[H.A.S.C. No. 118–44]

CAN IT WORK? OUTSIDE PERSPECTIVES ON DOD'S REPLICATOR PROGRAM

HEARING

BEFORE THE

SUBCOMMITTEE ON CYBER, INFORMATION TECHNOLOGIES, AND INNOVATION

OF THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES

ONE HUNDRED EIGHTEENTH CONGRESS

FIRST SESSION

HEARING HELD
OCTOBER 19, 2023

U.S. GOVERNMENT PUBLISHING OFFICE
55–527 WASHINGTON : 2024

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CAN IT WORK? OUTSIDE PERSPECTIVES ON DOD'S REPLICATOR PROGRAM

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON CYBER, INFORMATION TECHNOLOGIES, AND INNOVATION,
Washington, DC, Thursday, October 19, 2023.

The subcommittee met, pursuant to call, at 9:00 a.m., in room 2118, Rayburn House Office Building, Hon. Mike Gallagher (chairman of the subcommittee) presiding.

OPENING STATEMENT OF HON. MIKE GALLAGHER, A REPRESENTATIVE FROM WISCONSIN, CHAIRMAN, SUBCOMMITEE ON CYBER, INFORMATION TECHNOLOGIES, AND INNOVATION

Mr. GALLAGHER. The subcommittee will come to order.

Good morning, and welcome to today's CITI [Cyber, Information Technologies, and Innovation] Subcommittee hearing. The hearing really seeks to answer two fundamental questions: What is Replicator and can it work, how can it work?

The Deputy Secretary of Defense announced Replicator's expansive vision in late August, which is to field thousands of all-domain attritable autonomous systems.

So what is that A, A2, A—this is what my biggest problem with A2. I finally got A2/AD [anti-access/area denial] in my head and now I have to think of a new acronym here.

But to field all-domain attritable autonomous systems within 18 to 24 months to combat the Chinese Communist Party's greatest asymmetric advantage, which is sheer mass.

Now it's 2 months later—that would be 10 percent of the way through the 18-month timeline—and this subcommittee, the Armed Services Committee more broadly, and industry, I would argue, including small and medium-sized innovative companies seeking to supply our troops who would presumably be part of Replicator, and the American people, are still left without any details on Replicator, what is necessary to make it successful, whether it is feasible, and what counter-effects it seeks to offer to counter Chinese military capabilities.

Now, I agree with the Deputy Secretary that the threats we face warrant a revolution in the defense industrial base, expanding the number of supplies, reducing fielding timelines, scaling production, and modernizing the culture of acquisition across the armed services.

And though a small part of my soul dies every time we enter a new acronym into the DOD [Department of Defense] lexicon, I

want to be clear. I want this to work. I think we need to be moving heaven and earth to enhance near-term deterrence across the Taiwan Strait.

Otherwise, we will be—we may stumble into a war that would make the current conflicts in the Middle East and Eastern Europe look small in comparison.

So I want this to work. And, in fact, someone gave me this book yesterday which I'd never read and I haven't finished yet. It's a small book, though. So even I as a Marine can read it. It's called "Men, Machines, and Modern Times," by Elting Morison. Dr. Greenwalt seems to know this book.

It's the 50th anniversary edition I hold in my hands. And thus far, what I can deduce is that he kind of talks about this process of innovation and resistance to change and kind of identifies a cycle of resistance that involves, really, three stages.

The first is ignoring, the second is rational resistance, and the third is name calling. I want to be conscious of not falling into this cycle. Obviously, we're holding the hearing so we're not ignoring Replicator, though I worry about our ability to deliver on the timeline.

I'm not trying to resist just for the sake of resisting. And as for name calling, well, we already have the name for the initiative so I'm not going to denigrate it. Again, I want it to work. I want to work with the building and we're lucky to have a group of experts from outside of DOD to get their candid advice and perspectives on the challenges and opportunities presented by the Replicator initiative and the general theme which we can all rally behind, which is procuring more hard power faster.

We're joined by Mr. Bryan Clark, the senior fellow at the Hudson Institute, Dr. Bill Greenwalt, the nonresident senior fellow at the American Enterprise Institute, and Dr. Paul Scharre. Is that—am I saying that right? Yeah. Did I get that right, Scharre?

Dr. SCHARRE. [Off mic.]

Mr. GALLAGHER. Okay. Okay. We have had any number of discussions in person and I still have trouble with your last name. Executive vice president, director of studies, Center for—Center for a New American Security.

This is an amazing lineup of people. I'm really looking forward to this discussion. And with that, I will turn it over to the ranking member.

STATEMENT OF HON. RO KHANNA, A REPRESENTATIVE FROM CALIFORNIA, RANKING MEMBER, SUBCOMMITTEE ON CYBER, INFORMATION TECHNOLOGIES, AND INNOVATION

Mr. KHANNA. Thank you, Mr. Chairman. Thank you to our witnesses.

Like each of you I've followed the Department's Replicator program and I commend the chairman for holding this hearing and the briefings that resulted because of the hearings. I think it's important for the Department, really, to brief Congress about what this program is and why we need it, what the obstacles are.

As I've often said, briefing Congress is like briefing the American public. So the American public needs to know in simple terms what

is exactly the Replicator technology, what are our goals, and how are we going to achieve them and by when.

As you know, advanced technologies alone aren't—don't ensure effective capability. A new system hinges also on contracting, management, a committed industrial base, and being backed by training units and robust support functions.

I'm particularly interested in our industrial base's ability to support the Replicator program and where there may be vulnerabilities in our supply chains and want to hear what continued challenges you face and how this committee can help in ensuring that you hit your goals.

To each of our witnesses, thank you for lending your expertise and, Mr. Chairman, I look forward to this discussion.

Mr. GALLAGHER. Thank you.

Mr. Clark, you are recognized for 5 minutes for an opening statement.

STATEMENT OF BRYAN CLARK, SENIOR FELLOW, HUDSON INSTITUTE

Mr. CLARK. Thank you, Mr. Chairman.

Chairman Gallagher, Ranking Member Khanna, distinguished members of the committee, thank you for inviting us here to talk about Replicator and by extension DOD's other unmanned system initiatives.

Congratulations also on getting the DOD to actually start talking about Replicator and what it might be, because this hearing has led to a series of conversations that we have had both with the DOD and with others about the initiative.

So Replicator, you know, is pursuing a worthy goal. The initiative is trying to solve operational problems being faced by today's operational commanders, so combatant commanders, and trying to do that in a way that leverages new technologies.

It has a lot of the elements of a successful quick turn technology development program. We just did a study for the U.S. Navy that looked at this, and Replicator has some of those elements built into it.

But I'd say that there's a few things that it's missing, that it really will need to address in order for the program or the initiative to be successful.

First of all, it's aiming—it's kind of aiming at the wrong problem. You know, so the idea of using mass alone to be able to counter China's mass is probably not the right solution for the U.S.

You know, China as a resident major power we're going to be operating in their backyard. They can generate targets at a lower cost and more easily than we can generate successful shots on targets.

So if we are going to try to match mass for mass we have probably picked the wrong adversary, the wrong scenario, if we're thinking about an invasion of Taiwan scenario.

So what we need to do is think about not just using mass but using our innovative, you know, more creative operational capabilities. So just like Secretary Hicks mentioned in the announcement for Replicator, we need to enable operational innovation on the part of our warfighters.

Their creativity, their ability to generate new concepts and force compositions, will allow them to undermine China's planning ability, create uncertainty for China, degrade the ability of concepts like system destruction warfare to be successful.

So we can't just rely on mass alone. Replicator, especially in its first instantiation, which they call Replicator 1, should be aimed at something other than mass. It should be aimed at enabling operational innovation.

The—then that kind of suggests, well, what was the process by which they analyzed the solution set that Replicator 1 may pursue and that kind of brings to question what is the Replicator initiative's design in terms of how do they analyze potential solutions, come up with them, and I think that's a weakness of the effort thus far is they don't have a strong analytic background for the initial solution sets they're pursuing.

We're doing a study right now with Australia's DOD and this is one of the areas where they actually seem to have an advantage on the U.S. is they've got a very robust way of analyzing potential solutions, both looking at gaps and potential opportunities for asymmetric advantage. So not just trying to fill holes but also looking for ways they can create problems for an enemy.

This is an area where Replicator could improve, you know, by looking at a better way of doing the analysis. And if we want to be able to gain warfighting advantage the biggest challenge that Replicator faces and that they aren't really addressing yet, I don't think, is integrating unmanned systems together in ways that are going to enable them to communicate with one another, be managed by a command and control system, and then operate in a way that creates creative operational concepts for us to pursue and dilemmas for enemies to deal with.

So Replicator is going to have to create a process that allows the software of the vehicles, the software of a command and control system, and the networks that are connecting them all together to interact. The government's going to have to manage that. This is not an area that DOD has particularly been good at and the current way that Replicator envisions doing this is by having DIU [Defense Innovation Unit] buy vehicles, hand them over to the services, and have the services pursue this integration.

As we know, DOD doesn't do a great job of integrating between services or between domains and so that's going to create the challenge of integration and then maintaining that integration through successive changes to operational concepts and tactics that we're going to want to pursue if we want to create continued dilemmas for China to have to deal with and deter their aggression against an ally like Taiwan.

So, you know, overall I would say Replicator has good ambitions. It has a good goal of solving near-term operational problems faced by commanders. But in its implementation it's going to have to make some changes that start aiming at the right types of objectives, not just mass but looking at ways of enabling innovation that creates dilemmas for an opponent and then allowing for the integration that's necessary for unmanned systems and the existing force to work together to create those force packages, those con-

cepts, those tactics, that are going to undermine China's ability to be successful.

If we don't do those things then we're simply going to create more of the same and make our own force bigger but not make it any more difficult for the Chinese to defeat.

Thank you very much.

[The prepared statement of Mr. Clark can be found in the Appendix on page 29.]

Mr. GALLAGHER. Thank you, Mr. Clark.

Dr. Greenwalt, you are recognized for 5 minutes.

STATEMENT OF WILLIAM C. GREENWALT, NONRESIDENT SENIOR FELLOW, AMERICAN ENTERPRISE INSTITUTE

Dr. GREENWALT. Thank you, Chairman Gallagher, Ranking Member Khanna, and other distinguished members of the subcommittee.

I'd like to thank you for the opportunity to testify this morning on DOD's Replicator initiative. I ask that my written statement be part of the record.

And so to answer the subcommittee's question about whether the Replicator program can work, I think one first needs to figure out specifically what it is and then establish criteria for success.

I'm not really sure yet that any of us or even the Department can articulate how and with certainty how this concept will evolve. Still, I think there's enough information out there to say that deploying thousands of cheap autonomous sensors, weapons, communications nodes, and targets that serve as a deterrent and can complicate Chinese and other potential adversaries' calculations in a future conflict is probably a pretty good idea.

In that context, the Replicator-type drone program has the potential to be a significant game changer and may well be worth pursuing but only if it's done correctly and does not crowd out funding for near-term munitions and other critical requirements, given the current rising threats around the globe.

An even better idea that's coming out of the Replicator initiative and embedded in this initiative and the one that is probably really most radical is to eventually replicate the business processes necessary to eventually achieve rapid time-based innovation in operational deployment over a much wider portfolio of technologies.

Replicator proposes to be a vanguard for a massive and I would say much needed change in how the Department innovates at scale. Each of the initial stated Replicator goals, the short-term drone deployment and then the medium-term business development process change, face significant challenges.

The issue for Congress to consider is whether any of this is realistically achievable. I think it could be but the odds at the moment are pretty much stacked against success.

The biggest challenges revolve around DOD's culture and processes. DOD's culture and the management systems derived from that culture are stuck in a 1960s paradigm that has consistently rejected new approaches and commercial technology incorporation that does not conform to DOD's ingrained thinking.

The greater defense innovation problem is multifaceted and one that manifests itself in the extensive time it takes to deliver capa-

bility. The system is based on a planned step-by-step predictive process that takes decades to deploy anything of substance.

This is diametrically opposed to how DOD used to develop capabilities in the 1940s and 1950s and how things are done today in the commercial sector. It should come as no surprise to this subcommittee that the vast majority of technologies that the Department of Defense needs in the future reside in the commercial marketplace, which has adopted a time-based innovation system, and not in the Department of Defense or in the traditional defense industry.

DOD in the 1950s essentially created the time-based innovation playbook that Silicon Valley—that was the basis for Silicon Valley's subsequent success, and Replicator is perhaps one last chance for Silicon Valley to return the favor and reinvent DOD.

I say all this because the lesson from past DOD innovation efforts is that if Replicator is not taken outside of the acquisition budget bureaucracy and rules it will fail. The Pentagon's acquisition system is simply not capable of acting on the proposed timelines contemplated in the Replicator program except in very limited circumstances and then only when conducted outside the normal rules of acquisition and budgeting.

This committee and its sister committee in the Senate gave the Department 8 years ago a new playbook to create a time-based innovation and acquisition system.

It had created production other transactions, improved commercial item procurement, enhanced rapid acquisition authority—a new middle tier acquisition authority—all designed to bypass the cumbersome acquisition and budgeting processes.

The results to date have not necessarily been what we would hope to—hope to see. Older bureaucratic mandates particularly within OTAs [other transaction authority] and MTA [middle tier of acquisition] authorities have restored the ability to achieve the successes that I think Congress was looking for at the time.

I expect Replicator will face many of the same problems in trying to implement these authorities as it tries to move forward. I don't think it's hopeless. It's a fight worth fighting. I think it can be successful.

But it's something that DOD needs a lot of work and a lot of top-down direction to do so. I think the—this model is much needed and the stakes are really high to implement it and so I hope they can achieve some success.

Thank you again for the opportunity to testify on this topic and I welcome any questions.

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

Mr. GALLAGHER. Thank you, Dr. Greenwalt.

Dr. Scharre. Did I nail that?

Dr. SCHARRE. Perfect.

Mr. GALLAGHER. Okay.

STATEMENT OF PAUL SCHARRE, EXECUTIVE VICE PRESIDENT AND DIRECTOR OF STUDIES, CENTER FOR A NEW AMERICAN SECURITY

Dr. SCHARRE. Chairman Gallagher, Ranking Member Khanna, distinguished committee members, thank you for the opportunity to testify today.

