developed in a number of countries are not necessarily just tactical or low-end. Complex high-end capabilities are proliferating, too. AI is being applied to other complementary areas, such as jamming, to create cognitive EW (Electronic Warfare) pods that can be flown into action by a UAV.

And it is not just about the drones alone, but rather the fact that their employment in real theatres of conflict also entails a significant shift in the entire concept of operations. For example, it has been theorized that TB2 drones over Azerbaijan were controlled from Turkey, with larger Akinci drones acting as relays. ATGMs delivered at scale, against a peer-force by attritable, long-endurance platforms controlled by pilots hundreds of miles away… never before was this concept of operations employed. But even newer methods of employment are coming.

Turkish Aerospace and Bayraktar are collaborating with Aselsan to incorporate the Koral EW system onto their drones. Russia's Uran-9 UGVs have been improved after their performance in Syria was studied and gaps were identified. Chinese UAV developments are progressing at such a significant rate that it is difficult to capture them in a work that falls short of book-length. Sensors, control systems, vehicles, and conops are all evolving fast on the global scene and this means complex, multi-system threats employed in surprising ways.

Michael Peck, writing in National Interest suggests that "Turkey may have won the laser weapons race" when it deployed a laser weapon system in Libya that was able to shoot down a Chinese Wing Loong drone. He goes on to quote Alexander

Timokhin of Army Recognition; “the interesting thing in this whole story is how essentially newcomers to the laser theme occupy that niche in which the ‘grandees’ of laser business, such as Russia and the USA, do not even think to climb.” Indeed, space that is ceded will be occupied. Technological gaps between several leading nations of the world are no longer so insurmountable so as to allow complacency. And cost matters! How is it that Turkey, with a $22 billion defense budget, is able to drive so much innovation in air-to-air missiles, lasers, EW, drones, and many other areas, whereas our dollars do not quite seem to go as far in the United States.

Cost is a critical feature, too! Big, expensive, slow-to-evolve, slow-to-build and complex to maintain platforms need to be re-thought in an age where software is the most lethal weapon. One that is growing exponentially in capability over months, not years. You can not bend new metal fast enough to keep up. It is the relationship between the software and the metal that truly matters. In this context, how does the $35 billion carrier strike group evolve in the age of inexpensive DF-21D missiles and next-generation AI-powered cruise missiles? What about the tank? General Tony “T2” Thomas, the former commander of the United States Special Operations Command (USSOCOM), recently discussed this point with me and wondered whether Nagorno-Karabakh pointed us to the end of the tank-as-platform. General Thomas has also publicly tweeted his views on this topic; “The real debate is the role of massed armor in future warfare (there is a reason the Marines just gave up their tanks).”

There are signs of progress and improvement. Certainly, the United States has not been sitting entirely still. The Air Force’s announcement of the first test of a sixth generation platform is encouraging, in particular because it was developed so quickly. Also encouraging are the three Boeing, General Atomics, and Kratos “SkyBorg” prototype development efforts for loyal wingmen drones. But given history, one wonders how expensive new systems will be by the time they are deployed. Will future programs be able to avoid the types of issues that the F-35 program encountered? A $120 million, fifth-generation stealth platform for use against near-peer threats, but only used in anger with non-stealthy, externally mounted munitions to conduct missions in uncontested airspace. Are these missions not better suited to a 40-year old F-16 or A-10? Consider further the case of our B1s, which are exquisitely complex aircraft designed for low-altitude, high-speed penetration of highly defended airspace. To find some use, they were eventually used to drop conventional bombs in Afghanistan. Mundane, low-end work for a high-end platform.

It is high time we got over the platform and focused on the mission. If we keep buying $120 million jets with $44,000/hr flight costs to use them on missions better suited to $2 million drones that could cost us $2,000/hr, we will eventually find that financial oblivion we seem to be looking for. We do not need all high-end, all the time. And there are more imaginative ways of employing our existing high-end platforms than as frontline bomb trucks.

AI for Sense-Making, Cyber, and Space

While AI will play a huge role in augmenting conventional platforms, it will also play four additional roles. First, it has the potential to automate planning and strategy. Second, it can revolutionize sensor technology by fusing and interpreting signals more efficiently than ever before. Third, it has a massive role to play in space based systems; particularly around information fusion to counter hypersonics. Fourth, it can enable next generation cyber and information warfare capabilities.

Imagine an ocean in which submarines cannot hide effectively, negating one leg of the triad. Imagine middle powers fielding far more competent forces because while they lack the resources to train human pilots to the level of the United States

Air Force, they are capable of the design expertise required to field AI-powered platforms. Imagine cyber attacks engineered by AI and executed by AI at scale. Imagine long-running, fully automated information warfare and espionage programs run by AI systems. If AI is applied creatively in nation state competitions, it has the potential to create significant, lasting impact and deliver a game-changing edge.

