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SUPERCHARGING THE INNOVATION BASE

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SUPERCHARGING THE INNOVATION BASE

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
FUTURE OF DEFENSE TASK FORCE,
Washington, DC, Wednesday, February 5, 2020.

The task force met, pursuant to call, at 9:00 a.m., in room 2118, Rayburn House Office Building, Hon. Seth Moulton (co-chairman of the task force) presiding.

OPENING STATEMENT OF HON. SETH MOULTON, A REPRESENTATIVE FROM MASSACHUSETTS, CO–CHAIRMAN, FUTURE OF DEFENSE TASK FORCE

Mr. MOULTON. Good morning. The hearing will come to order.

I would like to welcome our task force members and the witnesses testifying before us today. This hearing addresses technology and the innovation base for the Committee on Armed Services' Future of Defense Task Force.

Technology is at the heart of today's great power competition and the United States no longer enjoys unrivaled dominance. Countries like Russia and China are not just trying to compete with the United States conventional military capability, they are trying to leapfrog us in emerging technologies to blaze a new technological frontier. As I speak, our adversaries are working to surpass us in a dizzying array of emerging technologies, from artificial intelligence to quantum computing to biotechnology and 5G, just to name a few.

My co-chair, Representative Jim Banks, and I just returned from Southeast Asia, where we saw firsthand the overwhelming influence of China's Belt and Road Initiative. We also saw the fruits of its technological revolution, where companies like Huawei, ZTE [Zhongxing Telecommunications Equipment], and Alibaba have made significant gains on U.S. competitors. China is investing billions and is resolute in its endeavor to be the world leader in many of these emerging technologies.

One cannot understate the fact that whoever wins this race will likely enjoy both military and economic superiority. To ensure U.S. strategic overmatch in these increasingly common battlespaces, the Pentagon must work to supercharge its innovation base. It will need to grow human capital, enhancing funding for research and development, foster partnerships with tech innovators in the private sector, and bolster ties with academia. We also need immigration policies that ensure the United States attracts the most talented people globally. And this effort will require a whole-of-government approach. The Pentagon will play an enormous role in that effort.

Initiatives like DARPA [Defense Advanced Research Projects Agency] have created a historical context. With an initial funding of $520 million, which would be $4.5 billion in today's dollars, DARPA led to current initiatives like DIU [Defense Innovation Unit] which, while particularly noteworthy, simply doesn't get the same level of support with a mere $41 million budget. We cannot expect the same success without the same level of commitment.

Additionally, the defense acquisition process is clearly broken, particularly with regards to the emerging technologies often discussed on this task force. The private sector must help provide the impetus for change. The simple truth is that a majority of the breakthroughs in innovation are occurring in the private sector and the DOD [Department of Defense] must emphasize agility to capitalize on these innovations and talent, as our national security depends on it.

Frankly, that is why the Future of Defense Task Force exists. We need to innovate. We need to create and leverage new capabilities, and we must win this race. Furthermore, we must create technological and economic advantages, and those advantages come through our American talent. We cannot lose that.

I have heard far too many stories about talented young people with the skills we need choosing to leave national security and the defense community. They do not depart out of a lack of patriotism but out of frustration with slow-moving bureaucracy and antiquated personnel policies. We owe them better.

As Congress considers the future of defense, it is important to remember the American warfighters. We owe it to our warfighters, and it is our duty as policymakers to catalyze innovation and maintain the military and technological superiority that not only deters conflict, but keeps our young people out of wars, and if that conflict occurs, makes sure that they never enter a fair fight.

I would like to thank Chairman Smith and Ranking Member Thornberry for continuing to support the task force, and I want to recognize my fellow task force members for their ongoing efforts in this important endeavor.

Now I would like to turn it to my co-chair, Congressman Jim Banks of Indiana.

STATEMENT OF HON. JIM BANKS, A REPRESENTATIVE FROM INDIANA, CO–CHAIRMAN, FUTURE OF DEFENSE TASK FORCE

Mr. BANKS. Thank you, Chairman Moulton. And thank you to the witnesses for being here today. I have really been looking forward to this hearing that we are about to have.

The task force has just crossed its halfway point. Over the last 3 months, we have held hearings and briefings focused on the theories of victory and explored the different critical technology areas that are fundamental to our national security: autonomous systems, biotechnology, cyber, artificial intelligence, and hypersonics.

Just as importantly, we have investigated how these technologies will interact in future conflicts that will require a fully sensing, intelligent, and distributed command and control environment. And while we are still a long way out from realizing the battlefield of the future that I described, the investments that we make today

in our innovation base and technology infrastructure will shape our future military superiority.

But government alone cannot lead this charge. It is critical that we partner with industry, leverage commercial research and development, harness emerging technologies, and break down the barriers that prevent the most innovative businesses from wanting to work with the Department of Defense.

This task force has also surveyed the front lines of the great power competition landscape where the U.S. and Chinese influence, technologies, and narratives are vying for a receptive global audience. One of the common themes that we have heard was the importance of U.S. competitiveness in critical technologies and the desire for Western alternatives to Chinese offerings. We must recognize that there is opportunity for the U.S. to lead in the development and responsible use of these capabilities, but also acknowledge that this will require additional investment in our domestic innovation base.

Welcome to our witnesses once again. Thank you, Mr. Eric Fanning, a special thank you to Mr. Raj Shah and Mr. Chris Brose, who I also had the privilege of serving with on the Reagan Institute Task Force on Innovation and National Security. It is good to see you all again. Each of the organizations that you represent exemplify our competitive advantage as a Nation. I applaud your willingness to tackle some of our most pressing defense challenges and your relentless courage to innovate. I look forward to hearing from our witnesses today.

And, with that, I yield back.

Mr. MOULTON. Thank you, Chairman Banks.

You know, this is an unusual subcommittee or task force in that Jim Banks and I are co-chairmen. So it is fully bipartisan, an equal number of Democrats and Republicans, and we recognize that this is a very bipartisan mission.

I am pleased to recognize the witnesses that we have today, and I want to thank you all for being here and echo my co-chairman's remarks.

Mr. Eric Fanning is the president and CEO [chief executive officer] of the Aerospace Industries Association and former Secretary of the Army. Thanks for being here, Eric.

Mr. Raj Shah is chairman and co-founder of Arceo.ai and the former head of DIUx [DIU Experimental]. Raj, great to see you.

Mr. Chris Brose is the chief strategy officer of Anduril and former staff director for the SASC, for the Senate Armed Services Committee, under Senator John McCain, someone whose presence in American politics we dearly miss today. So, Chris, thank you for being here as well.

So thank you all, and, Mr. Fanning, we will begin with you.

STATEMENT OF HON. ERIC FANNING, PRESIDENT AND CEO, AEROSPACE INDUSTRIES ASSOCIATION

Mr. FANNING. Chairman Moulton, Ranking Member Banks, members of the task force, thank you for inviting me to be a part of today's hearing. I am always happy to return to HASC [House Armed Services Committee], where I started my career as a re-

search assistant under Chairman Les Aspin more years ago than I can count.

I have spent much of my ensuing time in government, primarily in the Department of Defense. I am drawing on that experience as I think through today's hearing, but I am also drawing on the many things, some surprising, that I have learned about industry since becoming president and CEO of the Aerospace Industries Association [AIA].

The subject today is a broad one and includes a large ecosystem that Senator Jim Talent laid out in his testimony to this task force last year. It is not enough to focus on how to increase innovative capabilities and culture in each part of the ecosystem; we must also focus on how to strengthen the partnerships between the various parts. I have seen great innovation in the Department of Defense, the large and established defense primes, and new entrants. However, sometimes it has been hard for the innovation taking place in industry to find its way to our military in the field. Government must better adjust to private sector developments rather than force those developments to fit its needs.

At AIA, we focus our efforts in three broad categories—investment, framework, and workforce—all the elements necessary to maintain our competitive advantages. I think we need to look for changes and improvements in all three of these areas in order to supercharge innovation and across all aspects of the national security industrial base.

First, under investment, it is worth stating the obvious. We need to find a way back to regular order in the Federal budget process. The threat of continuing resolutions and government shutdowns, followed by the reality of continuing resolutions and shutdowns, is extremely disruptive to the planning and unimpeded work necessary to make sure we do not lose our technological and national security edge. China does not periodically shut down its government. Too often, we do.

It would also help, for planning purposes, to look beyond 1-year budgeting cycles. This is certainly not a new idea, but increasingly important as China accelerates and technology iterates faster.

The U.S. also needs to increase R&D [research and development] spending. While we have seen increases in defense R&D and overall defense spending in recent NDAAs [National Defense Authorization Acts], governmentwide spending in R&D has generally been declining, and in terms of percentage of GDP [gross domestic product], fell to pre-Sputnik levels in 2017.

Second, under framework, or in the case of this discussion, the acquisition process, much important work has been done inside the Department and recent NDAAs have included aggressive reform. And while the Department still needs to fully implement some of these reforms, more can be accomplished.

We have seen cases where the Department is becoming less prescriptive with requirements, particularly at the prototyping and demonstration phases. They indicate a smaller set of higher priority requirements and allow flexibility in competing to offer more diverse solutions. That said, including other players in the innovation ecosystem earlier in the conversation could prove useful, large primes and new entrants.

Discussing the original problem sets, when appropriate, before even getting to high-end requirements, might open the solutions aperture even wider. The problem, however, is that even though more entrants have access to these early phases, the valley of death before becoming a full program of record still exists for those new entrants and for the existing primes.

This has severe ramifications for all participants. Large companies may be better situated to survive this valley, but it can impede their ability to lock up partnerships with the many subcontractors they need from the supply chain, who are less able to survive.

Program managers and program executive officers develop schedules, but more emphasis should be placed on speed. Successful prototypes that the Department pursues should include plans on the Department's side to scale and field quickly.

We should also look for ways that returning to Congress doesn't needlessly slow down development. Oversight is critical, but technology moves faster than our budget process. For example, program managers and PEOs [program executive officers] might be given wider flexibility with program spending in the early phases when they are still defining costs.

This all, of course, leads to workforce. More authorities and more control with the expectation of increased risk require better training than the Department typically provides its workforce. And this is particularly true of the civilians who are not afforded the same development opportunities as those in uniform. It is not enough to pass reforms in the NDAA. We need to make sure that those on the receiving end are fully empowered to utilize that reform.

In addition to training the current workforce, we need to attract the future workforce. The United States needs to seriously recalibrate its investment in STEM [science, technology, engineering, and math] education at all levels. On so many different metrics, the Chinese are investing more than we are in this area.

Finally, there are many places throughout DOD and the government where interesting innovation is taking place and where we could find lessons to scale across the larger enterprise.

As this panel comes up with a series of recommendations for innovation in the national security ecosystem, it is worth noting that Congress just created a new branch of the military. We could shape the Space Force using templates from the last time we created a new service in 1947, or we could think of it as a test bed for all the changes we need to maintain our national security advantages.

Thank you. I look forward to your questions.

[The prepared statement of Mr. Fanning can be found in the Appendix on page 31.]

Mr. MOULTON. Thank you very much.

Mr. Shah.