Replicator has a bold agenda to field thousands of attritable autonomous systems in 18 to 24 months. This effort is not only valuable, it is necessary if the U.S. military is to reverse its decades-long death spiral of rising costs and shrinking quantities for major weapons platforms.

The United States will need large numbers of low-cost attritable systems to generate the mass necessary to prevail in a conflict with China. We have seen in Ukraine the scale of violence that is possible in an interstate war and the possibility that such a war could drag on for years. The level of casualties seen in Ukraine would render the U.S. Army combat ineffective in a matter of months.

The U.S. military will need expensive capital assets such as aircraft carriers and stealth bombers but it will also need low-cost uncrewed systems to bring greater mass. We have also seen in Ukraine the value of such an approach.

Both Russia and Ukraine have flooded the skies with low-cost drones to find and track ground targets. Ukraine is reportedly losing 10,000 drones a month, yet it is able to reconstitute those forces using cheap commercially available drones.

This is a way of fighting with mass that the U.S. military does not have in its current force. But it is a part of U.S. history. In World War II at the height of production allied factories were producing over three and a half times as many tanks and airplanes as the Axis powers.

Today, the war in Ukraine has strained the defense industrial base's capacity for munitions production. For the United States to be ready for a conflict with China it must be able to produce forces at greater speed and scale than it has done to date.

Replicator is a test of the Defense Department's ability to generate the types of systems it needs, in the quantity it needs them, and at the speed required to deter China. The Pentagon's bureaucracy is likely to face challenges along all three of these dimensions.

Low-cost attritable systems and autonomous systems are both paradigm-busting concepts inside the Defense Department. They have supporters, including the Department's current leadership, but they challenge the Pentagon's traditional ways of doing business.

DOD will also be challenged to move at the speed that is required. Even if DOD succeeds in its goal of fielding thousands of systems in 18 to 24 months, by then at best it will be 2025. Replicator is an important step but it is one the Department should have taken a decade ago. Speed is now essential.

We saw in Iraq and Afghanistan that the bureaucracy can move quickly when needed. DOD rapidly fielded ISR [intelligence, surveillance, and reconnaissance] aircraft, counter-IED [improvised explosive device] technologies, and MRAP [mine-resistant ambush protected] vehicles. Yet, each case required direct intervention by

the Secretary of Defense to circumvent traditional processes that were too slow and were not focused on urgent needs.

Similar senior level attention by Department leaders will be required for Replicator to succeed, along with congressional support. The DOD has had recent successes in breaking the mold and moving quickly. The Defense Innovation Unit has brought in commercial technologies in a matter of weeks and months, not years and decades.

But too often these innovation success stories have been small scale. To field thousands of systems DOD will need to operate quickly at scale, something it has often struggled to do.

Replicator is essential not just because of the capabilities it aims to field but because of the path it is blazing through institutional red tape. Speed and scale of acquisition and new warfighting paradigms will be needed not just for autonomous systems but across the force if DOD is to transform itself rapidly to counter a rising China.

If successful, Replicator can train the institutional muscle memory inside the Department—not just in the Pentagon but in industry as well—to move quickly, experiment with new concepts, and scale production.

Is it possible? The average time from program start to initial operational capability for major defense acquisition programs today is 11 years, yet the United States mobilized for and fought the entirety of World War II in only 6 years.

The United States can move faster when the moment demands it. Nor are these episodes confined to our distant past. Just recently, during COVID with government support U.S. industry rapidly scaled vaccine production to produce over 100 million vaccines per month by the end of 2021.

Despite repeated warnings, the U.S. defense establishment is not on a war footing today. Replicator is a chance to change that dynamic and congressional support will be essential for this vital effort to succeed.

Thank you.

[The prepared statement of Dr. Scharre can be found in the Appendix on page 67.]

Mr. GALLAGHER. Thank you very much.

First I want to ask unanimous consent to enter into the record a statement from the Association for Uncrewed Vehicle Systems International.

Without objection, so ordered.

[The information referred to can be found in the Appendix on page 81.]

Mr. GALLAGHER. Also I want to note how it feels a little bit scandalous to be holding a hearing in the absence of a Speaker but I kind of like it. So I'm glad—I'm glad we're doing this.

Okay. So let me confess that when I first read the speech announcing Replicator my rational resistance kicked in to the effect of, well, if we're going to do a crash program in the next 18 months let's replicate the existing systems we know we need in the Indo-Pacific: Long Range Anti-Ship Missile, SM–6 [Standard Missile 6], JASSM [Joint Air-to-Surface Standoff Missile], JDAM [Joint Direct Attack Munition], NSM [Naval Strike Missile], right. Like, the crit-

ical munitions, the long-range precision fires we know we need to be moving to maximum production rates of but we're still at minimum sustaining rates even after the collapse of deterrence in Ukraine.

So now my concern is that—is how do we accomplish Replicator without crowding out other programs if they say they don't need new money for Replicator. Put differently, my biggest concern is that, particularly when we know that the administration tends to prefer RDT&E [research, development, test, and evaluation] over procurement, is that hard power programs like munitions are going to end up being bill payers for this and I worry about that tradeoff.

So maybe I'll start with Mr. Clark. Can you comment on that? Is that concern valid?

Mr. CLARK. Absolutely. I mean, you think about where they're going to find money in the near term to be able to reallocate towards, you know, procurement of vehicles.

It's going to have to come from something that's relatively fungible and munitions are—you know, any procurement account is a place you can go to get that money. So something that's not got fully obligated funds will be a source of money for Replicator.

So that's a concern and I think, to your point, we need a combination of both the continued maximum production of long-range precision munitions but we also need what Replicator can bring in terms of creating a more recomposable and more flexible force structure that's able to create some dilemmas for the Chinese that are separate from what the long-range fires complex can do, because they've planned for and are dealing with, you know, in their systems destruction warfare our approach to long-range fires.

So more long-range fires is just going to make us better able to continue doing just business the way we do now. So we have got to also have what Replicator provides in terms of more flexible and creative operational constructs that are going to create dilemmas for the Chinese.

So if we're going to have to—we have to do both and I agree with you that that money cannot come from Peter to pay Paul.

Mr. GALLAGHER. Yeah. And I—the spirit of the question is that this shouldn't be an either/or choice. But if you were going to say to the SECDEF [Secretary of Defense], okay, this only—something can only happen in 18 months with SECDEF-level involvement and pushing the bureaucracy every single day and you can only focus on one thing, I would focus on long-range precision fires, right.

I mean, that would be—that is something you could make meaningful progress with SECDEF-level involvement and we're just not moving fast enough.

Maybe, Dr. Greenwalt, comment on this point but also perhaps tie it to the need for flexible funding that—in order to achieve Replicator's goals. You've offered extensive commentary on the use of expired unobligated balances at DOD in the defense modernization account.

Dr. GREENWALT. Yes. No, I mean, the potential of getting—crowding out other critical needs is one of my biggest concerns about Replicator right now and I think we need to basically take existing systems that we need in the INDOPACOM [U.S. Indo-Pacific Command] and ramp them up and I think your recent pro-

posal legislation in the FIRES [Funding Pacific Readiness and Enhancing Stockpiles] Act is exactly what's needed to basically harvest money at the end of the year and put it into production-ready assets in the munitions industrial base.

Funding flexibility and innovation is absolutely critical and right now there are very few pots of money that the Department can actually use and move around in the year of execution to essentially focus on things that look like they're going to be something that we can scale up.

In other words, what happens now—and Paul has talked about 11 years to achieve capability. That's when programs start. Right now it takes almost 8 years to get to the decision and get money to start that program. So it's 8 plus 11 so it's really 20 years that we're talking about.

One needs to be able to start a program, get on contract, and get money within year of execution. That's the way we did it in the 1950s but that's not the way we do it today.

So these various funds, whether it's the defense modernization account, which Congress tried to create a decade ago and has not been implemented by the Department to basically harvest about a billion dollars to focus on anticipated requirements in MDAPs [Major Defense Acquisition Programs], it's very difficult for the Department to want to execute and use flexible funding, for whatever reason.

Mr. GALLAGHER. I'm going to have to come back in a second round. But I want to foot stomp this point and highlight a lot of Dr. Greenwalt's analysis, which suggests that over the last decade we have lost hundreds of billions of dollars—$127 billion—in buying power, money that was appropriated to DOD and not spent and then it goes into Cinderella land, abeyance for 5 years in the Treasury and then it evaporates.

For example, we lost $11 billion dollars a few weeks ago in part not just because of intransigence here in Congress among certain committees but also a lack of enthusiasm from the building and the Comptroller's office. And I think it would be wise for us to take advantage of that money, which is, again, going to disappear and be used for nondefense purposes, in order to provide sustained, predictable funding for both long-range precision fires and potentially Replicator.

So help me help you, DOD. We want to give you this money.

With that, Mr. Khanna is recognized.

Mr. KHANNA. One of the challenges and vulnerabilities of democracies is that we're openly critical of our own systems. You would never have the Chinese discussing whether their systems work or are strong enough.

I guess my first question is how much of a deterrent effect is just the announcement of a Replicator program and that we're doing this, putting aside, obviously, that we want to do it successfully?

Mr. CLARK. Well, so I would say that there is a dissuasion effect. You know, maybe if you're—you know, if you think about this from the Chinese perspective they're looking at, you know, what are ways that the United States is going to present new challenges to us that we have not prepared for and this would be an example of that kind of challenge, this along with what Admiral Paparo talked

about recently in terms of wanting to create a hellscape, you know, in the Taiwan Strait to help thwart an invasion of Taiwan.

If you put those together and say the U.S. could be fielding large numbers of unmanned systems with the intent of orchestrating them in ways that are going to defeat or at least slow down our ability to rapidly invade Taiwan, that starts to, you know, maybe undermine their confidence in their ability to mount that invasion.

So, yeah, there's an effect that starts to chip away at the confidence that Chinese leaders might have about their likelihood of success. But you got to follow it up, right, because then it'll abate.

You know, so you got to follow it up with some actual tangible changes that are going to continue the—to drive that uncertainty and then you're going to have to evolve it over time. So it can't be just we send out a bunch of these unmanned boats and now they don't—you know, they do the same thing year after year.

You got to continue to evolve them. I think that's one of the challenges for Replicator is to present an evolving set of capabilities that are going to be—force dilemmas on the Chinese.

Dr. SCHARRE. I mean, certainly, there's nothing like seeing for believing and so, obviously, the Chinese military is going to be tracking what the DOD is saying.

But I do think that DOD needs to think strategically as they move forward about doing demonstrations that can demonstrate capability in ways that are going to have a deterrent effect.

We have certainly seen this in the past. Several years ago DOD did a big swarm demonstration out at China Lake with a hundred drones. That was followed not long after by China doing their own swarm demonstration.

We notice the things that they're watching, and so there's going to be a lot of capabilities we need to conceal but some that we want to think about strategically showing for deterrent effect.

Mr. KHANNA. What then, if we convene a year from now, as I'm sure the chairman will, do you think are the, let's say, top three things we want to have seen by then to demonstrate that this is a success both internally and in what we're projecting to the Chinese?

Dr. GREENWALT. I think deployment of capability. In other words, to actually have had programs with capability that are out in the hands of the warfighter who then are suggesting new improvements and we're making the next level of changes that are necessary. I think you have to show that you can actually deploy capability fast and in such scale that it makes a difference.

Mr. CLARK. I think another thing is having a rapid tempo of prototyping. You know, the DOD does prototyping now and that's some of the things they would do with Replicator. But if that tempo is, like, one or two exercises a year, that's not going to cut it.

The DOD is going to have to have a more rapid pace of prototyping in order to both assess a variety of potential solutions but also change those solutions over time, and if we don't see that in a year, that's an indication this is kind of going the way that other programs have.

Dr. SCHARRE. I think one of the things that we have seen in the past with new technologies like this is finding out how you use it effectively is one of the most difficult things.

So integrating this rapid prototyping, getting it in the hands of warfighters, with a tight loop between warfighters and developers so that they're figuring out how to use this most effectively is going to be key.

Mr. KHANNA. And, Dr. Greenwalt, I read in your testimony about the defense industrial base and I've been concerned about that.

I was surprised that the DOD didn't track exactly where all of our component parts are made, and we had an amendment in the NDAA [National Defense Authorization Act] this time just to say where are our vulnerabilities, what are we getting from China, what are we getting from other countries.

Do we know that this program—what our vulnerabilities are and is there an effort to make sure that we have a robust defense industrial base?

Dr. GREENWALT. I think that's a question that the Congress needs to continually ask. I've talked to a number of drone manufacturers who would like to scale up and they're looking at their supply chain and a lot of that supply chain is not American or even allied. And that's going to be a real problem when you try to scale up and the time to actually get those parts into the United States is going to be a delaying factor in achieving their objectives.

Mr. GALLAGHER. First up is an Alabaman, an EMT [emergency medical technician], and a "Price is Right" contestant, Mr. Strong.

Mr. STRONG. Thank you, Chairman Gallagher, and witnesses, thank you for being here today. And my questions are for each of you just whoever wants to take it.

Through Replicator the Pentagon is committed to fielding thousands of attritable autonomous systems within 18 to 24 months. We're not talking about just research and development or a small-scale pilot program. This is a large undertaking and the speed of it all within 2 years.

Don't get me wrong. I agree there is an urgent need for this type of a program. But I'll take Huntsville, Alabama, for instance. We waited on Space Command basing decision for more than 2 years when we came in first throughout the entire process and the Biden administration still chose the fifth most qualified location.

Now we're working to fix that but there are countless examples of programs and procurements being held up by protest and general delays.

My point here is that the DOD is not exactly known for being speedy as they are claiming they can implement Replicator with no additional funding or authorities. So my first question is do you see challenges with the DOD implementing the Replicator program based on current funding lines and existing authorities?

Dr. GREENWALT. I would say absolutely. But this committee has given in the past the Department ways to achieve those objectives if they so use them.

So the first one on funding is the rapid acquisition authority account which would allow for rapid reprogramming and then congressional notification after the fact. This has been a very useful authority ever since 9/11 to get capability in the hands of the warfighter faster.