Software: The Ultimate Weapon

Software, AI, autonomy—these are the ultimate weapons. These technologies are the difference between hundreds of old Mig-19 and Mig-21 fighter jets lying in scrap yards, and their transformation into autonomous, maneuverable, and so-called "attritable," or expendable, supersonic drones built from abundant air frames, equipped with swarm coordination and the ability to operate in contested airspaces. Gone are the days when effectiveness and capability could be ascribed to individual systems and platforms. Now, it's all about the network of assets, how they communicate, how they decide to act, and how efficiently they counter the system that is working in opposition to them. An individual aircraft carrier or a squadron of strategic bombers are no longer as independently meaningful as they once were.

In the emerging environment, network-connected, cognitive systems of war will engage each other. They will be made up principally of software, but also of legacy weapons platforms, humans, and newer assets capable of autonomous decision and action. The picture of the environment in which they operate across time and space will only be made clear by intelligent systems capable of fusing massive amounts of data and automatically interpreting them to identify and simulate forward the complex web of probabilities that result. Which actions are likely to be successful? With what degree of confidence? What are the adversary's most likely counter-moves? The large scale, joint application of autonomously coordinated assets by a cognitive

"Software Data analysis for an integrated computer system" (Ilya Pavlov, Unsplash Photos) system will be unlike anything that has come before. It is this fast-evolving new paradigm, powered by artificial intelligence at every level, from the tactical to the strategic, that demands our attention. We must no longer focus on individual platforms or stand-alone assets, but on the cognitive system that runs an autonomous "Internet of War."

Integrating the "LEGO bricks" of intelligence and autonomy into conventional platforms results in unconventional upgrades. A Chinese-built Shenyang J-6 Farmer fighter jet with autonomy is not just a 1950s era write-off. It becomes a system with new potential, diminished logistics dependencies, and an enhanced efficacy that goes far beyond an engine or radar upgrade. Broadly, the consequences of the use of AI to revitalize and reinvent conventional platforms will be hard to ignore.

Preparing for an Autonomous, Software-Fueled Future

Despite the change occurring globally in value shifting from the physical to the digital, and the tremendous latent potential of AI, the U.S. Department of Defense has not traditionally been at its best when it comes to understanding, acquiring, or deploying software capabilities. Hardware platforms come far more naturally to our acquisition professionals. We can hope for a change of heart and perspective, but absent that, in order for AI to be meaningful to them in the near term, we must reinvent, enhance, and reimagine existing platforms just as we build new ones. It is only then that we will cost-effectively fulfill needs and create significant new capabilities that open the door to even greater future potential. Briefing after briefing on the potential of AI, or distributing primers on machine learning inside the confines of the Pentagon will not lead to critical adoption; the performance gains that result when AI is integrated into platforms will be the proverbial proof that lies in the eating of the pudding.

We have made the mistake of being too slow to adapt, and not predicting the next conflict well enough to be prepared. Perhaps some of our allies have made the same mistake. In fact, a report from the European Council on Foreign Relations (ECFR) concluded that "the advanced European militaries would perform badly against Azerbaijan's current UAS-led strategy."[17] The truth is that we have developed an inflated opinion of the quality of our readiness because over the past 40 years we have not had to face opponents that were able to turn our omissions into unforgivable sins. The future may not be so kind.

To compete in this new era of exponential technologies, the U.S. military and our intelligence agencies need to go all-in on digital and physical systems powered by artificial intelligence. Imbued with synthetic cognition, such systems can make a meaningful difference to every branch of our armed services and our government organizations. A serious effort to fuel the development of such systems will lay the groundwork for true, full-spectrum AI adoption across government. But for any of this to become reality, long held views and processes in the Defense Department must change. In order to turn the tide, at a minimum, we need to:

1. Take a "let a thousand flowers bloom" approach with ideation and experimentation. Financially incentivize startups to contribute to innovation and encourage them to rethink platforms (Note: $50,000 is not an incentive especially in the context of the massive hurdles companies need to overcome to be a government supplier). Red tape—from clearances to past performance requirements—often makes it impossible for young companies to participate and should be re-thought. The focus should be on delivering capability, not how the capability is delivered.
2. Use existing platform upgrade opportunities to source autonomy and AI technology—particularly from younger, innovative companies—and

incorporate it into systems that already exist. Rather than transforming platform upgrades into a vendor annuity, DOD can use upgradation roadmaps to accelerate a broad based AI transformation and build subsystems that will find use across many areas.

3. Connect successful experiments with "end users" in our services early and quickly, capturing feedback and allowing rapid iteration.
4. Make fast funding mechanisms available directly to smaller, innovative companies to convert successful experiments to deployable systems. We must reduce bureaucratic burdens on smaller companies so that they can directly deliver to government customers. Presently, many smaller companies have no choice but to deliver their capabilities through a handful of primes. This can be both monetarily inefficient and unhealthy for the growth of the defense ecosystem.

If we are to remain competitive, an aggressive, fast-track effort to incorporate AI into existing and new platforms must be adopted. In the age of hyperwar, our willingness to embrace commercial innovation, our decisiveness in acknowledging that we live in a post-platform era, and most importantly, the speed with which we operationalize new investments, will be the attributes that lead to victory. PRISM

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