STATEMENT OF RAJ SHAH, CHAIRMAN AND CO–FOUNDER, ARCEO.AI

Mr. SHAH. Co-Chairmen Moulton and Banks, members of the task force, thank you for the opportunity to share my thoughts on what I believe to be the central challenge facing our Nation's long-term security: How best to harness our Nation's innovation strength to sustain security and peace around the world.

As someone who has spent large portions of his career both in our Armed Forces and in Silicon Valley, I applaud the focus of this task force. These two worlds are populated with extremely talented, mission-driven individuals, but have drifted apart in terms of both business process and culture.

The title of this hearing, Supercharging the Innovation Base, is aptly named. The challenges we face from an increasingly autocratic world are real. I fear that without an organized effort by the Department of Defense, the preeminence of our fighting force may no longer be undisputed.

Underpinning our innovation prowess is foundational research and development, a world-class talent base, strong connectivity between the DOD and companies leading development in technologies such as AI, autonomy, and cybersecurity.

But, to me, the word "supercharging" represents not an incremental improvement, but a step change. Apropos, the supercharger on the Merlin engine helped turn the tide in World War II. I strongly encourage this task force to think broadly about how we can implement change at significant scale.

The pacing challenge in thinking about innovation and national security, of course, is the remarkable progress made by China. Their public commitment to lead the world in innovation, particularly in AI [artificial intelligence], coupled with their concepts of civil-military fusion, make them a formidable competitor. With a growing population of 1.4 billion, China is turning to AI to perfect dictatorship, and its access to massive amounts of data has allowed it to close the gap with U.S. industry. For example, the most valuable AI facial recognition company in the world is Chinese.

This steady emphasis is bearing fruit. China now has more supercomputers than the U.S., total private venture capital investment surpassed the U.S. for the first time in 2018, and as of 2017, Chinese Government R&D as a percentage of GDP was higher than the U.S. Furthermore, the People's Liberation Army and technology startups enjoy close, though perhaps compelled, collaboration.

To counter these trend lines, the U.S. must play to its strengths: having the most vibrant ecosystem in the world, Silicon Valley, Boston, and other places; historic strong support for science funding; being a welcoming place for immigrants; and longstanding alliances with the free nations of Europe and Asia.

So I quickly would highlight five areas where I think this task force can have real, real impact. First and foremost, human capital. Our innovation superpower for the past half century has been our investment in human capital. From Wernher von Braun to the current CEOs of Microsoft, Google, and soon IBM [International Business Machines Corporation], the U.S. has been a magnet for foreign technical talent. The DOD has also attracted top talent for short tours without hindering their private sector careers, most notably McNamara's Whiz Kids. And finally, with a sprawling infrastructure of bases across the country, military service and the ethos of its members was ever present across all socioeconomic groups.

Unfortunately, all three of these human capital advantages have withered, and now is the time to reinvigorate. We can talk more in the recommendations that I might submit during the Q&A [question and answer], but let me highlight a few.

One, reopen a major military installation in each of our leading innovation centers, San Francisco and Boston, to help build personal community relationships; establish a national security innovation visa to fast track green cards for experts in key technical fields; increase opportunities for civilian service through a STEM corps; and expand Reserve and national service opportunities.

Second, engagement at scale. The Department of Defense's engagement with the innovation ecosystems have shown early success, but not yet at scale. Now is the time to supercharge DOD's access to innovation for new entrants as well as traditional defense contractors. The DOD spends less than $500 million annually with venture-backed startups and less than a billion in true AI research. This represents a half percentage point of the Department's procurement and R&D budget of $243 billion, quite literally a rounding error.

If we believe that the innovations transforming our daily lives, from self-driving cars to voice-activated televisions, will be core to future national security, we should massively increase support to the organizations meeting these challenges head on.

My recommendation would be to increase by tenfold the spend on successful innovation efforts, such as the Air Force's Pitch Day, DIU, Joint AI Center, and many others. Additionally, increasing Federal R&D to its historical levels of 1.1 percent would be very important.

Point number three, train and equip for the future. From the Section 809 Panel to the sustained efforts of the House and Senate Armed Services Committees, including Mr. Brose here, great progress has been made in the area of acquisition reform, so much so that I would submit that the real impediment is reforming management incentives rather than additional legislation. More importantly, there is a need to structurally refocus the training and equipping of our forces to meet an enemy emboldened by autonomous weapons. This tectonic shift of how we will fight is being overshadowed by the acquisition reform debate.

How do our concepts of operations change in the face of low-cost drones with embedded facial recognition? It will require congressional leadership to enable the DOD to be ambitious and depart from its comfort zones. One result will be large programs of records for nontraditional weapon systems. The sooner that we can recognize this coming change, make large bets on specific technologies and new companies, the quicker entrepreneurs and the venture investment community will apply their talents and risk capital to solve DOD needs at scale. In essence, who are the Billy Mitchells and William Knudsens of today?

My fifth point, allies and partners. Addressing the challenges discussed today will only be easier with our allies and partners. Fortunately, we have built goodwill over decades and can deepen these relationships to enact coordinated economic and defense strategies.

And in conclusion, finally, I wish to highlight one final near-term opportunity that Mr. Fanning did as well, which is, with the establishment of the Space Force, the Department can take a clean sheet approach to the technology and talent acquisition process. The timing is especially fortuitous as the commercial space industry is in the midst of a renaissance led by new entrants.

In sum, while the challenges are real and growing, our Nation has all the elements necessary to prevail in the defense of democratic values. We just need the collective will to do so. Many august organizations have developed robust recommendations. I urge you to help lead Congress and our Nation in their implementation.

Thank you, and I look forward to your questions.

[The prepared statement of Mr. Shah can be found in the Appendix on page 40.]

Mr. MOULTON. Thank you very much.

Mr. Brose.

STATEMENT OF CHRIS BROSE, CHIEF STRATEGY OFFICER, ANDURIL INDUSTRIES

Mr. BROSE. Thank you. Chairman Moulton, Ranking Member Banks, members of the task force, it is an honor to appear before you today. I am grateful for the opportunity, and I applaud the excellent work that you are doing.

When it comes to our defense innovation base, here is our predicament. I think the chairman and the ranking member laid it out well in their opening statements. Most of the people and companies that are most expert in the kinds of emerging technologies that the U.S. military needs for the future are not currently doing defense work, while traditional defense companies, despite their remarkable people and expertise, are not at the forefront of these emerging technologies.

The question then is how to realign our innovation base, and I have come to believe that we in Washington are overthinking this problem. Ultimately, it comes down to one thing: incentives.

Consider the scale of this problem. When the Cold War ended, there were 107 major defense firms. By the end of the 1990s, there were five. And since then, the middle tier of our defense sector has been systematically hollowed out, bought up by larger companies or driven out of business altogether.

At the same time, the defense sector has not been attracting and retaining new companies. From 2001 to 2016, of new companies that sought to work for the U.S. Government, 40 percent were gone after 3 years, more than half were gone after 5 years, and nearly 80 percent were gone after 10 years.

Indeed, since the end of the Cold War, in every technology sector in America there have been literally more than 100 startups that have grown to be valued at more than $1 billion, and in the national security sector there have been only two.

This didn't just happen. This was the result of incentives that we created in Washington, some conscious, some unconscious. Most detrimentally, we carved up what little money we have spent on research and development into lots of small contracts for lots of small companies that rarely make it across the valley of death that we have talked about this morning, rarely have become large-scale military programs and enables new companies to grow.

This is why so many of America's best technologists and investors have turned away from defense. It is not because they are unpatriotic; it is because they have not believed they could fully realize their talents, build successful companies, and make large re-

turns on investments by working in defense. And three decades of empirical evidence suggests they were not wrong.

Defense will never be a free market, but it is still governed by incentives. To supercharge the innovation base, we have to create different incentives, and we can, but the U.S. Government must recognize its proper role in this innovation ecosystem.

Innovative companies do not need the U.S. Government to try to play venture capitalist. America has plenty of money. Indeed, the amount of private capital in our Nation dwarfs the defense budget many times over. This money is not ideological. It will flow to what it perceives to be good investments. America also has plenty of innovators and engineers who would be willing to work with our military. More of them will want to do that if they perceive it to be a path to fulfillment, success, and wealth. They do not need U.S. defense agencies to try to turn themselves into tech startups or software development factories.

Innovative companies that are doing defense work need one thing more than any other from the U.S. Government: revenue. They need contracts for the best capabilities they are building, not tiny one-time awards for science projects that never get fielded, transitioned, and scaled into programs of record, but the kind of recurring revenue that comes from building and shipping products to more and more customers.

If the Department of Defense and Congress value AI-enabled capabilities, autonomous systems, small drones, and other emerging technologies that we are talking about here, you have to buy more of them. This will enable the companies that are doing this work to do more of it, to grow, to attract more engineering talent, to develop new technologies, and raise many times their current value in private capital that is just sitting on the sidelines and looking for good things to do. And as more of those investors come to see defense as a viable business model, they will direct more of their considerable resources to founding and helping to grow new innovative companies that want to work for the U.S. military.

Not all of those bets will succeed, but the ones that do can be huge winners, and their success can attract even more engineers, companies, and investors back into the defense innovation base, enabling it to grow larger, more vibrant, and more competitive. It can and must be a virtuous circle, but it all comes back to the U.S. Government creating the right incentives. This is starting to change, and we have talked a bit about it, but just barely.

At present, two things are simultaneously true. Thanks to the many reforms and new authorities that you all and your colleagues of Congress have given to the Department of Defense, it has never been easier for new innovative companies to get small contracts to work for the U.S. military. At the same time, it has never been harder for those companies to transition their good work, displace established but less capable programs of record, and win large-scale procurement contracts.

Ultimately, the way to supercharge the defense innovation base, in my opinion, is actually relatively simple: Buy more of what that innovation base is building right now. It is a question of supply and demand. The most important thing the U.S. Government can do is create greater demand. It has to clearly define our most important

operational problems, hold regular, fair, and open competitions to determine what capabilities and concepts work better than others. Pick winners. Do not try to make a thousand flowers bloom. Concentrate our limited government resources in smaller numbers of larger bets on the most promising capabilities that our Nation's innovation base is producing.

Getting from the military we have to the military we need will be a daunting challenge, but it can be done. We have the people, the technology, and enough money to do it, but we have to get the incentives right and we have to move with a sense of urgency, which I applaud this task force for working to create.

Thank you very much again for the opportunity to be here, and I look forward to your questions.

[The prepared statement of Mr. Brose can be found in the Appendix on page 51.]

Mr. MOULTON. I thank you all very much.

Now, the last time we had a hearing, our witnesses had so much to say and kind of maybe got a little bit carried away that my questions took forever. So I have offered to the committee to defer my questions to the end, and so we will start with my co-chairman, Mr. Banks.

Mr. BANKS. Thank you, Mr. Chairman. We accept your offer.

Mr. Brose, last year in Foreign Affairs, you wrote, quote, "a military made up of small numbers of large, expensive, heavily manned and hard-to-replace systems will not survive the future battlefield, where swarms of intelligent machines will deliver violence at a greater volume and higher velocity than ever before," end quote.

We are a week out from receiving the President's fiscal year 2021 budget request. What are some of the technology areas that you would recommend additional investment in order to realize the future battlefield that you described?