Other transactions, which is a contracting authority, allows the government to get on contract quickly. Could be 30 days versus—

and without protests. This was very successful in many, many DIU efforts and, frankly, was how the Falcon 9 was created at NASA [National Aeronautics and Space Administration]. So you have that.

The middle tier acquisition authority is a way to move around the cumbersome requirements and an acquisition process which adds years to the process. So there are tools they could use but if they use the traditional ways of doing business at the Department of Defense it will take decades to achieve this capability.

Mr. STRONG. Dr. Greenwalt, do you think that the Pentagon has identified and begun addressing these challenges?

Dr. GREENWALT. I think the Pentagon—parts of the Pentagon have. There are a number of innovation hubs that are taking advantage of this authority.

But as Paul has pointed out, it's not at scale. And so the Pentagon needs to focus these authorities laser like on programs of scale to bring these capabilities as fast as they possibly can to the warfighter.

Mr. STRONG. Thank you. The DOD can't do this all on their own. It's been made clear in the last year that our defense industrial base has atrophied. Is industry ready to scale up to meet the needs of the Replicator program?

Mr. CLARK. I would say not yet. They need the investment in order to be able to, you know, make the kinds of investments on their own that they're going to need to be able to build up the facilities because right now DOD's investment in unmanned systems has been pretty anemic, which has led industry to sort of back off and, you know, keep their powder dry, waiting to see if that demand is going to start to manifest.

And so as a result we don't have an industrial base right now to draw upon to scale at the type of pace that Replicator is envisioning. So it's going to take some time to make that happen even if we take advantage of emerging, you know, technologies for manufacturing.

Mr. STRONG. Thank you. Are there any previous autonomous programs of similar scale that the Replicator program should take lessons learned from?

Dr. SCHARRE. Well, we have certainly seen other attempts by the Department to scale quickly with commercial technologies.

You mentioned protests and delays, and I think it's worth pointing out that some of the challenges in addition to those inside the Department exist outside of the Department. The JEDI [Joint Enterprise Defense Infrastructure] cloud computing contract is an example of the Department trying to do this. And when the Department is using sort of small-scale innovation solutions, small money, they can do that.

When you got to a $10 billion contract with real money on the table then we saw protests and lawsuits that mired the entire process in 3½ years of delays. So I think that is a big risk when we start to see scale.

Mr. STRONG. Thank you again.

Mr. Chairman, I yield back.

Mr. GALLAGHER. Thank you. Next up a product of Pennsylvania and the United States Naval Academy, Mr. Deluzio.

Mr. DELUZIO. Thank you, Mr. Chairman. And good morning, everyone. Thanks for being here.

I want to ask about several nondefense AI [artificial intelligence] autonomy organizations, Google and many others, who have now adopted codes of ethics saying they're unwilling to support the use of their technology in defense, for defense purposes.

So I'm curious maybe from each of you, whoever wants to weigh in, to what extent are you thinking these principles impact DOD's ability to accomplish goals like those set forth in Replicator. And these are ostensibly American companies, I should note.

Dr. SCHARRE. Yes, thank you. We saw, I think, a big concern by those in Washington, in Congress, and in the Department several years ago when Google did not continue to work on Project Maven.

I think one of the things that we have seen since then is that while there are some companies that have said they don't want to work with the military, in fact we have seen a number of major tech companies stand up and say that they are American companies and they are going to work with the government, with the U.S. military, despite in some cases protests from their employees.

We saw the leadership at Microsoft and Amazon both say that. In fact, Google is now working with the Defense Department again. So, you know, and we have seen since then a huge growth in startups that are specifically oriented at the Defense Department as their customer—Shield AI, Anduril, many others.

So I think in practice this has been maybe more noise than substance and in fact there's just a huge segment of the tech community that's eager to work with the U.S. military.

Dr. GREENWALT. I think even the biggest problem that some of these companies face are not necessarily related to AI ethics but are related to how the government does business, how the government treats intellectual property, how the government contracts, the nonunique commercial processes that each of these companies has to create to be—to comply with having a government contract.

That's why other transactions and other means of having a commercial-type contract is important to these type companies but something that the Department of Defense is not exactly stellar at using.

Mr. CLARK. I'll just add one small corollary to this is that the new rules for the use of autonomous weapons that the DOD has put out are going to force Replicator to think through some really complicated mechanisms for command and control of these unmanned systems that allow them to meet rules of engagement requirements and a lot of commanders and operators to have a chance to make a decision whether a system is going to be used in a lethal manner or not.

That's not trivial and it's going to require Replicator to have, you know, some longer term effort to do the software integration and the updating of these systems even after they're fielded.

Mr. DELUZIO. Thank you.

Dr. Greenwalt, I want to come back to something you said about intellectual property. That was my next question so thanks for predicting it.

Look, several of these systems that are in DOD's inventory the government does not have intellectual property rights. So I'm curi-

ous if you want to start and if others want to weigh in, what should be DOD's strategies here around intellectual property for systems like the ones we're discussing where because DOD may not have those rights they can't grow and learn and gain insights from the systems that otherwise might be able to?

Dr. GREENWALT. Intellectual property in contracting is an incredibly hard subject and the Department needs to ahead of time understand which IP [intellectual property] it needs to maintain and operate systems and which IP it doesn't need so it can incentivize not just a monopoly provider but an entire ecosystem of competition and then systems can be replaced based on that. That is a very difficult process.

But at the same time it's something that the Department needs to become the expert at because it is so important, because this incentivizes industry but it also is a barrier to the Department using its own things that it's bought. So I think it's definitely one of these things that the committee is going to have to continue to shepherd and look at.

Mr. DELUZIO. Any other thoughts from the panel?

Dr. SCHARRE. I think there's just on IP and maybe more broadly a genuine tension for the Department in moving fast versus having the right procedures in place, having ideal contracting structures or requirements for systems. And to some extent if you're controlling for time, as the Department is trying to do here, there may be situations where you're purchasing something that you're not going to sustain over the long term and that's okay. And I think that we should acknowledge that that's fine because that goal of we're going to buy something that we're going to keep for 20, 30 years is the enemy of moving quickly.

Mr. CLARK. So—and one other thing is the government can exert its rights to own the interfaces or to manage the interfaces between software—and a lot of this intellectual property has to do with software—and the government can allow companies to provide their own software and develop that on their own but then, you know, force them to show that they can integrate through the interfaces that the government owns, in a way is similar to what iOS does with, you know, new apps trying to get into the app store.

Mr. DELUZIO. Thank you. Mr. Chairman, I yield back.

Mr. GALLAGHER. Next, a salty Marine infantry officer from Salem, Massachusetts, Seth Moulton.

Mr. MOULTON. Thank you very much, Mr. Chairman.

So Ukraine has done remarkably well at holding off the Russian bear in large part thanks to our help and yet all their most innovative warfighting is not from us because we didn't help them, you know, innovate with drones.

We didn't help them innovate with cyber. We're just trying to teach them tactics that America learned 50 years ago.

So what lessons are you taking from Ukraine's drone program to influence how you get Replicator up to speed so quickly, as it needs—clearly needs to be done?

Mr. CLARK. Well, I'd say one thing right off the bat is Ukraine has been able to do what they're doing not through necessarily just mass and throwing a lot of unmanned systems at the Russians but instead it's how they orchestrate, how they, you know, organize

themselves, how they use the tactics that the unmanned systems enable, how they employ those tactics in the field, how they, you know, basically sequence their operations.

So it's a lot of the kind of operational art is what they're bringing to bear that's actually yielding success rather than just throwing a bunch of, you know, mass at the wall and hoping that the Russians get overwhelmed.

So I think the lesson there is we've got to figure out ways to enable our unmanned systems to be employed in a very flexible way that tactical operators can then adjust in the field.

Mr. MOULTON. But what about from an acquisition perspective?

Dr. GREENWALT. I think that what we're seeing there is that the proliferation of commercial technology is influencing how an agile acquirer, and the Ukrainians are being very agile in this, and pulling together various commercial technologies to achieve military significant means, and I think the lessons learned that we should be taking from there is that the commercial marketplace is maybe light-years ahead of where the Department of Defense is and we need to figure out how to be agile and bring that in and then bring the unique military knowledge that we have to bear on that commercial tech. And that is going to be a process that moves against the Department of Defense's culture.

Mr. MOULTON. Well, I would just suggest you also consider that at least my understanding of how much of this is working in Ukraine is they're taking their DOD personnel—their military personnel—and actually embedding them in the companies as opposed to what you just said, which is taking the companies in and bringing them into the bureaucracy of the DOD.

I think we can all intuitively know which one would probably produce quicker results. So I think—I think we should look very, very carefully about that and, honestly—look, Kath Hicks came out in, I think, the end of August and announced the start of the Replicator program.

Just in terms of timeline, because speed is so important here and we all agree on that, at what point will Replicator have the capabilities of the Ukrainians?

Dr. SCHARRE. I mean, certainly not on any timeline that we're currently on. I mean, even if they achieve all of their goals we're looking at Ukraine is fielding tens of thousands of drones on a regular basis and Replicator doesn't even have that goal. So that would be years away.

One of the things that we have seen from an acquisition standpoint Ukraine do very successfully, they have a very decentralized approach. They have civilians, you know, sort of like spontaneously working drone operators working with industry, working with the military.

There's downsides to that. They have a very heterogeneous fleet so, you know, things like maintenance is hard. But if you're losing them at high volumes and you are focused on replenishing, that's fine. And one of the advantages of what they're doing is not only can they then scale through that direction but they do a lot of experimentation in the technology and then how it's being used because they're allowing a lot of freedom among those on the front

lines and the developers to try things and then figure out what works.

Mr. MOULTON. Well, does anyone know what percentage GDP [gross domestic product] Ukraine's is compared to ours at this very moment? I don't know either.

But what I—what I intend to do is write a letter to the Department requesting a basic chart that simply compares Ukraine's speed of fielding, acquiring these technologies—acquiring and fielding and getting them in the hands of warfighters compared to Replicator.

And we can come up with some basic metrics of how to—how to gauge that, but that should be a basic yardstick. I mean, I would say that if Ukraine's GDP is one one-hundredth of ours then we should be 100 times faster.

But be that as it may, let's at least just compare one to one how we're doing in terms of speed. I think that would be a great metric for how successful this program is.

Mr. Chairman, I yield back.

Mr. GALLAGHER. Next, from Norwood, Norfolk, and Nantucket, Mr. Keating.

Mr. KEATING. Thank you, Mr. Chairman, and your efforts at alliteration are wonderful this morning. The sailor from Salem and whatever.

Thank you very much for holding this hearing. I just have one kind of overall question that's—and maybe you can shed some light on for me.

Number one, the idea of a swarm of drones or low-cost decoys overwhelming an opponent, an enemy, it's—that's a pretty old concept. It's been around for a long time.

So my question is why now? Has something changed so this is now something we're going to implement, and how is the Replicator different than these old concepts?

Dr. SCHARRE. Why now, you know, I think I'm not entirely sure what's driving the Department. Certainly, the China threat is one that they are focused on and trying to move quickly.

We also can see quite clearly in Ukraine that a lot of these concepts are working and this idea of low-cost attritable autonomous systems has been a very contentious one in the defense community. It's not new. It's been around for at least the last 10, 15 years. People have been talking about it.

But right now we're seeing that it works. Like, you can build large numbers of low-cost things that are not individually survivable and, yet, you can replenish them quickly and that is effective in delivering combat power. And I think that that kind of real-world demonstration doesn't hurt.

Mr. KEATING. Has the technology changed that much?

Mr. CLARK. Yeah. I mean, what we have also seen, and Ukraine has exhibited that, is that the commercially available vehicles have been, you know, very effective. They've reached a point where they can be operationally useful in a military sense. So you can get large numbers of them very quickly into your forces' hands.

On the software side we have been able to manage them and control them in ways that are going to be more effective than just having a swarm go and try to overwhelm the enemy.

So I think on both the kind of hardware and software side we have seen technology evolve in a way that allows this to be an effective military capability.

And then to Paul's point, you know, the military threat right now—the potential for invasion of Taiwan by China—has gotten to the point where our traditional approach to dealing with that problem is not necessarily going to be as solidly effective as it has been trusted to be in the past. And so I think that's the other thing driving us is that the operational urgency is there.

Dr. GREENWALT. I also think it's a desire for the Department to create a new innovation model and drone technology is a segment in which they could actually do that.

They're essentially, you can argue, already doing that with space assets and the commercialization of space and so that's a successful model that they can replicate in Replicator and autonomous drones are kind of that next level. But there probably are a couple other technologies that they could pursue as well.

Mr. KEATING. Thank you very much, and I yield back.

Mr. GALLAGHER. Okay. I'm going to entertain a second round.

In my opinion, the only thing better than producing mass quantities of long-range precision fires ideally with advanced energetics inside of them is doing so in concert with our closest allies, particularly the Aussies and the Brits under AUKUS.

As you know, autonomous attritable weapon systems and technologies are a key part not only of AUKUS but the national technology industrial base and many of our bilateral agreements.

What needs to happen with our allies and partners to build out our magazine depth in this regard? And I'll just go—I don't know who—does someone want to volunteer?

Dr. GREENWALT. I'll start with that we need to incentivize the working together of the scientists and engineers in not just the government but in industry in the three AUKUS countries. And in that regard there is a need to reform our export control and our ITAR [International Traffic in Arms Regulations] process.

Right now that process designed to protect technologies that unfortunately now are many generations old are keeping our best scientists and engineers from working together to solve these problems and even to the point where Boeing Australia created a new loyal wingman drone that's ITAR-free.

Why? Because Australia itself wanted to have sovereign capability and the ability of not having to go every time they use that product to the State Department for approval on how to use it.

So we have to reform our export controls to incentivize that structure.

Mr. CLARK. That's a starting point, clearly, and I—and to build on Bill's point, Australia is concerned that if they provide the Ghost Bat to the U.S. military and then the military—U.S. military modifies it, then the Australians will not be able to get it back because now it'll be ITAR controlled.

So there would be a version of Ghost Bat that we use that's maybe more sophisticated and the version Australia has is still, you know, whatever—you know, baseline. So that's a concern that they had that they raised to us when we were down there for the study we completed.

I'd say the other big thing is, you know, the scientists are all working together. We talked with these guys and they're very interactive right now. But there's not a demand signal for buying the systems and fielding them and doing the experimentation because right now there's no experimentation venues that are across all three allies where they're actually looking at prototypes of these systems being employed in real operational settings.

We need to create that and have a pretty rapid tempo of that. And then we have got to create a demand signal in terms of investment, whether it's the U.S. making the investment or all three countries making the investment, that's going to draw these capabilities, you know, across the finish line into some useful operational form or else industry is never going to start ramping up the production.

Mr. GALLAGHER. Dr. Scharre, any thoughts?

Dr. SCHARRE. I mean, these export control barriers are killing us and the Ghost Bat example is a painful one and we can't—the problem is we're not going to be able to get to the things we need to be doing working jointly with them developing concept of operation if we can't do the basics in terms of sharing the technology. Those are things at the starting line that are really holding us up.

Mr. GALLAGHER. And also, like, at the most basic logical level if the problem is, like, PLA [People's Liberation Army] mass. Like, they can produce a lot of stuff and we can't sort of like counter that one for one. Then the logical thing to do would be, like, to assume risk and work with our partners and allies, which is our asymmetric advantage, right. They don't have allies and partners. They have vassal states and——

Dr. SCHARRE. Right. Great complexity for them, great uncertainty. Multilateralize the problem. You know, make it more difficult for China to feel like they're going to get a free shot at a place like Taiwan.

Mr. GALLAGHER. Yeah.

Dr. GREENWALT. But our allies are moving out. So, for example, not just Ghost Bat but Ghost Shark which is essentially a commercial unmanned submersible that's going to be—take commercial technology from actually the U.S. and the Australians are going to militarize it and try to, you know, flood the zone with a lot of autonomous undersea drones.

That's huge, but we—the U.S. Navy should be working together with the Australian navy on that concept and on the—on those cheap, you know, undersea attritable drones, so to speak. But we're not.

Mr. CLARK. So in the Navy's defense they are working together on programs like that and I think, you know, programs like Ghost Shark are a great example of how commercially derived technology can sort of circumvent these ITAR regulation limitations.

But I think, again, there's no prototyping environment for them to go and actually go play with these things and there's no demand signal to buy them.

Dr. GREENWALT. But I'd argue the Navy is also cognizant of the fact is that if it does go in on Ghost Shark it ruins it for the Australians and ruins it for them because they will be ITAR'd.

Mr. GALLAGHER. Clark is contractually obligated to defend the Navy. He's a homer. So, okay. I probably can't ask this next one in 25 seconds. Okay. Well, I'm going to do a third round anyway. So yeah. But do you want—do you want to ask a question?

Mr. KHANNA. I just have one question.

Mr. GALLAGHER. Okay. I'll yield to you.

Mr. KHANNA. My question actually builds off what the chairman started out with, which is that we obviously need NSM and we need SM–6. We need these anti—long-range anti-air anti-ship missiles. We also need the drones.

Obviously, we need everything in some way. But how would you prioritize in terms of what is more urgent when you have limited resources in the allocation?

Mr. CLARK. Well, I'd say that we probably need to take some money, even if it means cutting into some of the munitions programs, and get these drone programs up and running because this provides a hedge against that kind of high-risk maybe low-probability potential of an invasion of Taiwan.

So if we can give Admiral Paparo what he's talking about in terms of a hellscape, even if that means we maybe don't buy three or four or five or six additional missiles, that may be worth it in order to get this hedge, you know, going and be able to create the potential for China of a more complex situation in the strait instead of adding kind of more of the same in terms of the fires network that we're already thinking of employing against that kind of force.

Dr. SCHARRE. Yeah, I mean, I certainly—I don't think that the kinds of strike munitions that we need in this conflict should be the bill payer for this kind of effort and certainly we have seen historically that because of the flexibility in production that munitions are often a bill payer when you are looking for near-term money.

My colleagues, Dr. Stacie Pettyjohn and Hannah Dennis, at CNAS [Center for a New American Security] have analyzed, you know, sort of by year the rapid volatility in munitions funding that then has strained the industrial base and has, you know, directly led to the situation we are in today when we try to scale munitions production for Ukraine or for deterring China.

We're in a difficult place. But there are lots of other places that are bill payers in the Department, in ground forces, in legacy short-range TACAIR [tactical air] and lots of other things that are not going to be as relevant in this kind of conflict.

Mr. GALLAGHER. Have you—by the way, have you seen any innovative efforts on containerized fires from DOD, recognizing we're in an unclassified?

Mr. CLARK. Yeah. Yes, I have seen them. I don't know if we can go in detail on that. Yeah.

Mr. GALLAGHER. Okay. Interesting. Okay.

In the testimony that I entered into the record from the Association for Uncrewed Vehicle Systems International it lays out that the U.S. currently lacks the industrial base needed to meet the goals of Replicator in part due to Chinese drone dumping, an illegal trade practice that's been flooding the global market with subsidized Chinese manufactured drones.

It's estimated that Chinese drones account for more than 90 percent of the consumer market, 70 percent of the enterprise market, and 92 percent of the first responder market.

What steps can the United States take to revitalize our domestic drone manufacturing industrial base in order to help Replicator? I'll go reverse here and start with you, Dr. Scharre.

Dr. SCHARRE. Well, certainly, this is a problem DOD has been working on for a while with the blue UAS [unmanned aerial system] program, trying to find ways to build up some kind of domestic commercial base.

Part of the problem is even if you have drones that are made here all of the supply chain comes through China because the drone is, in essence, in many ways a flying smart phone. So I think that this particular problem is embedded into a much bigger problem of the U.S. tech relationship with China, deep degrees of entanglement, and finding ways to put in place incentives for industry to be moving production elsewhere, to partner or allied countries, is going to be really important.

Dr. GREENWALT. I think we missed an opportunity in this technology, not from the Department of Defense standpoint but from the regulation of the FAA [Federal Aviation Administration] as far as encouraging the type of testing and development of technologies and to open the airspace to do this, from the Department of State, whose interpretation on missile technology control regime that led to the—not companies investing and, frankly, the Turks taking certain marketplaces and the Chinese taking the market.

So we had—you know, we developed this technology. We were ahead 30 years ago and now we're not and it's going to take a whole lot of effort to try to overturn that. But it's a multi-governmental agency effort. It's not just the Department of Defense. The Department of Defense can't drive this technology and drive the industrial base. It's going to have to come from other agencies' help as well.

Mr. CLARK. Yeah. I mean, it requires supply chain transparency. We need to do the analysis to figure out, well, what are the components that are coming from China and what's the risk associated with that because, you know, batteries, for example, are going to be probably—inevitably are going to come from China and we probably have to accept that. But other things maybe we don't want to have come from China.

And then also, you know, creating that demand signal on the part of DOD for, you know, drones that are in this, you know, like Bill said the group two, group three size range where it's not your little DJI hobby drone but it's like a, you know, TB2 or something like that that's militarily relevant.

Creating a demand signal for those drones from the DOD will kind of force some of these controls to be put in place and help the emergence of a more stable U.S. domestic drone making market.

Dr. GREENWALT. They're also going to have to export to our closest allies and because we—our demand alone is not going to drive this market. So we need to—we need to share and that's going to be a—goes back to the State Department again.

Mr. GALLAGHER. Yeah. And ITAR specifically. Yeah.

Well, I'm cautiously optimistic we can fix ITAR in this Congress. We're making progress for the first time in a while and I want to commend the efforts of Chairman McCaul on the Foreign Relations—Foreign Affairs Committee. It's a very fraught issue.

A point of clarification. Okay. So Replicator is going to be coordinated through the Defense Innovation Steering Group—DISG, another acronym—with the support of DIU and we have great new leadership at DIU with Doug Beck. Just tell me how do the combatant commands fit in and the services, or how should they, rather?

Mr. CLARK. So the way that innovation is being managed right now at the Department is the combatant commanders, in particular INDOPACOM, is driving the definition of operational problems to be solved.

So that's the entering point is they provide the operational problem they want to address. That goes into the Defense Innovation Working Group and Steering Group and then they make decisions about prioritizing which operational problem to solve in which order.

Mr. GALLAGHER. Okay.

Mr. CLARK. And then that goes over to then the kind of vague solution identification process and that's what I was referring to earlier. It's not well defined, not well supported necessarily.

But then DIU is part of that and then will generate solution ideas and then DIU is responsible for going and procuring those solutions to get them to the warfighter.

Mr. GALLAGHER. Interesting. Any other comments on that basic management structure?

Dr. SCHARRE. I mean, I guess just we have seen this problem of this gap in the ability of the Department to respond to COCOM [combatant command] needs over the last 20 years. It's not a new one. There's been a lot of organizational solutions, JUONs [joint urgent operational needs] and JEONs [joint emerging operational needs] and other things. We'll see if this works.

But I think that there are just huge structural barriers inside the Department towards, you know, orienting the, you know, RDT&E, the production processes, or driving material solutions to the immediate needs of the warfighter or the near-term needs.

I'm encouraged by the level of attention by senior leadership but they do have a lot of work to do.

Dr. GREENWALT. I think from a managerial perspective you need to bring the operators in consistently as you do serial operational prototyping.

In other words, minimal viable product goes out to the—to the warfighter, they test it, look at it, see if it's operationally useful or not, suggest changes. Goes back into the process.

You prototype again, repeat, and this will be repeating over and over again and, frankly, should be repeating over and over again with software changes, with hardware changes. And the key thing that we have right now is this wall that we like to throw things over. And going to Congressman Moulton's idea of embedding, you know, the operator in certain areas is probably a real, real good one. The question is how do you do that.

Mr. GALLAGHER. Go ahead. Did you have a comment?

Mr. CLARK. Yes. I would say the—this gets to the need for rapid prototyping to be done on a tempo that's much faster than what the DOD is currently planning, which is like two or three of these events per year.

You know, that's not going to get you to where you need to be. And then the problem with the DIU idea of they're going to go procure these vehicles is who's going to actually do the prototyping and the evolution of these vehicles because DIU is more of a procurement agency, not a integration and R&D [research and development] type of agency. So I think those are challenges.

Mr. GALLAGHER. Yeah. Ro, I got one more. I'm sorry, but you're going to like this one.

Mr. KHANNA. You're educating me.

Mr. GALLAGHER. Well——

Mr. KHANNA. I'm, like, I'm listening to your terms and, like, I'm going to—I'm going to put those in my speeches. You know, make me sound good on defense.

Mr. GALLAGHER. The speeches will put everyone to sleep if you do that. But you'll like this one. So I'll do—are we in a fourth round now? I don't know what. Whatever. I'll just keep asking questions.

Okay. So let's say it's January 2025 and the newly elected President Ro Khanna comes to you and says, you know what, I've reviewed the intel and I think Xi Jinping was serious about this whole I'll take Taiwan by force if necessary and 2027 is the date. I just think that's—we got to plan against that. And I'm betting the farm—and you are each the Secretary of Defense in this fictional universe, which actually, I mean, there's—you know, there's a probability this could happen.

I'm betting the farm on Replicator to prevent this from happening. Like, you as Secretary of Defense, what do you need to make this successful in simple terms that the American people can understand?

Mr. Clark, we'll start with you.

Mr. CLARK. Well, I'd tell President Khanna that I think we——

Mr. GALLAGHER. Has a nice ring to it.

Mr. CLARK. It does. It does.

So I think we need to, you know, quickly get the operators to define how they intend to solve this problem, how would they go about tackling the—you know, stopping the invasion. And I think it'd be a combination of slowing down the invasion with unmanned systems that are going to create the hellscape that Admiral Paparo talks about and then the joint fires network that's going to be used to then eliminate those ships before they're able to get combat power ashore.

So that's the basic construct. What I need is the money to be able to go rapidly buy a bunch of unmanned systems that are going to enable me to gum up the Strait of Taiwan and I need to sustain the investment in the—in the munitions production that's going to get me those missiles to be able to eliminate the problem once they've been slowed down.

Mr. GALLAGHER. Thank you.

Dr. GREENWALT. Three things: money, production lines at full capacity, and then the third areas that we should already be working

on is how to deliver these and so the issue is platforms. Are we going to do these out of P–8s? Out of sonobuoy? Are we going to do it out of C–130s? Are we going to create a new arsenal plane on a commercial aircraft that's able to deliver these type of things?

Same thing undersea and on the surface. We should be thinking about those now and have these platforms ready to go and in 2025 we should just be cranking up full production lines on all of these things.

Mr. GALLAGHER. Sorry. Dumb question to interject. Are the ranges such that you could even have them prepositioned in, like, southern Japan, northern Philippines, or does that not work in the same——

Mr. CLARK. Right. Oh, no, it's very feasible.

Mr. GALLAGHER. Yeah.

Mr. CLARK. You could position these in Luzon, in the Sakishima Islands of Japan, or on Taiwan itself.

Mr. GALLAGHER. Interesting.

Secretary Scharre.

Dr. SCHARRE. Yeah. So flexible money, lots of it, and the Department is going to need to have a very tightly integrated system of experimenting with these systems to figure out how do you use them effectively and then what are the upgrades you need. We see in wartime that that cycle is measured in weeks and months. We have these very quick innovation cycles.

We see it in Ukraine. We saw it effectively for the U.S. in Iraq and Afghanistan with things like counter-IED [improvised explosive device] technologies where we saw this, like, very rapid innovation where we'd see the enemy do something, our folks would be innovating in our tactics and our materiel solutions, and the Department is going to need to have structures to do that that are ready to go in—ahead of a conflict to be effective.

Mr. GALLAGHER. Any other questions?

Mr. KHANNA. That's good. It was very helpful and educational.

Mr. GALLAGHER. Yeah. Thank you very much. This was a very productive discussion. Thanks for your analysis, your expertise, and your continued work on this important issue.

And I would like to reiterate our desire and request for the Department to come testify on Replicator, ideally the Deputy Secretary, perhaps, with the head of DIU.