Mr. BROSE. Thank you very much for the question. I think many of the things that I would be looking for are investments in the kinds of autonomous systems, AI-enabled capabilities that you referenced. I think the way that we are going to, as the U.S. military, get to the type of scales of systems that I believe are going to be necessary for future effectiveness are by automating a lot of that process of understanding and decisionmaking and action and really delegating a lot of that to kind of increasingly capable military systems.

The other thing, though, that I would encourage you to look for is, we are spending plenty of money on command and control battle management, software-defined capabilities like that. I think the U.S. Government has got too little value out of what we have spent on systems like that.

And I would echo the point you made in your opening statement, that, to me—and it is in my written testimony—the real comparative advantage for us in the future is going to be command and control. It is going to be the ability to make sense of enormous amounts of information that our military collects, turn that into understanding of the battlespace, enable human beings to make good and relevant and timely decisions, and then direct actions to what will likely be highly autonomous systems, and do that at a pace and at a scale that we have really not contemplated before.

Mr. BANKS. You also wrote, quote: "Military pilots and ship drivers are no more eager to lose their jobs to intelligent machines than factory workers are. Defense companies that make billions selling traditional systems are as welcoming of disruptions to their business model as the taxicab industry has been of Uber and Lyft," end quote.

Can you point to specific examples of where the Department is falling short in innovation and where additional engagement with the private sector is needed?

Mr. BROSE. Thanks. I would say there are areas where we have been working on programs as a government for so long that we have failed to realize that commercial technology has just passed us by. You know, I think an area that is kind of near to my heart in my current life is counter-drone systems where, you know, we can now use things like artificial intelligence, machine learning, computer vision to rapidly make sense of information and cue human decisions in the time-relevant way that is going to be necessary. Many of those technologies were not available several years ago, and I think we can take more advantage of it.

I would say another area is the way we process information. You have mentioned in your opening statement the distribution of command and control. That will only happen if we can distribute the process of computation. So edge computer processing, moving that out of large centralized operation centers is something that the commercial industry has done remarkably well in the form of self-driving vehicles. That amount of computational power is many times what is on the best military systems today. It is something that I think we have to take advantage of, because we are not going to be able to rely on a military that is fundamentally tethered to large operation centers or command centers that may not exist or be available in a future conflict.

Mr. BANKS. Mr. Fanning, we have taken some important steps over the last few months with the establishment of the Space Force, as you have already acknowledged, and have begun to recognize how critical the space domain will be in further conflicts. How can the United States better compete with China to increase the number of launches and resulting space capability, and should the Department of Defense continue to play a larger role in the launch industry or is there opportunity to increase partnership with commercial launch providers?

Mr. FANNING. Thank you for the question. I get this question a lot, we all do, I think, and I don't think it is an either-or. I mean, if you look at the historical evolution of the commercial space market, it started with the government deciding it wanted to go to the moon when there wasn't a commercial market, turning to industry to get us to the moon, and those investments leading to the market that we have now.

And I think it is an artificial separation in many ways when we talk about the defense industrial base space and commercial space, because I think that they are in many ways one and the same. When I think of commercial space, I think of paying for a service, and you can go to any company to do that.

The benefit for us as a country in our competition with China in launch is the increased demand for launch, both military and com-

mercial. And we ought to be thinking about that in a combined way when we think about making sure we don't lose a competitive edge to China.

Mr. BANKS. Okay. Mr. Shah, your experiences in the military as director of Defense Innovation Unit and now in the commercial sector provides an interesting perspective on the innovation gaps within the national security arena. In your written statement, you highlighted the need to, quote, "engage at scale with the innovation ecosystem." Can you elaborate on your recommendation on how we scale up these efforts across the Department?

Mr. SHAH. Great. Thank you for the question. I think there has been a lot of initiatives over the last few years to tackle this problem directly, and some of them are starting to bear real fruit. I think I highlight a few of them. Of course, DIU, DDS [Defense Digital Service], Air Force Pitch Day. I think they all are finding different pathways for these companies to get both smaller contracts that Chris highlighted, but then also bridge those gaps to get to prime contracts.

I think capital, venture capitalists, they are in the business of understanding where they can maximize return. We don't need to engage them. You don't even need to call them. If you make bets on companies that you think will be decisive for national security, they will follow, at least the good ones are. That is their job.

And I think you have to put yourself in the shoes of a young entrepreneur that is one of the leaders in their field, say it is AI or autonomy. You have a small company of 25 people building cutting-edge technology. You have to make a decision as to where do I want to put my resources, my engineers, and my sales team. The way that the life of a young company works is that you have to show demonstrated success every 12 to 18 months to continue to stay in business and get the next round of financing. If you don't, you go out of business, and that is the venture capital world.

And so if you know that you need to show traction in 12 to 18 months, even if you would love to work for national security problem sets because it is the mission and you are excited about it, if you can't show traction in 18 months, you are not going to do it. And that cycle continues until perhaps they become a very large company, a public company. And the unfortunate downside is the Department doesn't get access to its cutting-edge technology till 5 years later.

So my recommendation is that we have already experimented in several ways. The ones that are demonstrating success, 10X their budget, 10X their ability to bring these companies into the fold, and then you will get multiple orders of magnitude of private capital and support behind that naturally.

Mr. BANKS. I yield back.

Mr. MOULTON. Thanks very much.

I now turn to Ms. Houlahan.

Ms. HOULAHAN. Thank you. And thank you very much for coming. I am really, really excited to have this conversation. This committee makes me happy, because we are really actually thinking about the things that I think matter.

By way of my background, I am an engineer. I worked in the Air Force on command and control issues. I am an educator of STEM.

And I think all of the issues that you are talking about are really, really important.

And what I want to dive deep on and my first question is, you all spoke about recalibrating STEM and STEAM [science, technology, engineering, art, and math] efforts for the workforce. Can you explain what does that mean? You mentioned STEM corps as an example.

Just to give you a little background of what is going on here in Congress, I am a freshman. I have been here for 13 months. We founded the Women in STEM Caucus about a week ago. There has never been a caucus like that. But what I discovered as I founded that is there isn't an engineering caucus either. And so it really is pretty remarkable that there are only about 15 of us in Congress who have STEM or STEAM backgrounds, and I just want your help to try and articulate what it is that we can be doing to be helpful to recalibrate the STEM workforce.

Mr. SHAH. Thank you for that question. I think we are in a war for talent. We are in a war for these people that have very specific skills in AI and autonomy, and there are only so many of them.

Many of them would love to spend some years of their life, their formative career in the Department of Defense or the U.S. Government. We have the biggest problems, the biggest datasets, the most interesting things to work on. But if you are a recent grad and you are weighing a process that may take 3, 6, to 12 months to get a job versus four competing job offers, we are making it difficult for the folks that even want to serve.

And I think there are two downstream effects that—a result of this that we could fix. One, in the short run, we don't have access to that talent, right? So we are making decisions as to which technologies to invest in, which products to buy. You need these people on our side of the fence or the government's side of the fence to help decide.

But I think there is a longer-term issue as well, that even when these high-end talented people go and build their own companies, when they are in senior leadership roles, they have never had any direct experience with the government. And so they don't understand the nuances and the way the government needs to digest technologies. And that rift will continue to grow.

So I think there is also a long-term challenge, and by doing something such as a STEM corps, where folks can come in, spend a couple of years working on interesting government problems, continue to serve in some part-time capacity, can help ameliorate.

Ms. HOULAHAN. Mr. Fanning.

Mr. FANNING. I would—I am watching the clock tick down. Two things in particular. One, this is a place where I think government has an important role, which is seeding the field so that we have the most talent coming out of that pipeline when we need it. And that means increased STEM opportunities at every level of education. I mean, I see STEM as a series of off-ramps. It has got to be a big funnel, a wide funnel at the start to get the workforce you need at the end. And it is not just Ph.D.s, although that is an important part of it. It is vocational training. It is all sorts of things in the larger STEM ecosystem.

And that also means thinking even more seriously about diversity and inclusion, because we are leaving half of the country off the table in many ways at the start when you look at the demographics in STEM, even going back to elementary school.

And then one other thing that just to key off something Raj said. We can't think of industry and government as adversaries. The partnership is so critically important, and a key component of that has to be understanding each side. That is government understanding industry. There are so many misunderstandings inside of government. But industry also understanding government better.

And to the degree that we can build on some of this cross-pollinization, it just will make us stronger into the future and I think might get at some of the problems Raj hinted at or talked about, in terms of attracting talent into the government side. We want to create a career path for people in the government side that probably includes time outside of government. It is healthy for them and it is healthy for us and it makes that opportunity more attractive for them.

Ms. HOULAHAN. Yeah. And that is definitely something that in my early time here I have been trying through the NDAA process to elevate is the importance of creating career paths. As a young engineer, I couldn't see myself going anywhere. I didn't know where my path would go and largely separated partially because of that reason.

I have only 27 seconds, and I am confident that Elissa will be asking something similar, but I just want to put out in the ether, if we are creating something like the Space Force but we are putting it under the umbrella, at least at this point in time, of the Air Force and we are talking about having to innovate, I worry that we are just going to create another organization that looks like the one that came before it, which will have all the flaws that it had before.

How do we break up and destroy that would be my next question, and I will leave that on the table because I have run out of time, but I would love to come back around to that.

Mr. MOULTON. Great. And we should have time to come back around.

So now over to Mr. Mitchell.

Mr. MITCHELL. Thanks, Mr. Moulton.

A question for you, Mr. Shah, on venture capital investment. I came from the private business world before I showed up here, interestingly. And I think one of the conflicts we have is the investment window of venture capital or private equity in development of any kind of technology or program in a government sector. We almost, regardless what we do, or I guess I would be interested as to what input you have in how we can bridge that, which you guys call the valley of death, so that, in fact, it makes it attractive without literally just throwing money at it in order to keep venture capital happy because, I will be honest with you, I worked in that world and, well, that is great, more money. So can you help explain how we bridge that gap without just tossing buckets at it?

Mr. SHAH. It is a great question, sir. And I guess I would reframe it as in I wouldn't focus on how do we get venture capitalists interested in defense companies, but, rather, to focus on what do we

think, as the title of this task force, the future of defense is. What are the key technologies that we need and demand to get them earlier, right?

So if we think that software and command and control is important, we should say, we want to have a system that works, it needs to work within 12 months, and it is a fair and open playing field for anybody. And if we then actually follow up and award large contracts to companies that are at the forefront of this type of development, the venture capitalists, the private equity, that whole ecosystem will follow.

I think, again, it is the signal here that the government is willing to invest in the capabilities that we need for the future and understand that software is built differently, that the way low-cost hardware is built is differently, and are willing to put markers in the sand.

So, again, so my focus, again, would be on being able to work with these companies at scale, and the rest of it will solve itself.

Mr. MITCHELL. Let me ask you a question, I would be interested, any of the panelists, I mean, the Department of Defense recently announced that they were effectively abandoning the procurement on the Optionally Manned Fighting Vehicle that, in fact, ultimately they only had one bid that met their expectations. And they abandoned that after the investment by a private contractor, admittedly a large one, in that.

What message does that send to the investment community you are talking about when, in fact, a significant investment was made and because, literally, there was only one that really came close, they are starting over? What message does that send, in your opinion, to that community?

Mr. SHAH. I think it is very difficult when the public pronouncements and the followthrough on the acquisition side are at odds. So there has been no shortage of senior-level folks that have come to places like the Valley and Boston and say, we want this innovation, we love it, but then when it comes time to find relatively modest contract sizes say, look, it's unable, you know, we love AI, but we can't find, you know, $20 million for this project. To me, it just—it is a signal that it is not really important.

And the advantage, again, I think that the DOD has is that of scale, and they should use it to maximize its value.

Mr. MITCHELL. Let me pivot. Mr. Brose, you may have an answer to that, but I want to pose another question for you before time runs out. Under the Optionally Manned Fighting Vehicle as well as any distributed computing, one of the big challenges is communication in a contested environment. And I pursued answers to that question in multiple, including classified briefings and, at best, received what I would consider to be a pretty vague and lame answer to that question.

So I would like to know your confidence—in this environment we can talk about it—of achieving that. Otherwise, we have a significant problem with that idea.

Mr. BROSE. To answer that and then a couple points on the previous comment.

Mr. MITCHELL. Sure.

Mr. BROSE. My assumption in terms of how we have to build military forces for the future is that we are going to have to do all of this at the tactical edge. We are not going to have backhaul to a cloud. We are not going to have backhaul to a centralized operations center.

So the question becomes, how can I collect, make sense of, interpret, make decisions on information forward where, you know, you actually have troops in contact? I think the good news is the technology is actually helping us solve a lot of those problems, particularly in the form of edge computer processing.

To touch on the previous question, just two brief points that I would add. I mean, I think on the requirements question, this is something that I know Congress has done a lot of thinking and work on, and I would encourage you to keep going.

I think part of the problem that I have seen in my career is that the Department of Defense treats requirements as a one-way street. They micromanage the exact thing that they believe they want, and then they go out and ask industry to build it. If I approached my mobile device that way, I would have the best flip phone in America right now. We have got to be open to being surprised by industry and things that industry are doing that we in the defense establishment just aren't aware of.

The other thing I would say just briefly is, injecting competition into programs is critical, and it is going to be harder with larger capital-intensive hardware systems. But there are plenty of systems—battle management, command and control, other types of programs—where winning a program of record can't be like getting tenure at a university, where you have it and forever it is yours. Like, every year or so you have got to find a way for, you know, some new company to come in and take a swing at the current incumbent and give yourself the option of on-ramping a better capability, but then telling that incumbent, look, we are going to come back and do this in a year or two, bring your A game and you will have a chance to win back what is yours. Finding a way to inject that competition I think is critical to making sure that you are getting the best capabilities for your dollars out to the warfighter.

Mr. MITCHELL. Thank you. My time has run out.

Thank you, Mr. Moulton.

Mr. MOULTON. All right. Thank you very much.

Ms. Slotkin.

Ms. SLOTKIN. Thanks for being here. This is great. And I think one of the things that this committee is trying to do is make our recommendations actually relevant and actionable, including in the NDAA that hopefully is coming right around the corner.

My question is, I think we have successfully diagnosed the problem and we agree with you that we just don't have a culture around innovation in the Defense Department that supports bringing in ideas that are readily available in the private sector in a quick and then scaleable way. And the valley of death I think is perfect.

We know inside the Department that we have a problem in our culture around innovation and incorporating innovation, but also around failure, right, which I gather, as someone who hasn't been in the private sector, is important when you are innovating. Some-

times you are going to fail. And, actually, Congress has made it hard for the Defense Department to fail at things without us kind of jumping on them.

So, Mr. Shah, you had a very good comment on this, that we need to change the culture in the Department. Give us three ways to do it.

Mr. SHAH. Well, thank you for that question. The first thing I would say is, actually, I would not say the Department has an innovation problem, in the sense that if you go out to our warfighters and deployed forces, they are the most innovative people you see.

Ms. SLOTKIN. Of course, on the ground, in the field, the best. But back at the Pentagon——

Mr. SHAH. They will take whatever kit we have given them and not fail. And so the problem is, we have actually shifted risk of innovation from cubicles in the building out to people actually fighting.

So three recommendations that perhaps I would make is, one, incentivize what we want. So if we think speed is important, then incentivize speed. But no one gets fired for going too slow, no one gets promoted for going faster. Let's incentivize the behavior that we want.

Two, if we think about technologies of the future, AI, autonomy, they are very software-driven and -heavy, impossible to create a list of requirements and get what you want at the outset. So find ways to get the operator closer to the developer. Right now, there are four steps in between, and they don't really get to work in this iterative, iterative manner.

And then thirdly, make big bets on and be willing to make big bets on initial indicators of success. So there are lots of these R&D and trial programs, AI to solve driving ships, planes. Pick two or three that we think are promising and bet big on them and watch them flower.

Ms. SLOTKIN. And, Mr. Brose, we have talked before about the personnel systems and how they affect kind of who comes into the Department and when. My question is, on folks who have a STEM background on these high-demand fields, do you think it is more valuable that they come in in the beginning of their career, like a PMF, a Presidential Management Fellowship, for STEM folks who get to come in for 2 years early on and hopefully you hook them? Do we want mid-career professionals? In order to work on some of these, the nexus between the Department and the innovators, what is the right way to bring personnel in to do that?

Mr. BROSE. Thank you. I think the answer is yes. I think the thing that is most needed in our personnel system is greater flexibility, and I know the committee has done thinking and work on DOPMA [Defense Officer Personnel Management Act] reform, and I would really encourage you to keep going with that. I think the real question is the ability to bring in talent and recognize that your future workforce is going to want flexibility and permeability in their career.

So, to your question, absolutely, you want to be able to bring that new person in at the front of their career, but then recognize that it might be the best thing for that person for whatever reason, it might be the best thing for the government to say, you know what,

take 5 years, go out, work in industry, work somewhere else, develop new skills, but then I want to compete for your talent and bring you back in as a mid career when you start to say, you know, I miss government service, I want to get back into the mission.

It is that ability to go in and out without being penalized, without losing your sort of place and rank that I think we have to get a better hold on, both because that is just the way our economy and workforce is shaping up now, I think it is what people expect and want for their careers, and I think it is going to give us the best ability to compete for the top talent.

Ms. SLOTKIN. And then, Mr. Fanning, can you just talk to us about tradeoffs? And, you know, we don't live in a place of infinite resources. You know, we have folks, frankly, both on the left and the right who are pushing for smaller Pentagon budgets. So can you help me understand if we are going to invest in promoting innovation and bringing that into the Department, what gets to go?

Mr. FANNING. Well, I think—I don't want to use the time to talk about what prevents us from being able to do that. And part of it is——

Mr. MOULTON. Your microphone.

Mr. FANNING. Part of what prevents us, I think, from being able to make those hard choices is the process by which we go about that. We are all responsible for making sure we are delivering what the warfighter needs, and yet when we decide to make a change to move investment from one place to another place, that is when the antibodies come out.

It is usually a conversation between people who have stakes in those things and not all of the people who have stakes in those things at the same time.

Industry has a huge stake in this. They have invested in the technology. They have invested in workforces, which take a very long time to build and are very difficult to maintain. Obviously, Congress has a stake in this in deciding on the budget, and clearly the customer, the Department of Defense, does. And so I think we need to find ways to make these decisions together. I wouldn't recommend anything like the BRAC [base realignment and closure] process, but if we think—and the existence of this panel leads me to believe that we do—that we are at a moment in time where we may need to make some pivots, we need to find a way to do this and to support the Department when it is trying to make some of the hard choices.

Mr. MOULTON. Okay. Thank you very much.

Dr. DesJarlais.

Dr. DESJARLAIS. Thank you, Mr. Chairman. Thank you all for being here today.

We have kind of been nibbling around this all day, and maybe I just don't fully understand. Who is "we"? Who currently oversees R&D, and who makes the big bets? That sounds like a big responsibility. Is it a panel? Is it one person? How does that work?

Mr. FANNING. I would start by saying I think there are phases in this. And we talked about government R&D as a percentage of GDP. For me, there is basic research, and that is a part of it. But I look at the ecosystem as a timeline. I see government and research facilities, academia as being part of the early thing. Doing

the basic research where maybe there isn't a commercial market. Industry, investors figuring out how to take and apply that research.

And so there are multiple places—and then government again deciding what they want to buy. There are multiple places where——

Dr. DESJARLAIS. I guess my point is, who makes those decisions? Who do you present that to, and who is responsible for overseeing these choices that we make, who we invest in, who we pick?

Mr. FANNING. I think it is a collaborative effort of all those, Congress, industry, academia, working together to figure out where the most promise is.

Dr. DESJARLAIS. But somebody has got to make the call.

Mr. SHAH. The central place is the program executive offices, the PEOs, the major weapon systems, which, of course, are overseen by the committees here. And, again, while I think the research and development arms, again, of each one of the services have done great progress, the set of incentives for the PEOs has not been necessarily to take on the risk of working with new entrants.

And so there is sort of a continuum, right? You go from R&D, PEOs, all within DOD. There is something I think we haven't talked about that highlights the importance of this is that many of the things that a PEO or a service does to invest in a particular technology will have implications that go far beyond the Department of Defense.

I can share two examples, right? If we talk about the fact that low-cost drones, 80 percent of the world market is owned by one company, DJI [Da-Jiang Innovations], you know, Chinese with clear ties to the PLA [People's Liberation Army]. If we think about the upcoming revolution in 5G, there is not really a strong American player that is economically viable.

So if we were to—if the DOD were to lead helping to grow companies in these two spaces, it would have dramatic implications for our allies, for the country even more broadly than national security. And so I think that has so many cross-components that Congress, I believe, is the one place that can start to begin to draw those lines.

Dr. DESJARLAIS. Okay. I am going to yield back because I know, Chairman, you haven't had a chance to ask questions and we are up against another hearing. Thank you.

Mr. MOULTON. All right. Doctor, thank you very much.

Great questions. This is a fantastic panel. I want to just try to understand things a little bit more in relation to some of the other testimony that we have heard and briefings that we have received over the past few months.

Mr. Brose, you talked a lot about decisionmaking at the tactical edge, and you also talked about how our comparative advantage should be in command and control. But a lot of the briefings that we have received on some of these other, you know, advanced technologies require very sophisticated communication networks. In fact, at the last hearing, we heard that one of the most promising programs right now is the Air Force's command and control system and new communication system. It is being run well. It is the kind of advanced communication system that we need. But that seems

to conflict with your point about making decisions at the tactical edge.

So can you kind of dissect that a little bit for us so we can better understand what you mean?

Mr. BROSE. Thank you. The way I see it is I think the model that we have built our military on is just fundamentally going to have to change. You know, it has been very centralized and concentrated, where information at the edge is sort of brought back to the center so that, you know, generally and sort of highly manual processes, we can make sense of it and then push decisions out.

I think we are going to have to do this in a distributed way, not least because our adversaries have figured out how we fight and they are building weapons to cripple and shatter our ability to command and control our forces.