Mr. KHANNA. And I just echo that. You know, on the Democratic side we support that.

Mr. GALLAGHER. Great. See, we're very bipartisan and we all look forward to the Khanna administration fixing all of these problems.

Mr. KHANNA. We just need a Speaker. Gallagher [inaudible] Speaker first.

[Laughter.]

Mr. GALLAGHER. No comment. The subcommittee hearing stands adjourned.

[Whereupon, at 10:08 a.m., the subcommittee was adjourned.]

A P P E N D I X

OCTOBER 19, 2023

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

OCTOBER 19, 2023

Hudson Institute

Prepared statement by:

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Senior Fellow, Hudson Institute

Before the House Armed Services Subcommittee on Cyber, Information Technologies, and Innovation at an October 19, 2023 hearing titled "Can It Work? Outside Perspectives on DoD's Replicator Program."

October 14, 2023

Chairman Gallagher, Ranking Member Khanna, and distinguished members of the committee, thank you for the opportunity to discuss the Replicator initiative and DoD's overall efforts to field uncrewed systems. Since its announcement last month, Pentagon officials have said little about Replicator, except that it is intended to field thousands of uncrewed systems during the next two years. The initiative's main goal, according to Deputy Defense Secretary Hicks, is to provide attritable mass that can counter the geographic and capacity advantages enjoyed by China's People's Liberation Army (PLA) in potential western Pacific confrontations.[1]

There is little evidence the DoD and its industry partners can field thousands of operationally-relevant uncrewed systems in the next two years. The Pentagon's anemic procurement of uncrewed systems has generally discouraged industry from ramping up its production capacity.[2] And in those cases where privately-funded companies or traditional defense contractors have invested in manufacturing infrastructure, they have lost money or exited the sector entirely.[3]

But production capacity is not the biggest problem. Even if Replicator is successful, simply adding mass to today's US military is unlikely to improve its ability to deter or defeat China. With its proximity to likely areas of conflict, lack of global responsibilities, and ability to focus on US forces, the PLA can field targets at a lower cost and greater scale than the US military can generate successful shots on target. If it competes only in terms of mass, the DoD will find itself perpetually playing catch-up.[4]

However, there are glimmers of hope. In her discussion of Replicator, Deputy Secretary of Defense Hicks suggested the initiative is designed to exploit the creativity of US warfighters in addressing problems faced by today's operational commanders. Compared to chasing mass, this approach offers a better path to gaining advantage over the PLA and could mitigate the challenges US industry will likely face in rapidly producing thousands of militarily-relevant uncrewed systems. But unlocking Replicator's ability to deliver innovative solutions for pressing operational problems will require the DoD to integrate uncrewed systems into the mainline force rather than continuing to treat them only as surveillance systems or extensions of crewed ships and aircraft.

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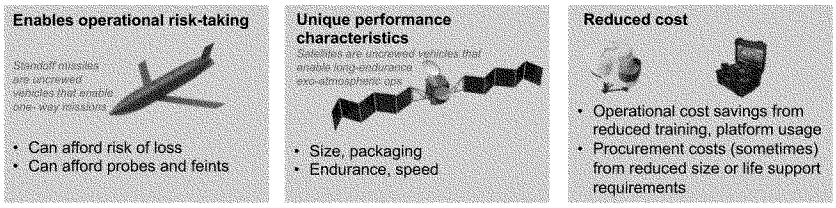
Until the twenty-first century, the DoD mainly accomplished integration by aligning doctrine and procedures because humans operated nearly all equipment. Today, automation and machine-to-machine communication between vehicles, platforms, and systems reduce the need for human operators to act as intermediaries—in most missions, increasing operator involvement is more likely to reduce performance than to improve it.

Integration, rather than long-term research and development (R&D), should therefore be the Pentagon's focus for Replicator. The DoD does not have time to develop sophisticated new uncrewed systems from scratch, nor does it need to. Existing and emerging uncrewed technologies can give US and allied militaries the edge they need against the PLA if combined with existing units and orchestrated in ways that create adaptability for friendly forces and uncertainty for the enemy.

Replicator should pursue adaptability, not mass

In prioritizing mass, Replicator seems to rely on the same uncrewed system characteristics US forces have exploited for decades, summarized in figure 1. Because they do not carry human operators, even expensive uncrewed vehicles may be lost to combat or equipment failure with little regret.[5] Without the confines of human limitations, uncrewed systems can operate in unforgiving environments or circumstances such as space. And without human operators, uncrewed vehicles can be less expensive than their manned counterparts due to fewer requirements for life support, protection, live training, or multi-mission capability.

Figure 1: System-Level Value Proposition For Pursuing Uncrewed Solutions



High-priority uncrewed systems being developed by the DoD like the Air Force's Autonomous Combat Platform (ACP) (formerly Collaborative Combat Aircraft), Army Air-Launched Effects (ALE), and Navy Large Uncrewed Surface Vessel (LUSV) are exploiting these characteristics to extend the reach and persistence of their crewed ship, aircraft, or artillery teammates.[6] Such manned-unmanned teaming (MUM-T) made sense when the US military was dominant and trying to maximize efficiencies.[7] However, this approach also tends to perpetuate the limitations of crewed systems, which operate in standardized formations for sustainment and protection and rely on well-defined doctrine and procedures that facilitate training.[8]

Binding uncrewed systems to the predictable operations of their crewed counterparts plays into

the PLA's concept of system destruction warfare, or systems warfare. Under this approach, the PLA assesses the systems of systems (SoS) US forces are likely to use in combat and their potential vulnerabilities. The PLA then develops and fields capabilities that can attack what it perceives as US weaknesses and undermine the ability of US and allied militaries to intervene on behalf of allies like Taiwan.[9] For example, the PLA fields a variety of electronic warfare systems that target key US networks and has exploited commercial and proliferated military technologies to undermine traditional US advantages in air defense, precision strike, and long-range power projection.[10]

The US military will need to be less predictable and more adaptable to gain an edge against the PLA. Replicator could help if it prioritizes operational innovation, as Secretary Hicks noted in her announcements, and seeks advantages from force employment and associated command, control, and communications (C3) capabilities instead of strictly through superior weapon, sensor, or platform technology. This, rather than mass, is the goal of the Ukrainian military in fielding uncrewed systems, whose efforts Secretary Hicks cited in her Replicator announcement. Uncrewed systems on the sea and in the air have provided Ukraine's military modes of attack and fires coordination that Russian forces have often been unable to anticipate or counter.[11]

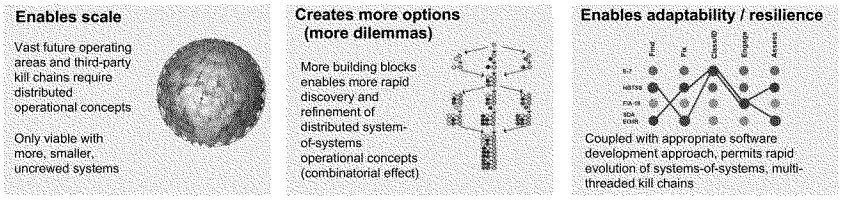
The US military is already pursuing more adaptable operational approaches that could employ systems emerging from the Replicator initiative. The Joint Warfighting Concept (JWC), Distributed Maritime Operations (DMO) concept, and Joint All-Domain Command and Control (JADC2) initiative rely on distribution; recomposable force packages; and long-range effects chains connecting sensors, commanders, and weapons or electronic warfare systems to undermine PLA systems warfare.[12] By degrading an opponent's sensing and sense-making while affording US forces more options for offensive action, these initiatives aim to increase the US military's lethality and resilience.

Budget constraints will prevent the US military from becoming more distributed and recomposable by simply growing the existing, mostly crewed, force. To surmount this obstacle, the DoD will need to expand the proportion of the force that is uncrewed while investing in the ability to identify and integrate new effects chains using AI-enabled C3 software.[13] Rather than acting as extensions of crewed units, uncrewed systems in future effects chains will need to perform as independent elements of force packages or SoS.[14]

As figure 2 summarizes, adopting an SoS approach to force employment will allow the US military to fully exploit the characteristics of uncrewed systems. Because they are less expensive compared to crewed units, uncrewed systems can enable scaling the force to increase distribution. The advent of a robust commercial robotics technology ecosystem further expands this opportunity by lowering costs and avoiding time-consuming R&D. With their scale and expendability, uncrewed systems can expand the variety of effects chains available to commanders and the dilemmas they impose on adversaries—provided forces treat them as independent players in an SoS. And because uncrewed systems can be more specialized and modular compared to crewed units that require multi-mission capability, forces can more easily

plug them into effects chains to adapt an SoS to new missions or environments.

Figure 2: Systems-Of-Systems Value Proposition For Replicator



A useful comparison is Australia, which faces similar military challenges from the PLA as the United States and is pursuing a range of uncrewed technologies, some of which are encompassed under the Australia-United Kingdom-United States (AUKUS) agreement's Pillar Two. Hudson Institute is working with the Australia Department of Defence (ADoD) to refine its efforts at fielding uncrewed systems. Because it lacks the resources of the US DoD, the ADoD has had to scope its uncrewed system development to emphasize relatively mature technologies and near-term challenges faced in its near-abroad, such as defending Australia's northern approaches from intrusion or attack. Perhaps the most innovative dimension of Australia's uncrewed system development is its equal promotion of opportunities to gain asymmetric advantage, rather than simply fill gaps in current capabilities. By using uncrewed systems to open up new concepts, the ADoD seems to exemplify the characteristics needed in the Replicator initiative.[15]

Replicator should align requirements with limits on autonomy

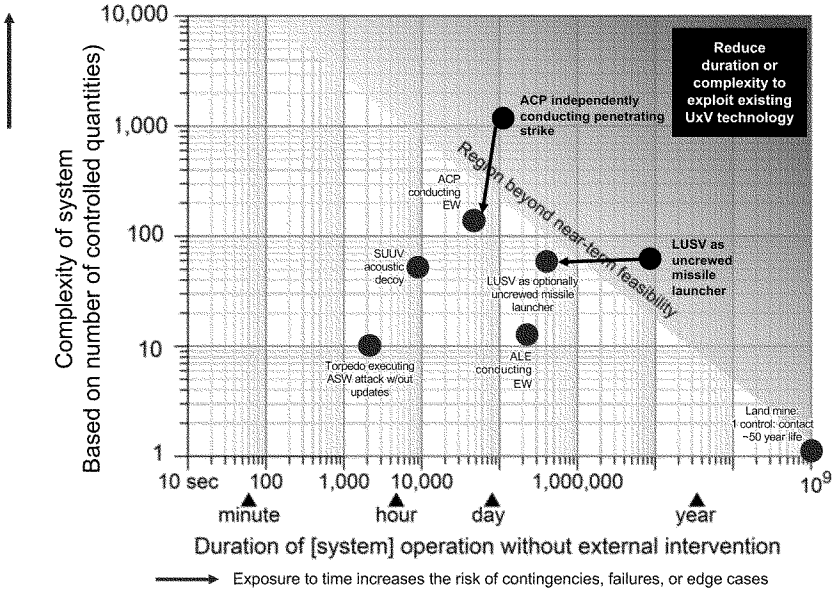
Adopting a SoS context in Replicator will also help field uncrewed systems more quickly, because together the elements of a SoS can mitigate limitations in uncrewed system autonomy, or *the degree to which a system can be self-governing or operate without outside support in executing a task or function*. A popular characterization of uncrewed systems is that they are "autonomous," but this is an overstatement because uncrewed systems depend on other force elements for essential support functions, from navigation to logistics.[16]

Crewed ships, aircraft, or ground vehicles are also limited in their autonomy, but the constraints on uncrewed system autonomy are often more severe in degree depending on the mission, operating environment, and sophistication of the unit in question, as shown in Figure 3. Some combinations of complexity and duration will be unachievable with available uncrewed vehicle technology, as indicated in the figure's upper right. Systems that need to operate in this region, including several of the DoD's high-profile uncrewed vehicle programs, drive R&D efforts that take years to culminate.

Although hardware will define the upper limit of how many variables a machine like an uncrewed vehicle seeks to control (e.g., how many control loops or similar control logic implementations are in its hardware and software), the use case dictates the number of necessary

control loops. For example, driverless automobiles that operate outside known environments require a very large number of controlled variables, and with current technology they cannot operate for long periods without operator intervention, as recent accidents suggest.[17] So for now driverless automobiles can only conduct short trips in environments like urban centers that are well mapped and where the vehicles can gather large amounts of data regarding local traffic patterns and behaviors.

Figure 3: Relationship between Vehicle Sophistication and Endurance[1]



Instead of treating the limitations on autonomy as a problem that more expensive and sophisticated platforms and systems are needed to solve, the DoD should embrace the inherent constraints on uncrewed autonomy as a necessary corollary of using already-available systems. Revising its requirements for uncrewed systems to make them achievable with today's technology—as the US Congress directed in its FY2023 appropriations—would help the DoD speed its fielding of uncrewed vehicles and associated SoS.[18] For example, as shown in Figure 3, the Air Force could lower the sophistication needed in ACPs by using them to conduct stand-in

[1] SUUV=Small uncrewed undersea vehicle; ASW: Anti-submarine warfare

electronic warfare (EW) jamming rather than expecting them to evade threats and deliver weapons into highly-contested areas. Conversely, the Navy could reduce the time its LUSV needs to operate autonomously as a missile magazine by making it an optionally-uncrewed vessel that is only automated for short periods.

Commercial developers sometimes use threshold use cases to ensure a new system can deliver a minimum viable capability for its most important application.[19] Other use cases can come later. For example, the reference use case for the initial iPhone was to provide the functionality of the iPod mp3 player, access the web, and make telephone calls.[20] Today, iPhones and other smartphones can support hundreds of different use cases.