I think the opportunity with kind of edge computer processing and making sense of information at the edge is that particularly when you bring in artificial intelligence and machine learning, you now have the ability to collect and make sense of information at the tactical edge. So you are not actually transmitting huge amounts of information back to, you know, a rear area, a TOC [tactical operations center] or something like that. So you actually don't need the large pipes and sort of communications infrastructure to get that information back.

You actually need what you are going to have, which is probably pretty degraded, spotty comms [communications]. You have to be pretty agnostic as to what network you are going to ride on. But the recognition is that, you know, looking for decisions and information is like looking for needles in haystacks. Right now, we send all of the hay back to a central place for people to go looking for the needles.

If I have automated processes that can collect and make sense of information right at the point of decision, I am actually not sending all of that back to one place. I am not taxing my networks the way that we are now. You are actually sending around the bits of information that are most relevant so that human beings can make decisions quickly, which is actually what I think we need for operational effectiveness. It is also more in line with what I think we should expect in terms of how degraded and denied our communications in the future are going to be.

Mr. MOULTON. Mr. Shah and Mr. Fanning, do you agree with that assessment?

Mr. SHAH. I do, in the sense that we need resilient solutions in the face of heavy cyberattacks, direct attacks on network nodes, and in the light that many of our threat scenarios have us playing an away game versus a home game and distributed forces. We need to be resilient in the face of new and novel attacks, and as Chris said, having distributed edge computing where systems, both autonomous and manned, can make their own decisions to pursue a particular strategy is important.

Mr. FANNING. I think of it as a both, as a yes answer. I mean, for all the reasons Raj said, we need to be able to, if we lose that pipe back to the central place where a higher echelon view of the battle's taking place, we need the forces that are distributed and are forward deployed to be able to continue to fight. And so it is

fighting through all the anti-access, anti-denial capabilities that the adversary might have. And so I see it—I think of it as an aspect of resiliency, like Raj said.

Mr. MOULTON. It seems like it would also be very important for us to be able to communicate with our allies, not just back at a central headquarters, but on the battlefield. And I also take your point, several of you made, but I think Mr. Brose emphasized, on concepts of operations that reflect this. It doesn't seem like we are playing war games right now that reflect the reality of this kind of warfighting environment.

Mr. BROSE. I would completely agree with that. I think one of the things we have lost in the past 10 to 15 years is just a focus on experimentation. I think we need to be doing a lot more of that. I think we need to be funding that. And to your point, technology is not going to save us. It ultimately is the thing that will enable us to operate differently, fight differently, make different kinds of decisions.

Unless we are experimenting with how to use that technology to do different things, we are just going to be kind of continuing the way that we have.

Mr. MOULTON. So, Mr. Brose, just to double-down on Ms. Slotkin's question earlier, you have been a staff director of the Senate Armed Services Committee. A lot of what we are talking about is investing in new technologies at the expense of old technologies. We have to get rid of some of the old stuff to free up time, energy, personnel, and most of all, money. How do we change the incentives here in Congress to make people willing to do that?

Mr. BROSE. Yeah. It is a great question, and to me it is the crux of the matter. I think ultimately what it comes down to is greater competition. You know, it may be that a new technology is going to be a better answer. It may be that actually an old technology used in a different way is the better answer. It may be that a blend between the two is the better answer. Unless we are actually taking these things out into real-world environments, to your point, experimenting with them and figuring out based on real operational metrics, outcome-oriented metrics, what works best, we are just not going to know.

And that is why I think a lot of these technologies don't transition. It is like, interesting lab project, did some cool stuff, but it never actually showed itself to be different in an operational case, so it never went anywhere.

I think the real challenge is going to be, Congress always wants to know how the Department is spending its money, and you are entitled to that. I think that we have gone too far as a Nation in tying the hands of the Department. I think greater flexibility for experimentation in current fiscal year is vital. I can't tell you the number of instances I have had in my time since leaving the SASC where someone in the government says, you guys are doing really interesting stuff, we would love to bring you in and do this, I don't have any money, I can POM [program objective memorandum] for you 2 years from now. It is like you have billions of dollars, you say this is important; 2 years from now, like, I might not exist. Like, we have got to find a way to bring this in, experiment, and make it outcome-oriented.

Mr. MOULTON. Great. Thank you.

I will defer now to my co-chairman, Mr. Banks, for any additional questions.

Mr. BANKS. Mr. Chairman, that is all I have. This has been a very good hearing, very insightful. I appreciate it very much.

Mr. MOULTON. Okay. I have a couple more questions, then. So I want to get back—one of the things that Mr. Shah and Mr. Brose have emphasized is we have got to be willing to make some big bets. You know, it is not enough just to do a little science experiment and then say, oh, that was nice, but we are not going to employ it operationally, we are not going to experiment with it, we are not going to be willing to make a significant investment so that there is the correct incentives for people, for private sector companies to compete and actually do well by pursuing a contract like that.

But how do you square that with another comment that you made, Mr. Brose, which is that the government can't play VC [venture capitalist]? Can you kind of dissect that a little? I think I understand, but so that we are all on the same page here and we understand the difference between making big bets but also not, quote/unquote, playing VC?

Mr. BROSE. Yeah, for sure. When I talk about making big bets, I talk about betting on capabilities that have proven to be effective in the kinds of operational experimentation, real-world scenarios that we are talking about. You don't want to make bets on paper airplanes and PowerPoint presentations. I think we have done a lot of that in the past, and we have gotten into problems as a result of it.

I think you want to find a way to bring technology in, be clear in defining what your operational problems are. I think a lot of times we talk about joint all-domain command and control. It is like, what does that mean? Like, explain it in a way that a military operator and an engineer can understand to build a capability to help solve that problem.

And then I think you have to fly things off. I think you have to take them out and say, you know, may the best system, may the best program, may the best technology win, and where you see effectiveness in new capability, that is when I think you really double-down and try to scale.

It is not injecting money into companies in the sense of financing. You know, there is plenty of money to do that in America. What that money is looking for is the most important thing the government can do, which is say, I have defined my problems and I have identified winning capabilities that I think are best positioned to solve them. That is when private money is going to flow in behind government money and help companies scale.

But it is really on that side of things that are being proven out to solve real problems that the warfighter has. There has got to be a way to identify those winning solutions, you know, in competition with other capabilities, and then scale the things that are successful.

Mr. SHAH. Thanks. The nuance, I guess I would add, is that the entrepreneurial world and new technology is moving so fast and the cultural divides between these two worlds is so deep that we

have to engage early in order to help shape these companies, to build the solutions we want to eventually get en masse.

I can give you a specific example. We worked with—when I was in government service, we worked with a fast-growing company that was building analytics for a whole host of things, but their focus was on maintenance of energy systems, oil transport, refineries, et cetera. They had done no work with the Department of Defense, but we said, look, your technology and your ability to incorporate data could help us with one of the key operational problems that the Department is facing, which is low—the maintenance of airplanes. And so we worked with this company, took paper forms from the E–3 Sentry. They did their analysis and had drastic improvement in their ability to predict when parts were going to fail and improve the availability rates.

Just last week, it was announced that this company has received now a program of record, I believe, close to a hundred million dollars, to take this to the F–35 and into the Navy. But I think if we had not engaged with that company earlier in its development path, it may not have built the tech that we need.

So I think there—I agree with Chris that it comes down to contracting, but things are moving so fast we need to engage early.

Mr. MOULTON. So just continuing on this line of questioning. Mr. Fanning, you were Secretary of the Army. How do we get the services to actually do the kind of CONOPS [concept of operations] planning and experimentation that Mr. Brose is talking about?

Mr. FANNING. I think we have to build that in to the very earliest part of the planning. We talk about cost, schedule, and risk. The Department is now talking about cybersecurity as an element of that. But schedule and speed are different things. And Raj and Chris have both talked about what attracts and incentivizes investment.

It is not just a clear demand signal from the Department about a technology or a capability that is necessary. It is the investor seeing that there is a payoff, that there is a light at the end of the tunnel for it.

And I think every—the program element of the Department of Defense, when they are thinking about investing in something, placing a big bet, whatever you want to call it, they should be required to have a plan, not just to scale it quickly, but to make it operational quickly. And so the CONOPS that we have talked about from the start, that is one of the things, I think, that you would want to see early on in your oversight as you are thinking about making these big bets in a different way. How has the Department convinced you that they have a CONOP for it and they are going to be able to field it, in addition to scaling it to speed, so that the investment is incentivized to continue?

Mr. MOULTON. What about just getting our commanders to play more innovative war games?

Mr. FANNING. I think there is clear—I think all of us would agree with this. You have heard it. We need more wargaming to think through how—because, you know, it is a circle, and where does that circle start in terms of the requirements, the investments, the technology development and so forth. And, ultimately, it comes back to what is our larger concept of how we fight war, how we

deter, and how does that drive the deployment of forces, which then drives what the Department is trying to buy. I think wargaming, in term of testing some of these technologies earlier, would be—it has to be a part of this.

I mean, I will go back, I am the only one that has spoken about the OMFV [Optionally Manned Fighting Vehicle]. I think there was a signal from industry, all parts of industry, that the requirements that were being levied for this weren't realistic when taken in their totality. There was a clear signaling from the defense industrial base that the requirements from the Army weren't realistic. And we have talked about the requirements being a one-way street, how we can make the requirements maybe less prescriptive, but I think you want to go back before that altogether and have a conversation with the collective industrial base—national security industrial base, what are the effects we want, what are the problems we are facing, and how—what ideas might we have to go about these differently, and then test them.

Mr. MOULTON. Okay. So just one final question, and it is about investing in innovation. Mr. Shah, you were the head of DIUx, and DIUx has been widely praised by people we have heard from on the short length of this task force. It may not be perfect, but it is—it is doing the kind of thing that we want to see more of here.

Now, the comparison I made in my opening remarks was to DARPA. I think DARPA was started under President Johnson. It was a bipartisan effort funded to the tune of $4.5 billion in today's money. Right now, DIU has a $41 million budget.

Sometimes I think these numbers are hard to kind of really understand. That is 40 compared to 4,500. Or in other words, if you sort of reduce that fraction, using my STEM knowledge, you know, 4 to 450. For every 450—for every $4 we put into DIU, we put $450 into DARPA.

Are we making a big mistake? Are we—or do you think that, no, this is right-sized for the effort?

Mr. SHAH. I guess I go back to my earlier statement. As we think about the technologies of the future and we think about how that is going to change our concepts of operations, and if we believe that we want these types of technologies—and everyone says they are—then we must double-down and bet on organizations that are working. And I think I would say it is—I would say two things.

So, one, I think the reason why that organization is working is it has the right types of people, meaning it has people that have deep operational knowledge—military knowledge, as well as knowledge of what is happening in the innovation ecosystem, very focused on speed, and then again, having a way to put operators next to developers.

But, again, if we believe that these things are the future, there is no better signal to entrepreneurs than 10X-ing that budget, because all of that will eventually flow to those companies. And, you know, for every—I think we get so much leverage. For every dollar you put towards these types of companies, you are getting $5 to $10 of private investment, risk capital. All those companies may not succeed, but I think, I guess I would urge, look at the range of programs and let's supercharge, let's go to scale to the ones we think are working.

Mr. BROSE. Just a very brief comment to add. I think the real question for you to track, like literally track as a metric, is which of these organizations is transitioning the capabilities they are bringing in most successfully to the operational forces. We have DIU, we have DARPA, we have all the research agencies, we have AFWERX. We have a proliferation of organizations that are trying to bring new entrants research capability into the Department. Where does it go?

I mean, in my last life, I couldn't have told you, on the SASC, you know, how many of these things were transitioning. I mean, if I were back in my old job, I would literally want like a baseball card of, you know, how successfully are these companies, are these programs bridging the valley of death and getting into the operational forces where they can make a real impact. And then reward the ones that are doing best, you know, give them more money.

Mr. MOULTON. Great. All right. Well, thank you all very much. It is an honor to have you here. Your expertise means a lot to this panel, and we will be in touch as we go forward.

As I have often said about this Future of Defense Task Force, fundamentally we are a task force that should not have to exist. We exist today because we are not thinking enough about the future defense. And if we are successful in our recommendations, we will get back to a place where we don't have to stand up this task force again, where it is inherent to the daily work of the Department of Defense and, frankly, this committee here in Congress, to think far into the future, to prepare for the challenges that are coming well down the road, and to make sure that this country is safe, not just for us, but for our kids.

Thank you all very much.

[Whereupon, at 10:16 a.m., the task force was adjourned.]

A P P E N D I X

FEBRUARY 5, 2020

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

FEBRUARY 5, 2020

Testimony of Eric Fanning
President and CEO
Aerospace Industries Association

before the

House Armed Services Committee Future of Defense Task Force
Hearing on "Supercharging the Innovation Base"
U.S. House of Representatives
February 5, 2020

Chairman Moulton. Ranking Member Banks. Members of the task force. Thank you for inviting me to be a part of today's hearing. I am always happy to return to HASC, where I made my professional debut as a research assistant under Chairman Les Aspin.

I have spent much of the ensuing time in government, primarily in the Department of Defense. I'm drawing on that experience as I think through today's hearing, but I'm also drawing on the many things – some surprising – that I've learned about industry since becoming President & CEO of the Aerospace Industries Association.

The subject today is a broad one and includes a large ecosystem that Senator Jim Talent laid out in his testimony to this task force last year. It's not enough to focus on how to increase innovative capabilities and culture in each part of this ecosystem. We must also focus on how to strengthen the partnerships between the various parts. I've seen great innovation in the Department of Defense, the large and established defense primes, and the new entrants. However, sometimes it has been hard for the innovation taking place in industry to find its way to our military in the field. Government must better adjust to private-sector developments rather than force those developments to fit its needs.

At AIA, we focus our efforts in three broad categories: investment, framework, and workforce – all the elements necessary to maintain our competitive advantages. I think we need to look for changes and improvements in all three of these areas in order to supercharge innovation.

First, under investment, it's worth starting with the obvious. We need to find a way back to regular order in the federal budget process. The threat of continuing resolutions and government shutdowns, followed by the reality of continuing resolutions and shutdowns, is extremely disruptive to the planning and unimpeded work necessary to make sure we do not lose our technological and national security edge. China does not periodically shut down its government. Too often, we do.

It would also help, for planning purposes, to look beyond one-year budgeting cycles. This is certainly not a new idea, but increasingly important as China accelerates and technology iterates faster.

The U.S. also needs to increase R&D spending. While we've seen increases in defense R&D and overall defense spending in recent NDAAs, government-wide spending on R&D has generally been declining and, in terms of percentage of GDP, fell to pre-Sputnik levels in 2017.[1]

Second, under framework, or in the case of this discussion, the acquisition process, much important work has been done inside the department, and recent NDAAs have included aggressive reform. And while the Department still needs time to fully implement some of these reforms, more can be accomplished.

We've seen cases where the Department is becoming less prescriptive with requirements, particularly at the prototyping and demonstration phases. They indicate a smaller set of higher priority requirements and allow flexibility for those competing to offer more diverse solutions. That said, including other players in the innovation ecosystem earlier in the conversation could prove useful. Discussing the original problems sets, when appropriate, before even getting to high-end requirements might open the solutions aperture even wider.

The problem, however, is that even though more entrants have access to these early phases, the "valley of death" before becoming a full program of record still exists. This has severe ramifications for all participants. Large companies may be better situated to survive this valley, but it can impede their ability to lock-up partnerships with the many sub-contractors they need from the supply chain who are less able to survive.

Program managers and program executive officers (PEOs) develop schedules, but more emphasis should be placed on speed. Successful prototypes that the Department pursues should include plans to scale and field quickly.

We should also look for ways that returning to Congress doesn't needlessly slow down development. Oversight is important, but technology moves faster than our budget process. For example, program managers and PEOs might be given wider flexibility with program spending in the early phases, when they are still defining costs.

This all leads to workforce. More authorities and more control, with the expectation of increased risk, require better training than the Department typically provides its workforce. This is particularly true of civilians who are not afforded the same development opportunities as those in uniform. It's not enough to pass reform in the NDAA. We need to make sure those on the receiving end are fully empowered to utilize that reform.

[1] Federal R&D Budget Dashboard, American Association for the Advancement of Science, https://www.aaas.org/programs/r-d-budget-and-policy/historical-trends-federal-rd.

In addition to training the current workforce, we need to attract the future workforce. The United States needs to seriously recalibrate its investments in STEM education at all levels. On so many different metrics, the Chinese are investing more than we are in this area.

Finally, there are many places throughout DOD and the government where interesting innovation is taking place and where we could find lessons to scale across the larger enterprise. As this panel comes up with a series of recommendations for innovation in the national security ecosystem, it's worth noting that Congress just created a new branch of the military. We could shape the Space Force using templates from the last time we created a new service, in 1947, or we could think of it as a test bed for all the changes we need to maintain our national security advantages.

Thank you and I look forward to your questions.

WITNESS BIOGRAPHIES

Eric Fanning

Eric Fanning is President and Chief Executive Officer of the Aerospace Industries Association (AIA), an advocacy organization for the aerospace and defense industry with nearly 350 companies in its membership – ranging from multinational prime contractors to family-owned businesses.

Fanning joined AIA after serving as the 22nd Secretary of the Army where he provided leadership and oversight of our nation's largest military service. He previously served as Chief of Staff to the Secretary of Defense, Acting Secretary of the Air Force and Under Secretary of the Air Force, and Deputy Under Secretary of the Navy/Deputy Chief Management Officer. He is the only person to have held senior appointments in all three military departments and the Office of the Secretary of Defense.

During his more than 25 years of distinguished government service, Fanning worked on the staff of the House Armed Services Committee, was Senior Vice President of Strategic Development for Business Executives for National Security, was Deputy Director of the Commission on the Prevention of Weapons of Mass Destruction Proliferation and Terrorism, and was associate director of political affairs at the White House.

Fanning holds a bachelor's degree in history from Dartmouth College. His awards include the Department of Defense's Medal for Distinguished Public Service (twice awarded), the Department of the Army's Decoration for Distinguished Civilian Service, the Department of the Navy's Distinguished Public Service Award (twice awarded) and the Department of the Air Force's Distinguished Public Service Award and Decoration for Exceptional Civilian Service

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Hearing Date: 05 February 2020

Hearing Subject:

Supercharging the Innovation Base

Witness name: The Honorable Eric Fanning

Position/Title: President and CEO

Capacity in which appearing: (check one)

○ Individual ◉ Representative

If appearing in a representative capacity, name of the organization or entity represented:

Aerospace Industries Association

Federal Contract or Grant Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts) or grants (including subgrants) with the federal government, received during the current and two previous calendar years and related to the subject matter of the hearing, please provide the following information:

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N/A	N/A	N/A	N/A

2019

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
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2018

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
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2019

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
N/A	N/A	N/A	N/A

2018

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
N/A	N/A	N/A	N/A

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Organization or entity	Brief description of the fiduciary relationship
AIA	President and CEO

Organization or Entity Contract, Grant or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts or grants (including subcontracts or subgrants) or payments originating from an organization or entity, whether public or private, that has a material interest in the subject matter of the hearing, received during the current and two previous calendar years, please provide the following information:

2020

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
Membership Dues	AIA Members (see attached)	TBD	Dues
Contract	AIA	TBD	Salary

2019

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
Membership Dues	AIA Members (see attached)	$13,058,947.00	Dues
Contract	AIA	$1,182,057	Salary

2018

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
Membership Dues	AIA Members (see attached)	$12,736,462.00	Dues
Contract	AIA	$1,104,824	Salary

Testimony of Mr. Raj M. Shah
Future of Defense Task Force, House Armed Services Committee
U.S. House of Representatives

Hearing Titled: "Supercharging the Innovation Base"

February 5, 2020

Co-Chairmen Moulton and Banks, members of the Task Force and Committee, thank you for the opportunity to share my thoughts on what I believe to be the central challenge facing our nation's long-term national security: how best to harness our nation's innovation strengths to sustain security and peace for our country and the world.

As someone who has spent large portions of his career as a pilot and civilian executive in our Armed Forces and as an entrepreneur and investor in the Silicon Valley ecosystem, I applaud the focus of this Task Force. These two worlds are populated with extremely talented, mission driven individuals, but have drifted apart both in terms of business process and culture.

The title of this hearing, supercharging the innovation base, is aptly named. The challenges we face from an increasingly hostile and autocratic world are real. I fear that without an organized effort by the Department of Defense (DoD), the preeminence of our fighting force will no longer be undisputed. Underpinning our innovation prowess is foundational research & development, a world-class talent base, and strong connectivity between the DoD and companies leading development in technologies such as Artificial Intelligence (AI), autonomy, and cybersecurity.

To me, the word supercharging represents not an incremental improvement, but a step-change towards success. In fact, the supercharger on the Merlin engine helped turn the tide in WWII.[1] I strongly encourage this Task Force to think broadly about how it can implement change at significant scale, doubling down on proven pathways and initiatives.

The pacing challenge in thinking about innovation and national security is, of course, the remarkable progress made by China. China's public commitment to lead the world in innovation, particularly in AI, coupled with their concept of civil-military fusion,[2] makes them a

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[1] Nicholas O'Dell, "The Engine That Won World War II," HistoryNet (Sept. 2009), https://www.historynet.com/the-magnificent-merlin.htm.
[2] Elsa B. Kania, "In Military-Civil Fusion, China is Learning Lessons from the United States and Starting to Innovate," Center for a New American Security, (Aug 29, 2019), https://thestrategybridge.org/the-bridge/2019/8/27/in-military-civil-fusion-china-is-learning-lessons-from-the-united-states-and-starting-to-innovate

formidable competitor. By seamlessly integrating economic and military might, they are accelerating tech development and generating maximal leverage on the world stage.

"AI is mission critical" to the Chinese Communist Party. With a growing population of 1.4 billion, China is turning to AI to "perfect dictatorship," and its access to massive amounts of data has allowed it to "close the gap" with US industry.[3] This steady emphasis by Chairman Xi Jinping is bearing fruit. China now has more supercomputers than the US,[4] total private venture capital investment in China surpassed the US for the first time in 2018,[5] and as of 2017 Chinese government R&D spend as a percentage of GDP was higher than the US with a trajectory to reach parity in absolute terms.[6] Furthermore, the People's Liberation Army (PLA) and technology startups enjoy close, though perhaps compelled, collaboration.