In defining its uncrewed system reference use cases, the DoD should learn from commercial industry. In the last few years, at least ten companies attempting to develop universally applicable self-driving vehicles have failed or have been sold.[21] Meanwhile, a robust industry has flourished around driver assistance technologies, including sensing, object recognition, automated steering, and braking.[22] If self-driving cars eventually become viable from an economic and regulatory standpoint, it will be because these underlying technologies achieved scale in simpler use cases like hands-free highway driving.[23]

Replicator should leverage existing systems

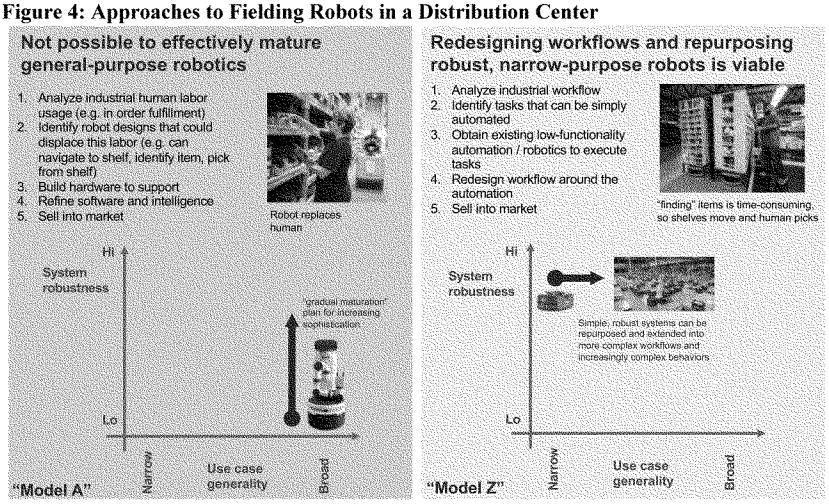
Defining threshold use cases and reconciling DoD's uncrewed system requirements with their autonomy limitations in the abstract would be cumbersome and time-consuming. Like technologists in commercial industry, Replicator could streamline it by focusing, as Secretary Hicks says, on combatant commander's operational problems. Rather than developing new uncrewed systems to address predictions of future need as directed by the DoD's requirements process, Replicator should use commander's highest priority challenges as a starting point. The Replicator process would then assess how existing and emerging systems could solve them and then prototype potential SoS solutions.

This approach has a parallel in the commercial world. Manufacturing and logistics companies began employing robots widely in the 1990s to gain a competitive advantage by improving the speed, repeatability, or cost of their processes. For example, the regional hub of a package delivery company receives packages, sorts them, and routes them to the intended recipients as efficiently as possible. Although the company can routinize the hub's workflow, it will need to accommodate changing volumes, sizes, and types of packages; respond to seasonal variability in demand; and adapt to the timing requirements of customers and suppliers.

An initiative to expand the use of robotics in a warehouse can take one of two paths, as figure 4 shows. The left side depicts the option of replacing workers with machines that mimic the roles and actions of humans. If successful, this top-down approach would develop robots that could replace workers in any task they currently conduct. In addition to enabling the incorporation of robots into existing workflows, this approach would simplify scaling of the hub's operations. However, efforts to develop versatile human-like robots have failed to produce mature, useful

systems.[24] Although researchers can integrate sufficiently capable hardware, albeit at a high cost, software that enables such systems to operate robustly has been elusive. The DoD is arguably taking this approach with its ACP and LUSV programs, which require the same endurance, speed, and ability to avoid or defeat threats as their crewed counterparts.

Figure 4: Approaches to Fielding Robots in a Distribution Center



The right side of figure 4 depicts an alternative path to introducing robots into the warehouse's workflow. In this bottom-up approach, existing robots with limited functionality, range, endurance, and sophistication perform simple tasks, and the company organizes the workflow around their capabilities. While the model on the left requires a robot to move, think, and pick up objects like a human, the model on the right demands only that robots perform tasks they can already do, like move from one location to another based on direction from a central routing management computer. In the model on the right, humans continue to conduct functions that are easy for them but are hard to enable a robot to do, like recognize and pick up various-sized objects and place them in a specific location.

Building workflows around existing technology also enables more adaptable workflows. The warehouse on the left side of figure 4 can add robots to increase production, but costs will increase linearly with productivity. In contrast, the warehouse on the right could scale by deploying additional inexpensive robotic carts and software to make each human worker more efficient; costs in that case would increase less than linearly with productivity. As new robotics or automation software becomes available, the company can decompose and reallocate tasks to

incorporate new systems and technology. This allows businesses to view automation not as a one-time efficiency improvement but as a tool to achieve continual, year-over-year advances in not only efficiency but also other metrics like resilience and adaptability.[25] However, realizing the sustained benefits of this approach requires the ability to integrate never-ending combinations of robots and information technologies into ongoing operations.

Addressing operational needs by combining existing crewed platforms and available uncrewed systems into SoS is nearly the opposite of the US military's current approach to fielding new capabilities. Today, the DoD often uses a top-down process of defining requirements based on projected future scenarios and analyses of predicted US and adversary system performance. This process could be an appropriate method of SoS development if many of the necessary systems do not exist and if there is sufficient time to develop, integrate, and field them.[26] However, neither of those conditions exists today. A wide variety of sophisticated capabilities are available from government, defense industry, or commercial providers. Meanwhile, defense officials regularly note that the US military needs to be prepared for a conflict with China within this decade.[27]

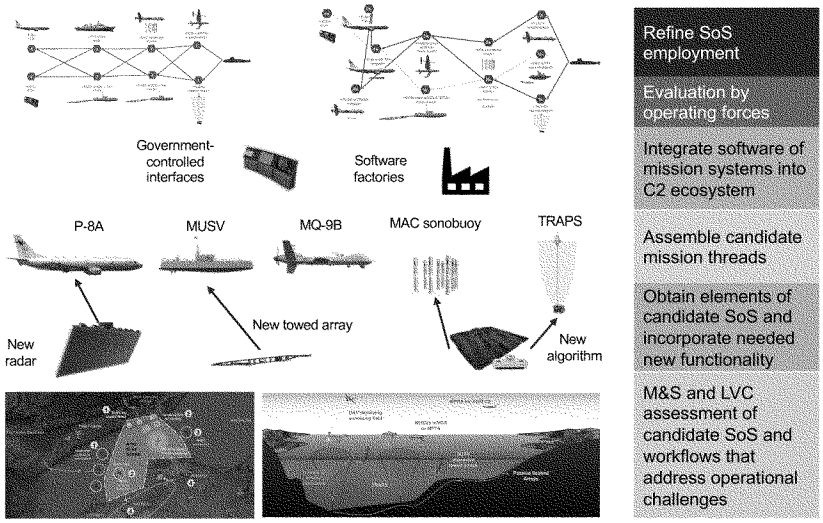
Therefore, the DoD should shift the focus of its technology development from long-term development of exquisite individual systems to *integration* of those that already exist to focus on high-priority *missions* that today's commanders have identified.[28]

Replicator should be a process for solving operational problems

Mature uncrewed systems in all domains are available but generally lack the combination of speed, functionality, range, and payload common in crewed platforms. As a result, DoD's prevailing top-down methodology would inevitably create requirements that do not align with existing uncrewed systems' specifications and lead to either a long-term R&D project or a protracted process, like the Navy's Requirements Evaluation Teams (RET), that refine requirements to align with a program's technological or fiscal constraints.[29]

A bottom-up approach of *mission integration* would be better suited for developing SoS that incorporate uncrewed systems. As in the example of a package distribution center, Replicator should be a process that composes extant systems, or slightly modified versions of them, into viable workflows to address operational problems and that evolve as new technology emerges. Figure 5 summarizes the technical aspects of this approach.

Figure 5: A Bottom-Up Mission Integration Process



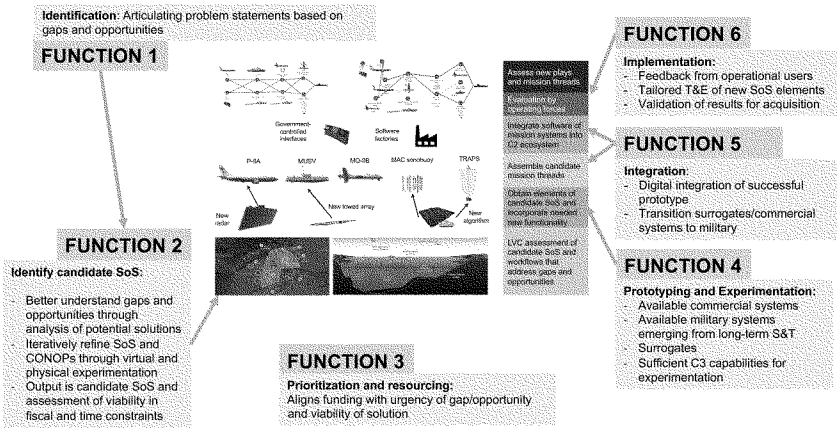
The DoD already performs the activities described in Figure 5, but focused on traditional crewed platforms and associated systems. With regard to uncrewed systems, these efforts are largely ad-hoc, uncoordinated, and lack resources.[30] Organizations or offices will need to be empowered with orchestrating the process of mission integration for Replicator to deliver uncrewed SoS in its planned timeline of less than 2 years.

In Section 904 of its FY2024 National Defense Authorization Act (NDAA) the Senate proposes a promising solution. The approach would charge Assistant Secretary of Defense for Mission Capabilities (ASD(MC)), Executive Director for Acquisition Integration and Interoperability (AI2), and DoD Chief Data and AI Officer (CDAO) with managing a process for joint integration that would tackle combatant commander operational problems.[31] This construct could be applied to support the Replicator initiative.

Building on the Senate's proposed approach, Figure 6 summarizes the functions needed to implement a mission integration process like that associated with Replicator. The process starts with **Function 1**, in which a commander such US Indo-Pacific Command (INDOPACOM) identifies a key operational problem for Replicator to address. **Function 2** assesses potential SoS solutions to commander's problems using modeling and simulation (M&S) and live, virtual, and constructive (LVC) capabilities. In addition to the analytic capabilities embedded in combatant

commanders like INDOPACOM and agencies like the Defense Advanced Research Projects Agency (DARPA) or the Strategic Capabilities Office (SCO), Replicator could draw upon analysis support from industry providers or service organizations such as Air Force Research Laboratory and Navy Surface Warfare Center. Turning to the Senate NDAA's model, ASD(MC) could lead Functions 1 and 2, since it will have insight into the kinds of uncrewed system capabilities available or emerging from DoD research efforts.

Figure 6: A Functional View of Mission Integration for Replicator



Function 3 is an activity largely missing from today's DoD uncrewed system development efforts—resourcing and orchestrating the process of integrating new capabilities into the force. The implementation of JADC2 has prompted military services to establish more deliberate integration activities, such as the Navy's Project Overmatch, but these efforts largely focus on more effectively integrating the existing force. New capabilities are introduced through lengthy testing, delivery, and training processes that would be appropriate for fielding major programs such as crewed platforms that demand substantial preparation. But these cumbersome processes are likely not necessary or appropriate for incorporating existing capabilities such as uncrewed systems that solve near-term challenges and integrate largely through machine-to-machine communication.

These are some service organizations that could take on the role of performing Function 3 to coordinate and fund the process of mission integration, such as the Air Force Rapid Capability Office, Army Rapid Capabilities and Critical Technologies Office, or the Navy's new Disruptive Capabilities Office.[32] However, there is no activity for managing the type of joint or DoD-level process Replicator would require. The construct proposed by the Senate NDAA could provide

this process.

The most promising SoS identified in the analysis of Function 2 would be assessed as prototype SoS through experiments in **Function 4**. The DoD conducts many experiments today, but they are generally not part of a sustained effort to solve pressing operational problems; are too infrequent for findings of one experiment to be evaluated in the next; lack the preparatory analysis needed for the experiment to be conclusive; or only assess new equipment, rather than the whole SoS and its associated workflow.

Replicator could provide a process that focuses DoD's uncrewed systems experimentation on operational problems and addresses the above shortfalls in its current prototype and experimentation efforts. Better conceptualizing and assessing new SoS in Function 2 would improve the likelihood experiments yield useful results. Establishing organizations and associated program managers through Function 3 to orchestrate SoS integration would provide a way to identify and obtain prospective SoS elements from organizations such as DARPA, SCO, the Defense Innovation Unit (DIU), and the services.

To assess prototype SoS, Replicator could take advantage of existing experimentation campaigns such as those under the Rapid Defense Experimentation Reserve (RDER) that are managed by the ASD(MC). To increase the tempo of experimentation, SoS to be evaluated might rely on physical and digital surrogates, sidecar computing, and workarounds that enable interoperability without modifying underlying software to show whether a particular workflow is useful and executable. For example, civilian ships or aircraft could stand-in for military platforms and developers could temporarily modify the software of a developmental multi-function RF system to test new behaviors or waveforms necessary in the new use case without making class-wide changes to those systems. The Navy is pursuing experiments like this already with US Central Command's Task Force 59 in the Persian Gulf and with the US Third Fleet's series of integrated battle problems.[33]

Perhaps the most important aspect of Replicator is digitally integrating successful prototype SoS in **Function 5** to support operational evaluations by the commanders that originated the problem to be solved. As noted above, machine-to-machine communication is increasingly central to military operations. The role of digital integration is to provide the environments, infrastructure, tools, and processes that enable development of the software necessary to connect, share data, and coordinate the elements of a SoS. In its role leading the technical aspects of JADC2, the CDAO would be an appropriate lead for the Replicator digital integration effort.

New software advancements will likely emerge faster than fixed standards can evolve to accommodate. Therefore, in contrast to prime contractor models where a single vendor provides the hardware and software for a new system, software for SoS developed through Replicator will need to come from a variety of developers within and outside the DoD. The function of digital integration will then need to treat the overall software environment as a separate product from the platforms and systems that interact with it. This will help lower barriers to entry for developers, including those outside the traditional defense industry.