To counter these trendlines, the United States must play to its strengths: having the most vibrant innovation ecosystem in the world (Silicon Valley), historically strong public support for science funding, being a welcoming place for immigrants, and having deep, long-standing alliances with the free nations of Europe and Asia.

I wish to briefly highlight 5 key areas in which I hope this Task Force can affect real impact.

1. **Human Capital** - Innovation at its core is a human endeavor.
2. **Engagement at Scale** - A core strength of DoD is the size of its organization and budget
3. **Foundational Research and Development** - Underpins both private sector and defense innovation
4. **Train and Equip for the Future** - Acquisition reform represents only the tip of the iceberg
5. **Allies and Partners** - Need friends to meet this generational challenge

Human Capital

The United States' innovation superpower over the past half-century has been its investment in human capital. From Wernher von Braun to the current CEO's of Microsoft, Google, and soon IBM, the US has been a magnet for foreign technical talent. The DoD also historically attracted

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[3] Graham Allison, "Is China Beating America to AI Supremacy?" The National Interest (Dec. 22, 2019) https://nationalinterest.org/feature/china-beating-america-ai-supremacy-106861?page=0%2C1.
[4] Eric Schmidt, "Losing Ground: U.S. Competitiveness in Critical Technologies," Hearing before U.S. House of Representatives Committee on Science, Space, and Technology (Jan. 29, 2020), https://science.house.gov/imo/media/doc/Schmidt%20Testimony.pdf.
[5] Jason D. Rowley, "Q4 2018 Closes Out A Record Year For The Global VC Market," Crunchbase (Jan. 7, 2019), https://news.crunchbase.com/news/q4-2018-closes-out-a-record-year-for-the-global-vc-market/.
[6] Robert D. Atkinson and Caleb Foote, "Is China Catching Up to the United States in Innovation?" Information Technology and Innovation Foundation (April 2019), http://www2.itif.org/2019-china-catching-up-innovation.pdf/.

top talent for short tours without hindering their private sector careers, most notably McNamara's Whiz Kids.[7] Finally, with a sprawling infrastructure of bases across the country, military service and the ethos of its members was ever present across all socio-economic groups. All three of these human capital advantages have withered - now is the time to re-invigorate these strengths.

Recommendations

- Reopen a major military installation in each of our leading innovation centers, San Francisco and Boston, to build personal, community relationships between technologists and uniformed members.
- Establish a National Security Innovation Visa to fast track green cards for experts in AI, Cyber, Remote sensing, and other key technical fields. Today over 45% of STEM doctoral grads are foreign with growing numbers returning to their home countries.[8]
- Increase opportunities for civilian service through a STEM corps.[9]
- Expand reserve and National Guard service opportunities for technologists.

Engage at Scale

The Department of Defense' engagement with technologists and the innovation ecosystems have shown early success, but not yet at scale. Now is the time to have a step-change to supercharge DoD access to innovation from new entrants as well as traditional defense contractors. The DoD spends less than $500m annually with venture-backed start-ups and less than $1B in true AI research - representing a half percentage point of the department's procurement and R&D budget of $243 Billion - quite literally a rounding error.[10] If we believe that the innovations transforming our lives - from self driving cars to voice-activated televisions - will be core to future national security, we should massively increase support to the organizations meeting this challenge head on. Further, we must reclaim our national focus on basic science and technology.

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[7] TIME, "Nation: The Pentagon's Whiz Kids," *TIME* (Aug. 3, 1962), http://content.time.com/time/subscriber/article/0,33009,896423,00.html.

[8] Josh Trapani and Katherine Hale, "Higher Education in Science and Engineering," National Science Foundation (Sept. 4, 2019), https://ncses.nsf.gov/pubs/nsb20197/demographic-attributes-of-s-e-degree-recipients; see also Science & Engineering Indicators 2018, National Science Board (2018), https://www.nsf.gov/statistics/2018/nsb20181/assets/901/tables/tt03-27.pdf.

[9] Jim Talent and Robert O. Work, "The Contest for Innovation: Strengthening America's National Security Innovation Base in an Era of Strategic Competition," Report of the Task Force on 21st-Century National Security Technology and Workforce, Ronald Reagan Institute (Dec. 2019), p. 24, https://www.reaganfoundation.org/media/355312/the_contest_for_innovation_report.pdf.

[10] Office of the Under Secretary of Defense (Comptroller), "National Defense Budget Estimates for FY 2020," (May 2019), https://comptroller.defense.gov/Portals/45/Documents/defbudget/fy2020/FY20_Green_Book.pdf.

Recommendations

- Increase by 10 fold the spend on successful innovation efforts such as AF Pitch day,[11] Defense Innovation Unit (DIU),[12] Defense Digital Service (DDS), Joint AI Center (JAIC), and Kessel Run[13]
- Increase Federal R&D to 1.1% of GDP[14]

Train and Equip for the Future

From the Section 809 Panel[15] to the sustained efforts of the House and Senate Armed Services committees, great progress has been made in the area of acquisition reform. So much so, that I would submit that the real impediment is reforming management incentives for our talented acquisition core, rather than additional legislation.

However, there is a need to structurally refocus the training and equipping of our forces to meet an enemy emboldened by autonomous weapons. This tectonic shift in how we will fight is being overshadowed by the acquisition reform debate. How do our Concepts of Operations change in the face of low cost drones with embedded facial recognition? These difficult questions require deep analysis. It will require congressional leadership to enable the DoD to be ambitious and depart from its comfort zone.

One result will be large programs of records for non-traditional weapons systems. The sooner we can recognize this coming change and make large bets on specific technologies and companies, the quicker entrepreneurs and the venture investment community will apply their talents and risk capital to solve DoD needs at scale. Who are the Billy Mitchell's[16] and William Knudsen's[17] of today?

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[11] Debra Werner, "Air Force Awards $9 Million on First Space Pitch Day San Francisco," SpaceNews (Nov. 5, 2019), https://spacenews.com/air-force-awards-9-million-on-first-space-pitch-day-san-francisco/.
[12] Scott Maucione, "SPECIAL REPORT: Failure is an option for DoD's experimental agency, but how much?" Federal News Network (Oct. 30, 2019), https://federalnewsnetwork.com/defense-main/2019/10/special-report-failure-is-an-option-for-dods-experimental-agency-but-how-much/.
[13] Steve Kelman, "Why Kessel Run Is Such a Big Deal," FCW (Feb. 12, 2019), https://fcw.com/blogs/lectern/2019/02/kelman-kessel-run-usaf-big-deal.aspx.
[14] James Manyika and William McRaven, "Innovation and National Security," Independent Task Force Report No. 77, Council on Foreign Relations (Sept. 2019), https://www.cfr.org/report/keeping-ouredge/pdf/TFR_Innovation_Strategy.pdf.
[15] Advisory Panel on Streamlining and Codifying Acquisition Regulations https://discover.dtic.mil/section-809-panel/ (July 2019)
[16] For more see Alfred F. Hurley, *Billy Mitchell: Crusader for Air Power.* Indiana Universicty Press. 1975.
[17] Arthur Herman, *Freedom's Forge*. Random House. 2013.

Recommendations

- Recognize the massive change that AI & Autonomy will bring to warfare and revise doctrine and Concepts of Operations.
- Demonstrate to entrepreneurs and the venture community that start-up companies can scale and thrive serving the DoD.

Allies and Partners

Addressing the challenges discussed today will only be easier with our allies and partners. Fortunately we have built goodwill over decades and can deepen these relationships to enact coordinated economic and defense strategies.

Recommendations

- Fast track regulations for a larger set of close allies and partners including FIRRMA exceptions, export controls, and data sharing.[18]
- Tip the scale for emerging nations to acquire US and Western technology infrastructure, through financial incentives and transfer mechanisms.

Conclusion

I wish to highlight one final near-term opportunity: With the establishment of the Space Force - the department can take a clean sheet approach to the technology and talent acquisition process. The timing is fortuitous as the commercial space industry is in the midst of a renaissance led by new entrants.

In sum, while the challenges are real and growing: our nation has all the elements necessary to prevail in the defense of democratic values - we just need the collective will to do so. Many august organizations have developed robust recommendations - I urge you to help lead Congress and our nation in their implementation. Thank you and I look forward to your questions.

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[18] See Talent and Work, "The Contest for Innovation: Strengthening America's National Security Innovation Base in an Era of Strategic Competition," https://www.reaganfoundation.org/media/355312/the_contest_for_innovation_report.pdf.

WITNESS BIOGRAPHIES

Raj Shah

Raj Shah is the chairman of Arceo.ai, a cyber-security start-up. Raj is also a visiting fellow at the Hoover Institution at Stanford University. Most recently he was the managing partner of the Pentagon's Defense Innovation Unit Experimental (DIUx), reporting to the Secretary of Defense. Raj led DIUx in its efforts to strengthen U.S. armed forces through contractual and cultural bridges between Silicon Valley and the Pentagon. Previously, Raj was senior director of strategy at Palo Alto Networks, which acquired Morta Security, where he was chief executive officer and co-founder. He began his business career as a consultant with McKinsey & Company. Raj serves as anF-16 pilot in the US Air Force and has completed multiple combat deployments. He holds an AB from Princeton University and an MBA from the Wharton School at the University of Pennsylvania.

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Hearing Date: 05 FEBRUARY 2020

Hearing Subject:

Supercharging the Innovation Base

Witness name: Raj M. Shah

Position/Title: Chairman, Arceo.ai

Capacity in which appearing: (check one)

● Individual ○ Representative

If appearing in a representative capacity, name of the organization or entity represented:

Federal Contract or Grant Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts) or grants (including subgrants) with the federal government, received during the current and two previous calendar years and related to the subject matter of the hearing, please provide the following information:

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none			

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none			

2019

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
none			

2018

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
none			

Testimony of Christian Brose
Chief Strategy Officer, Anduril Industries
Hearing of the Future of Defense Task Force
"Supercharging the Innovation Base"
Wednesday, February 5, 2020

Chairman Moulton, Ranking Member Banks, members of the Task Force: It is an honor to appear before you today, and I am grateful for the opportunity.

To address the question you have posed—how to supercharge the innovation base—we need to start with the bigger questions that your task force is considering: To what end? Why does it matter? What are the stakes?

Put simply, America has been building a military for three decades based on assumptions that are being overturned—overturned by the deliberate strategies of our competitors, primarily China, and by the ongoing information technology revolution. To be successful, militaries must be able to understand the battlespace, make good decisions, and take relevant actions—what our military calls "closing the kill chain." How our military does this today is relatively slow, overly manual, undynamic, inflexible, and difficult to scale. In part, this is because we have built a military that is overly dependent upon small numbers of large, exquisite, expensive, heavily manned, and hard to replace things that struggle to share information effectively, if at all.

To succeed, we will need a very different kind of military. This will require us to prioritize networks over platforms. Those networks must be highly dynamic, distributed, re-composable, self-healing, and intelligent. And those platforms must be far larger in number, smaller in size, lower in cost, and highly autonomous. The core metric of success will be our people's ability to turn vast amounts of information into understanding, generate decisions, and take actions—and do it all so much better, faster, and at such larger scales than our competitors that we shatter their ability to keep up. In short, our competitive advantage will be all about command and control. And the technologies that will enable this advantage will be less hardware-defined than software-defined, such as artificial intelligence, autonomy, edge computing, and mesh networking.