For example, the Apple iOS operating system is a distinct project from the iPhone and from applications in the Apple AppStore. Apple publishes the interfaces that applications need to use within iOS and provides developmental toolkits for vendors to create applications. Companies proposing applications and peripherals for the iPhone need to prove that they can effectively and securely integrate with iOS before they gain approval for use.[34] For the government, the integration challenge is more daunting. Whereas Apple has only a dozen iPhone versions using iOS, the US military has tens of thousands of existing mission systems and crewed platforms it may need to integrate with hundreds of emerging uncrewed systems, creating a web of data engineering, radio interoperability, and security issues. The DoD's JADC2 strategy wrongly assumed that all these legacy and new systems would eventually need to integrate with one another. In contrast, the bottom-up model of Function 5 would instead integrate only those SoS that demonstrate value in solving near-term operational problems.[35]

After a new SoS succeeds in the field, the DoD will need to promptly acquire the elements not already extent in the force at sufficient scale to be operationally relevant. **Function 6** would consist of commanders assessing a prototype SoS in the field and either validating its requirements or proposing refinements. Under the Senate NDAA model, the Executive Director of AI2 could take on the task of initially procuring the SoS elements needed to field it at an operationally-relevant scale until the necessary programs can be established.

Successful mission integration will depend on iteratively evolving SoS in response to new technologies and operator feedback. Therefore, although Figure 6 implies Functions 1 through 6 happen in series, they would actually occur in parallel and interactively. For example, Function 1 of defining operational problems and initial solutions depends on uncrewed vehicles and mission systems that the DoD identifies and obtains as part of Function 4. Function 6 will provide insights back to Functions 2 and 4 regarding useful operational concepts and systems. The process of concept development in Function 2 can be informed by efforts at digital integration in Function 5, which will highlight SoS combinations that are harder or easier to create. And conversely, the use of detailed digital model-based analysis in Function 2 can make digital integration easier to perform in Function 5.

Recommendations for Replicator

The US military cannot rely on its historical dominance to deter and defeat aggression against a major power like the PRC in its own back yard. Instead, the DoD will need to use a force that is less predictable, more adaptable, and increasingly resilient to attack the PLA's strategy of system destruction warfare and its decision-making processes. By rapidly growing the variety of effects chains that are possible with US military forces without the costs associated with crewed platforms, uncrewed systems can undermine PLA planning and concepts and afford US forces the capacity to sustain a protracted conflict.

But realizing the low cost, attritability, and scale associated with uncrewed systems depends on accepting their limitations in terms of autonomy and multi-mission capability. Therefore, the DoD will need to employ them as part of SoS with other uncrewed systems and crewed

platforms. This will exacerbate the US military's long-standing struggles to combine forces between and within each service branch. The DoD should establish through Replicator a routinized processes for integrating new SoS. Otherwise, the US military services will continue treating uncrewed systems as separate from the mainline force and fail to achieve Replicator's objectives of enabling innovative solutions to commander's operational problems.

US military services are already pursuing mission integration through initiatives in concept development, experimentation, rapid acquisition, and digital integration and JADC2. However, these efforts are generally not well synchronized, focus on long-term service objectives rather than near-term operational problems, and use a top-down approach to guide requirements for future systems rather than a bottom-up process that exploits the systems and technology that are available today.

To bring uncrewed systems into the force more quickly and to realize their benefits, the DoD will need to incorporate uncrewed systems where it can best use them, instead of attempting to build uncrewed systems that extend or replace existing crewed platforms. As in a commercial distribution warehouse, the fastest and most effective way to assimilate robotics is to adjust the organization's workflow as opposed to developing robots to replace humans in existing workflows.

Implementing Replicator will require the DoD and Congress to create processes that support integration of existing and emerging uncrewed systems into the force, specifically:

1. **Formalize Replicator as a process that would conduct the six functions of mission integration to address near-term combatant commander operational problems.**

The DoD should adopt the process suggested in Section 904 of the Senate FY2024 NDAA, and empower the ASD(MC), CDAO, and Executive Director for AI2, and to lead appropriate aspects of problem definition, solution development and experimentation, resourcing, prototyping and experimentation, digital integration, and operational refinement.

2. **Establish resource sponsors for Replicator and the mission integration process.**

As part of instituting the mission integration process for Replicator, Congress and the DoD should resource ASD(MC), AI2, and CDAO to conduct their respective parts of Functions 1-6. For example, the Senate version of the FY2024 appropriations bill includes a provision to consolidate funding for CDAO in support of JADC2 that could be employed for digital integration under Replicator.

Over the longer term, The DoD should also assign funding to ASD(MC) and AI2 in broad PE lines like those used for defense-wide R&D to enable the prompt transition of promising SoS into procurement and fielding.

3. **Establish program managers in ASD(MC) and AI2 to support Replicator and mission**

integration.

The DoD should establish program managers in ASD(MC) and AI2 to contract for services and procurement or transfer funding to other government offices for analysis under Function 2, prototype development and experimentation under Function 4, and initial procurement of successful SoS elements under Function 6.

The establishment of dedicated program managers for the integration process will mark a significant cultural shift by bringing acquisition professionals into the experimentation and requirements process. However, connecting experimentation and acquisition is appropriate when available technologies are increasingly able to meet current and anticipated military needs and when more rapid introduction of new capabilities is essential to gaining an operational advantage.

4. **Expand the cadre of software program managers in CDAO to support Replicator and mission integration.**

Software is increasingly the source of military capability and advantage in new weapons, mission systems, and vehicles. Software is also the mechanism by which military forces integrate today, much as past generations integrated through doctrine and procedure. Software program managers would own government interfaces that connect vehicle, mission system, and C2 software and would oversee integration of new systems into the ecosystem. Rather than taking more software development work into the government, the establishment of software program managers would enable the government to manage and oversee software development efforts by vendors, including software factories that maintain C3 environments and gauntlets in which new system providers demonstrate their ability to digitally integrate with the ecosystem.

In an environment where dominance is no longer a given, the US military needs to return to operational innovation. Historically, US forces have excelled when given the tools and processes to improvise and be creative. Many of the pieces necessary to enable effective innovation through mission integration are already in place. Accelerating and realizing the benefits of uncrewed systems will require better orchestration and execution of these activities to solve today's operational problems. If the Navy and DoD fail to do so, they may miss their best opportunity to gain an enduring advantage against peer opponents like China.

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Bryan Clark
Senior Fellow and Director, Center for Defense Concepts and Technology
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Bryan Clark is a senior fellow and director of the Center for Defense Concepts and Technology at Hudson Institute. He is an expert in naval operations, electronic warfare, autonomous systems, military competitions, and wargaming.

From 2013 to 2019, Mr. Clark was a senior fellow at the Center for Strategic and Budgetary Assessments (CSBA) where he led studies for the DoD Office of Net Assessment, Office of the Secretary of Defense, and Defense Advanced Research Products Agency on new technologies and the future of warfare.

Prior to joining CSBA in 2013, Mr. Clark was special assistant to the chief of naval operations and director of his Commander's Action Group, where he led development of Navy strategy and implemented new initiatives in electromagnetic spectrum operations, undersea warfare, expeditionary operations, and personnel and readiness management.

Mr. Clark served in the Navy headquarters staff from 2004 to 2011, leading studies in the Assessment Division and participating in the 2006 and 2010 Quadrennial Defense Reviews. His areas of emphasis were modeling and simulation, strategic planning, and institutional reform and governance. Prior to retiring from the Navy in 2008, Mr. Clark was an enlisted and officer submariner, serving in afloat and ashore submarine operational and training assignments including tours as chief engineer and operations officer at the Navy's nuclear power training unit.

Mr. Clark is the recipient of the Department of the Navy Superior Service Medal and the Legion of Merit. He received his MS in national security studies from the National War College and BS in chemistry and philosophy from the University of Idaho.

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 House of Representatives for the 118th 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), and contracts or grants (including subcontracts and subgrants), or payments originating with a foreign government, received during the past 36 months either by the witness or by an entity represented by the witness and related to the subject matter of the hearing. Rule 11, clause 2(g)(5) also requires nongovernmental witnesses to disclose whether they are a fiduciary (including, but not limited to, a director, officer, advisor, or resident agent) of any organization or entity that has an interest in the subject matter of the hearing. As a matter of committee policy, the House Committee on Armed Services further 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 past 36 months 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 24 hours before the witness appears to the extent practicable, but 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: 10/19/2023

Hearing Subject:

Can It Work? Outside Perspectives on DOD's Replicator Program

Witness name: Bryan Clark

Position/Title: Senior Fellow

Capacity in which appearing: (check one)

● Individual ○ Representative

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

I am a senior fellow at Hudson Institute, but appearing in an individual capacity.

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 past 36 months and related to the subject matter of the hearing, please provide the following information:

2023

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
N00164-19-9-0001	Department of the Navy	$103,000.00	Joint integration and JADC2 workshops and study
FA8075-14-D-0021	Department of the Navy	$115,805.00	Sub-launched UAS wargame and study

2022

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
N00164-19-9-0001	Department of the Navy	$84,400.02	Navy unmanned system development

2021

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

2020

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

Foreign Government 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 a foreign government, received during the past 36 months and related to the subject matter of the hearing, please provide the following information:

2023

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

2022

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract, grant, or payment
N0025322P5004 (FMS Case)	Japan	$75,000.40	Cross-domain warfare study

2021

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

2020

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

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

Organization or entity	Brief description of the fiduciary relationship

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 past 36 months, please provide the following information:

2023

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant, or payment
Grant	Northrop Grumman Corporation	$25,000	Support for Center for Defense Concepts and Technology (CDCT)
Contract	Leidos	$90,000	Operations Analysis Study - Australia's Northern Approaches
Grant	Lockheed Martin Corporation	$75,000	Support for CDCT

2022

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant, or payment
Grant	General Atomics	$750,000	Support for CDCT
Grant	Boeing Company	$40,000	Support for CDCT
Grant / Contract	Northrop Grumman Corporation	$50,000 / $121,206	Support for CDCT / Japan ISR Study
Grant	L3Harris Technologies	$75,000	Support for CDCT
Grant	Lockheed Martin Corporation	$115,000	Support for CDCT

2021

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant, or payment
Grant	General Atomics	$750,000	Support for CDCT
Grant	Boeing Company	$50,000	Support for CDCT
Grant	BAE Systems	$55,480	Support for CDCT
Grant	Northrop Grumman Corporation	$50,000	Support for CDCT
Grant	Lockheed Martin Corporation	$175,000	Support for CDCT

2020

Contract/grant/ payment	Entity	Dollar value	Subject of contract, grant, or payment
Grant	General Atomics	$500,000	Support for CDCT
Grant	Lockheed Martin Corporation	$145,000	Support for CDCT
Grant	Northrop Grumman Corporation	$37,500	Support for CDCT

Statement before the House Committee on Armed Services Subcommittee on Cyber, Innovative Technologies, and Information Systems on "Can it work? Outside Perspectives on DOD's Replicator Program"

DOD's Replicator Program:

Challenges and Opportunities

Dr. William C Greenwalt
Non-Resident Senior Fellow

October 19, 2023

DOD's Replicator Initiative: Challenges and Opportunities

Chairman Gallagher, Ranking Member Khanna, and other distinguished members of the subcommittee, I would like to thank you for the opportunity to testify this morning on DOD's Replicator initiative.

On August 28, 2023, Deputy Secretary of Defense Kathleen Hicks announced a Pentagon initiative to "field attritable autonomous systems at scale of multiple thousands, in multiple domains, within the next 18-to-24 months." This is the Replicator attritable drone initiative, which may seem compelling (although perhaps lagging or reactive) given the disruptive qualities that inexpensive air, ground, and sea-based drones have already demonstrated in Nagorno-Karabakh, Ethiopia's civil war, and Ukraine. Reports of Hamas's use of drones to drop grenades on Israeli surveillance towers illustrates what terrorists can now do with the technology. For the cost of as little as a few hundred dollars, tens of millions of dollars in military capability and many lives can be put at risk. The means and economics of warfare are changing and the ability of autonomous aircraft and naval vessels to provide persistent surveillance and deliver ordnance undetected will likely be seen as a revolutionary step in military technology development.

Specific details of Replicator remain publicly elusive and indications are that it is still in its formative phase. Still, this is a good time for Congress to begin asking questions to ensure that, if DOD does embark on this effort, it is on the correct path and it can achieve its objectives. It is my hope to outline not only some of the challenges and pitfalls that await the Department, but also the opportunities and tools that it already has at its disposal to make substantial progress if it moves forward. I will predominantly focus on managerial, industrial, and business process challenges and solutions needed.

Unfortunately, the Department's culture and business practices stack the odds against the Replicator effort succeeding. Several iterations of serial prototyping of deployed capability are likely needed before a significant difference is made in the INDOPACOM theater by attritable drones and during that time senior advocates will have moved on and urgency could be lost. Supporters might argue that an initiative such as this should have already begun several decades ago and may be arriving too late. A Replicator-type program has the potential to be a significant game-changer and may well be worth pursuing, but only if it is done correctly and it does not crowd out funding for near term munitions and other critical requirements, given

rising threats and tensions.

I will first outline the stated goals of the initiative and some of the challenges facing it, and then identify the authorities and tools that will be needed to overcome these challenges.

What are the goals of Replicator? DOD's first stated goal is for Replicator drones to be attritable, or in other words, cheap enough to lose. One should be able to lose contact with a drone or have it shot down without worry – either from a cost or technology perspective. If operators have to track down and recover a downed exquisite and expensive drone in enemy territory because of a concern about the technology getting in the wrong hands, it is doubtful they will want to use the technology in the first place. Examples of that happening in Afghanistan and Iraq drive home the drawbacks of using such exquisite technology.

DOD's next goal is to produce Replicator drones in the thousands. Economies of scale are needed not only from a production standpoint but, more importantly, to overwhelm defenses. Establishing a layered defense for dozens of incoming cruise or ballistic missiles is still much easier than seeing those defenses try to address thousands of targets all at once. As an aside, counter-unmanned aerial systems (C-UAS) technologies and integrated air and missile defenses will become ever more important no matter what the US does in its offensive drone programs as adversaries learn and adopt lessons from drone warfare in Ukraine.

The Department wants to explore multi-domain solutions i.e., air, ground, sea-surface, and underwater autonomous systems. As the Congressional Research Service has pointed out, unmanned air systems can perform a variety of missions including intelligence, surveillance, and reconnaissance; close air support; cargo and resupply; communications relay, aerial refueling; air-to-air combat; strategic bombing; battle management and command and control (BMC2); suppression and destruction of enemy air defenses; and electronic warfare (EW). Similar and other additional missions can be performed using ground robots and surface and undersea autonomous systems. Any of these missions could be appropriate for Replicator.