When it comes to our defense innovation base, however, here is our predicament: Most of the people and companies that are most expert in the kinds of emerging technologies that the US military needs are not currently doing defense work, while traditional defense companies, despite their remarkable people and expertise, are not at the forefront of these emerging technologies.

The question, then, is how to realign our innovation base. I have come to believe that we in Washington are overthinking this problem. Ultimately it comes down to one thing: incentives.

Consider the scale of this problem:

When the Cold War ended, there were 107 major defense firms. By the end of the 1990s, there were five. And since, the middle tier of our defense sector has been systematically hollowed out, bought up by larger companies or driven out of business altogether. At the same time, the

defense sector has not been attracting and retaining new companies: From 2001 to 2016, of new companies that sought to work for the US government, 40 percent were gone after three years, more than half were gone after five years, and nearly 80 percent were gone after ten years.

Indeed, since the end of the Cold War, in every technology sector in America, from consumer electronics and new media to financial technology and biotechnology, there have been more than one hundred startups that have grown to be valued at more than $1 billion, what investors call "unicorns." In the national security sector, there have only been two: SpaceX and Palantir.

This did not just happen. It was the result of incentives—some conscious, some unconscious—that Washington has created. We have spent increasingly larger shares of the defense budget sustaining old things instead of buying new things. We have allowed military "requirements" to become a barrier to new ideas and capabilities that our defense establishment did not invent. We have optimized our acquisition system not for speed to fielding the best available technology, but for compliance, cost accounting, and ease of administration. We have locked ourselves into defense budgets that are programmed years in advance, leaving little flexibility to bring in new capabilities and non-traditional companies during current fiscal years. And most detrimentally, we have carved up what little money we have spent on research and development into lots of small contracts for lots of small companies that rarely make it across the "valley of death," become large-scale military programs, and enable new companies to grow.

This is why so many of America's best technologists and investors have turned away from defense. It is not because they are unpatriotic. It is because they have not believed they could fully realize their talents, build successful companies, and make large returns on investments by working in defense. And three decades of empirical evidence suggest they were not wrong.

Defense will never be a free market, but it is still governed by incentives. To supercharge the innovation base, we have to create different incentives, and we can. But the US government must recognize its proper role in this innovation ecosystem. Innovative companies do not need the US government to try to play venture capitalist. America has plenty of money. Indeed, the amount of private capital in our nation dwarfs the defense budget many times over. This money is not ideological. It will flow to what it perceives to be good investments. America also has plenty of innovators and engineers who would be willing to work for our military. More of them will want to do it if they perceive it to be a path to fulfillment, success, and wealth. They do not need US defense agencies to try to turn themselves into tech startups or software development factories.

Innovative companies that are doing defense work need one thing more than any other from the US government: revenue. They need real contracts for the best capabilities they are building. Not tiny, one-time awards for science projects that sound good in government press releases but never get fielded, transitioned, and scaled into programs of record, but the kind of recurring revenue that comes from building and shipping products to more and more customers.

If the Department of Defense and Congress value AI-enabled capabilities, autonomous systems, small drones, and other emerging technologies, you have to buy more of them. This will enable the companies that are doing this work to do more of it, grow, attract more engineering talent, develop new technologies, and raise many times their current value in private capital that is just

sitting on the sidelines looking for good things to do. And as more of those investors come to see defense as a viable business model, they will direct more of their considerable resources toward founding and growing new innovative companies that want to work for the US military.

Not all of those bets will succeed, but the ones that do will be huge winners. And their success will attract even more engineers, companies, and investors into the defense innovation base, enabling it to grow larger, more vibrant, and more competitive. It can and must be a virtuous circle, but it all comes back to the US government creating the right incentives.

This is starting to change, but just barely. At present, two things are simultaneously true: Thanks to the many reforms and new authorities that Congress has given the Department of Defense, it has never been easier for new, innovative companies to get small contracts to work for the US military. But it has never been harder for those companies to transition their good work, displace established but less capable programs of record, and win large-scale procurement contracts.

Ultimately, the way to supercharge the defense innovation base is simple, really: buy more of what that innovation base is building right now. It is supply and demand. The most important thing the US government can do is create greater demand. It has to clearly define our most important operational problems. Hold regular, fair, and open competitions to determine what capabilities and concepts work better than others. Pick winners. Do not try to make a thousand flowers bloom. Concentrate our limited government resources in smaller numbers of larger bets on the most promising capabilities that our nation's innovation base is producing. Ultimately, our goal should be a future defense innovation base that is not comprised of five $100 billion companies, whichever they may be, but dozens of viable, multibillion-dollar companies.

Getting from the military we have to the military we need will be daunting. But it can be done. We have the people, the technology, and enough money. But we have to get the incentives right. And we have to move with a sense of urgency, which I applaud this task force in working to create. Our entire business model of national defense is being disrupted. We are like Blockbuster Video amid the rise of Apple, Netflix, and Amazon. We have to adapt, and quickly, or we will be overtaken. And that means losing our ability to deter war, if not losing a war altogether.

WITNESS BIOGRAPHIES

Chris Brose

Christian Brose is Head of Strategy at Anduril Industries and Senior Fellow at the Carnegie Endowment for International Peace. From 2015-18, he was staff director of the Senate Armed Services Committee. In that capacity, he managed the Committee's professional staff in support of the Chairman and other majority members in overseeing all of the programs, policies, and resources of the Department of Defense, as well as confirming all of the Department's senior civilian and military leaders. He was also responsible for leading the production, negotiation, and passage of four National Defense Authorization Acts (FY16-19), which set policy and authorized spending for all U.S. national defense activities.

From 2009-14, he served as senior policy adviser to Senator John McCain (R-AZ), supporting his work on the Senate Armed Services Committee, the Senate Select Committee on Intelligence, and the Senate Foreign Relations Committee. He conducted official travel to more than 60 countries during his work in the Senate.

From 2008-09, he was senior editor of Foreign Policy magazine. Prior to that, he served as policy adviser and chief speechwriter to Secretary of State Condoleezza Rice from 2005-08, working as a member of the Secretary's Policy Planning Staff and supporting the Secretary on regular foreign travel. He began his career in public service as a speechwriter for Secretary of State Colin Powell. He studied political science at Kenyon College and international economics at the Johns Hopkins University's School of Advanced International Studies. He lives in Washington, DC with his wife and two sons. He is a member of the Aspen Strategy Group.

DISCLOSURE FORM FOR WITNESSES
COMMITTEE ON ARMED SERVICES
U.S. HOUSE OF REPRESENTATIVES

INSTRUCTION TO WITNESSES: Rule 11, clause 2(g)(5), of the Rules of the U.S. House of Representatives for the 116th Congress requires nongovernmental witnesses appearing before House committees to include in their written statements a curriculum vitae and a disclosure of the amount and source of any federal contracts or grants (including subcontracts and subgrants), or contracts or payments originating with a foreign government, received during the current and two previous calendar years either by the witness or by an entity represented by the witness and related to the subject matter of the hearing. As a matter of committee policy, the House Committee on Armed Services further requires nongovernmental witnesses to disclose whether they are a fiduciary (including, but not limited to, directors, officers, advisors, or resident agents) of any organization or entity that may have an interest in the subject matter of the hearing. Committee policy also requires nongovernmental witnesses to disclose the amount and source of any contracts or grants (including subcontracts and subgrants), or payments originating with any organization or entity, whether public or private, that has a material interest in the subject matter of the hearing, received during the current and two previous calendar years either by the witness or by an entity represented by the witness.

Please note that a copy of these statements, with appropriate redactions to protect the witness's personal privacy (including home address and phone number), will be made publicly available in electronic form not later than one day after the witness's appearance before the committee. Witnesses may list additional grants, contracts, or payments on additional sheets, if necessary. Please complete this form electronically.

Hearing Date: 05 FEBRUARY 2020

Hearing Subject:

Supercharging the Innovation Base

Witness name: Christian Brose

Position/Title: Chief Strategy Officer

Capacity in which appearing: (check one)

○ Individual ● Representative

If appearing in a representative capacity, name of the organization or entity represented:

Anduril Industries, Inc.

Federal Contract or Grant Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts) or grants (including subgrants) with the federal government, received during the current and two previous calendar years and related to the subject matter of the hearing, please provide the following information:

2020

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
Anduril Industries is a defense startup founded in 2017 in Orange County, CA, with a variety of customers spanning the Department of Defense and the Department of Homeland Security. Several representative contracts are listed below.			

2019

Text

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
FA8650-20-C-9300	DoD - AF	12,000,000	MDC2
FA8808-20-C-006	DoD - AF	749,999.95	Space Sit. Awareness
M9549419C0012	DoD - USMC	13,500,000	Base Protection
FA875119PA027	DoD - AF	50,000	Counter Intrusion

2018

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant

Foreign Government Contract or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts (including subcontracts or subgrants) or payments originating from a foreign government, received during the current and two previous calendar years and related to the subject matter of the hearing, please provide the following information:

2020

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment

2019 **A representative foreign contract is listed below.**

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment
2000332091	UK Marines	995,000GBP	Counter Intrusion

2018

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract or payment

Fiduciary Relationships: If you are a fiduciary of any organization or entity that may have an interest in the subject matter of the hearing, please provide the following information:

Organization or entity	Brief description of the fiduciary relationship
Anduril Industries, Inc.	**Executive**

Organization or Entity Contract, Grant or Payment Information: If you or the entity you represent before the Committee on Armed Services has contracts or grants (including subcontracts or subgrants) or payments originating from an organization or entity, whether public or private, that has a material interest in the subject matter of the hearing, received during the current and two previous calendar years, please provide the following information:

2020

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
Salary	**Anduril Industries, Inc.**		

2019

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment
Salary	**Anduril Industries, Inc.**		

2018

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant or payment

QUESTIONS SUBMITTED BY MEMBERS POST HEARING

FEBRUARY 5, 2020

QUESTIONS SUBMITTED BY MRS. DAVIS

Mrs. DAVIS. Mr. Fanning, in your opening statement, you said "It's not enough to pass reform in the NDAA. We need to make sure those on the receiving end are fully empowered to utilize that reform." Can you talk about how we can better train and empower the workforce? Are there specific opportunities in the short term (like DAU or formal education programs)?

Mr. FANNING. [No answer was available at the time of printing.]

Mrs. DAVIS. At our last hearing, the witnesses wisely steered us away from further changes to the acquisition process. That brought up some interesting questions, maybe we shouldn't focus as much on how we buy but instead what we decide to buy. Are their areas in the requirements process that might make the Department be more innovative and agile?

Mr. FANNING. [No answer was available at the time of printing.]

Mrs. DAVIS. Mr. Shah, can you discuss the "problem curation" process that DIUx used under your leadership? How do you think that process could be used more broadly when it comes to requirements across the department?

Mr. SHAH. [No answer was available at the time of printing.]

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Mr. SHAH. [No answer was available at the time of printing.]

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Mr. BROSE. [No answer was available at the time of printing.]