Replicator is currently China-theater focused. In her original speech, Secretary Hicks outlined that Replicator is expressly designed to help the US overcome China's numerical advantage in ships, missiles, forces and anti-access/area denial systems. The goal is to provide a lot more targets that are expensive for China to destroy, but it could also lead to the destruction of Chinese targets either directly or serving as jammers or by providing targeting information.

The next goal is speed to capability. Secretary Hicks called for deployment of Replicator in the next 18-24 months. This timeframe should encourage off-the shelf existing technology that will likely primarily rely on commercial information systems, sensors, and software solutions.

Yet another goal of Replicator is for it to serve as an innovation playbook, or as Secretary Hicks imagines, "replicate and inculcate *how* we will achieve this goal, so we can scale what's relevant in the future again and again and again." Repeating successful business practices could be done in each of the 14 emerging technology areas that the Department has identified as critical for

its future. In autonomy, as in the vast majority of these technologies, competence and innovation reside in the commercial market rather than in the traditional defense industry.

Finally, in what may be the toughest and most daunting goal, the Deputy Secretary has outlined that "Replicator will use existing funding, existing programming lines, and existing authorities to accelerate production and delivery at scale." This would be done by pulling together already-funded programs from across the services with the goal of overcoming, in Hick's words, "the production valley of death."

Challenges: Each of the Replicator goals face significant challenges, and the issue for Congress to consider is whether any of this is realistically achievable in the short term. It could be…. but the odds may well be stacked against this initiative becoming anything more than a buzzword or a new lightning bolt on a Joint Staff PowerPoint briefing chart.

The first set of challenges revolve around DOD's culture. DOD's culture and the management systems that derive from that culture are stuck in a 1960s paradigm that has consistently rejected new approaches and commercial technology that does not conform to DOD's engrained thinking. Just as was the case in the Soviet Union, centrally-planned, linear, predictive processes and mindsets continue to destroy innovation and creativity. These processes originally took root at DOD under former Secretary of Defense McNamara and have had over 60 years to engrain themselves in culture.

The greater defense innovation problem is multi-faceted. First, there is no sense of urgency. Defense management systems were first created to conform to the ideology of predictive systems analysis and then optimized for a peacetime cadence after 30 years without a great power competition or conflict. It took years to get to this point and without focused leadership it will be difficult to adjust to a different set of circumstances. Process compliance is the most valued objective in the acquisition and budgeting system, rather than time. Time to operational capability as described in the report "Competing in Time" that I wrote with Dan Patt has been the primary historical forcing function for disruptive innovation, and yet it is little valued in DOD. Replicator needs to be a time-based approach and thus will be a threat to the traditional acquisition and budgeting bureaucracies' approach.

Budget inflexibility in year of execution and long lead times to allocate resources are at the root cause of DOD's declining competitiveness and innovation failures (especially in the many versions of the Valley of Death that Secretary Hicks is attempting to address with Replicator). The predictive and lumbering military-controlled requirements process forecloses innovation opportunities from the start as it is the gateway to the acquisition and budgeting system. Operational interests are not aligned or supported within the acquisition and budgeting systems – both at the combatant command and service component command levels. Replicator will need both agile budgeting and constant operator feedback or it will fail.

The defense contracting system has become more of an enforcer of rules than an enabler of capability. Unique non-market rules keep out non-traditional and commercial companies and

solutions and drive-up costs. These are the exact companies that are needed to make Replicator a reality, but they find the defense contracting system a morass filled with excess overhead and financial disincentives. There has been a constant undermining by the contracting community of the authorities designed to attract non-traditional commercial contractors such as commercial item contracting and Other Transaction Authority (OTA) that Congress has given the Department. Finally, the authority and ability of program officials to do their jobs has been limited by adversarial oversight. Testing, technology, and auditing bureaucracies double down on time-consuming "gotcha" check the box oversight rather than provide cooperative insights and proactive value add.

The result of these problems manifests itself in the extensive time it takes to solve them. The system is based on a planned linearity so everything is a step-by-step predictive process that takes decades to deploy anything of substance. This is diametrically opposed to what happens in the commercial market which is the main reason why the commercial market and its time-based development culture is now leading in most of the technologies the DOD will need in the future. By contrast, in the traditional defense acquisition system, it normally takes many years for a technology to be considered mature and then 2-3 years for a requirement to use such a technology to make its way through the Joint Capabilities Integration and Development System (JCIDS) process. Then such an effort can enter the Planning, Programming, Budgeting, and Execution (PPBE) process and take another 3 years to work its way through the overarching budget process to be included in a defense appropriations bill. Once those appropriations are released, a full and open competition can take almost 2 years to select an industry partner to get on contract to obligate the money to start the program. Industry will start the process to tool up only once they have the money, then spending 18-24 months to build a production line. Typically, it takes 5 years after obtaining funds to produce something incrementally different than before and 10-20 years for something that is still in development. The enormity of the obstacles that a time driven program such as Replicator faces within the DOD acquisition system is daunting.

DOD's culture and processes have also impacted its historical approach to autonomy and commercial development practices. The not-invented or predicted here syndrome has precluded the adoption of commercial and outside innovation for decades. The US was the original leader in unmanned systems almost by accident beginning with Abe Karem's Amber in the 1980s and the Gnat that eventually became the Predator in the 1990s. Karem's capability was developed with DARPA support in a garage and outside of the DOD acquisition process. The pushback on adoption of this technology was a leading indicator that something was seriously wrong with DOD's innovation system over 30 years ago. The lack of follow on support for drones by DOD eventually bankrupted Karem's company and led to the selling of his Predator technology to General Atomics. The Predator experience is one of those innovation case studies that Congress should spend time exploring as it is highly relevant to not only Replicator but all future innovation efforts led by small entrepreneurial companies. The takeaway is that historically for DOD, autonomy is nice as long as it doesn't disrupt or replace anything the Department is currently invested in.

Congress has been for decades (starting with former SASC Chairman John Warner) disappointed by DOD's lack of support for autonomous systems and even set a goal in the 2001 NDAA "for the Armed Forces to achieve the fielding of unmanned, remotely controlled technology such that— (1) by 2010, one-third of the aircraft in the operational deep strike force aircraft fleet are unmanned; and (2) by 2015, one-third of the operational ground combat vehicles are unmanned." That none of that ever happened and Karem's and many others' subsequent ideas for more advanced autonomous systems were never pursued is a testimony to DOD's entrenched culture. If DOD would have listened more to Congress, we would likely be much farther along than we are in this technology and the US would have an overwhelming lead rather than be reacting to new technological advancements.

The lesson from past innovation efforts for the Replicator program is that if it is not taken outside of the acquisition/budget bureaucracy and rules it will undoubtedly fail. The outside innovation entities and hubs in Special Operations Command, the service WERXs, the relevant combatant commands, DIU, and CDAO do not have the authority or budget to do what is needed to do at scale. Giving the acquisition chain, any route is likely problematic as the Pentagon's acquisition system is simply not capable of acting on the proposed timelines contemplated in the Replicator program except in very limited circumstances and then only when conducted outside the normal rules of acquisition and budgeting.

The budget issue is more than just process time and inflexibility as it has also become a zero-sum game. An important question for Congress is whether this initiative will stall or rob other programs that are vitally needed in preparing to deter a fight against China or other adversaries. The announcement that this will be done under existing budgets and authorities appears to require Congress to suspend belief that preparing for any potential war with China will be cost-free. More ships, munitions, space and surveillance assets are already needed in the INDOPACOM theater and those programs cannot become bill-payers for the pursuit of a future technology that may or may not work as intended. More resources are vitally needed to fund multiyear procurements of munitions. We have run out of time with regards to China and first need to produce at scale what we already have developed but don't have enough of.

The need to fund Replicator through existing funds instill some contrary incentives via the PPBE budget process. Rather than focus on new efforts that are achievable within an 18- 24-month time-frame (two of which have already gone by since the announcement of the program) the services may not be able to help themselves as they try to include in Replicator their own version of complex technologies they would like to develop but are not yet ready for near term production and deployment. Even worse, the services may hold back existing near-term efforts that are ready for production for fear of "not making the cut" and see their program become the bill payer for something else. The machinations in the competition for budget resources could doom the effort from the start.

On the industrial base side there are other causes for concern. The US defense industrial base is a microcosm of DOD and optimized for a peacetime cadence. The barriers to civil-military integration of the industrial base have continued to widen as DOD prefers to dictate solutions

to defense-unique monopoly providers rather than incentivize commercial innovation. Replicator needs the commercial base and greater civil-military integration but barriers to bringing that base into the DOD acquisition system remain.

There are also concerns that the US currently does not have the production capacity needed to produce Replicator's thousands of drones, specifically those most relevant to the Indo-Pacific's geography. Production capability is a key component to innovation and has been allowed to deteriorate both in the traditional defense and commercial industrial bases. DOD ignored the implications of the last two decades of commercial globalization and production outsourcing to China that has hollowed out the US industrial base. Just in time efficiency requirements and barely minimal sustainable production rates have also destroyed defense specific industrial capabilities and undermined military readiness.

When the autonomous system supply chain is analyzed as RAND recently did, we will continue to find that many parts required for Replicator are not in the US or allied supply chain. A more advanced commercial UAS base could have been relied upon but as RAND suggests that did not happen because of the impact of FAA policies that have limited the advancement of the US commercial drone industry. It is perhaps ironic that we may want to explore through the Defense Production Act or other authorities the need to secretly buy foreign parts necessary for Replicator drones. Otherwise, we may end up reliant on brokers with extremely high markups for parts to meet future demands.

Another continuing challenge for the industrial base will be the lack of information and demand signals coming from DOD about Replicator and drone programs in general. The lack of information on which drones are being selected could make it more difficult for industry to know where investments must be made ahead of time to scale production (and as a result, meet the initiative's aggressive timeline of 18-24 months). The Pentagon may well intentionally not provide many specifics on the drones being considered for the initiative so as to not tip off China but in doing so may further compresses the timeline for making Replicator a reality. Industry needs a demand signal and most importantly contracts before it will invest in new plants, equipment, workforce, and parts.

Another challenging area of inquiry for Congress is why the Chinese and the Turks have been able to dominate the export market for these capabilities. In addition to FAA's limited approvals for testing and the usage of unmanned systems in federal airspace one need look no further than the US State Department. State's interpretation of the requirements of the Missile Technology Control Regime (MTCR) has held back the ability to export drones from the US but also inflicted ITAR requirements on many future capabilities. It has also inhibited cooperation with our allies and lagging US investment. Security and technology control policies such as ITAR have been built around an era of US defense technological dominance that has long passed and now serve as barriers to innovation. Both commercial companies and allied cooperation will be needed to compete against China but outdated thinking and processes will hinder such cooperation. The degree that our allies are now pursuing their own ITAR-free air and undersea drone programs without US participation to include our closest AUKUS allies is a growing

concern.

Pathways to Success: The first step to a successful Replicator program is establishing a sense of urgency combined with a time-based innovation and acquisition strategy. This is what Secretary Hicks appears to be proposing. This approach needs to be executed from the top down but only in the sense that senior managers need to remove the barriers to those entrepreneurial and disruptive parts of the Department so they can be empowered to act. The naysayers need to be sidelined for the moment to allow for new capability to be produced quickly and be tested and used by the operators in the field.

The Department needs to establish and maintain a clear understanding of what it is creating. Replicator should not be a linear or predicable Major Defense Acquisition Program (MDAP) program or even a series of such programs. It should be an agile process that deploys capability quickly and at scale in such numbers that make China's calculations so difficult that they will not take aggressive action. To succeed, it will be necessary to restore many of the attributes of the time-based acquisition system from the 1950s. This approach has been used successfully on stealth programs in the 1970s, arguably in the B-21 bomber, in rapid acquisitions such as the MRAP and counter-IED systems that supported operations in Iraq and Afghanistan, in the development by NASA of SpaceX's Falcon 9, and most recently, with the COVID vaccine.

Replicator will require the adoption of agile acquisition and budgeting practices and the leveraging of commercial technology and companies that do not traditionally do business with the Department of Defense. This is an initiative that could have begun almost 10 years ago when the Pentagon was given new acquisition authorities by this Committee in the aftermath of the annexation of Crimea and the initial buildup of illegal Chinese military bases in the South China Sea. Understanding the history of the under-execution of these authorities is helpful in understanding why the Pentagon has been impervious to change and is falling behind its adversaries.

HASC and SASC in the 2016 and 2017 NDAAs tried to create pathways to replicate the more agile time-based system of the past. These pathways began with flexible funding lines, OTA, Commercial Solutions Opening (CSO), and improved FAR Part 12 commercial contracting authorities, an updated Rapid Acquisition Authority (RAA) and a new Middle Tier Acquisition (MTA) authority to bypass the requirements and traditional acquisition system. The results to date have been marginal at best as these authorities have been undermined by the reimposition of old processes (particularly within the OTA and MTA authorities), the inability to achieve greater flexible funding that have been stymied at the DOD Comptroller, OMB, and appropriations committees. Without the use of flexible budgeting and acquisition authorities Replicator cannot happen on 18–24-month timeframes even before we consider the problems with the industrial base.

Is it hopeless? No but this is what would need to happen.

Program decision time measured from requirement generation, obtaining funds and getting on contract has to comprise just a few months rather than the up to 8 years as under the current system. This will first require some type of initial flexible funding. Reprogramming existing funds is probably not practical for this effort given the timelines for Congressional approval, although some smaller efforts could be kickstarted through below threshold reprogramming. The one current authority DOD could consider using would be Rapid Acquisition Authority (RAA) which allows for rapid reprogramming of funds up to $800 million in various categories with a subsequent notification to Congress. This authority has been successfully used since the aftermath of 9/11 and was enhanced on the 2016 and 2017 NDAAs.

If modifications to an MDAP are needed for such platforms as the P-8 and C-130s to deliver drones at scale, DOD and Congress should consider using the Defense Modernization Account (DMA) (10 U.S.C. 3136). This authority would allow for up to $1 billion in expiring funds to be used for such purposes once approved by the configuration steering board of the program. Unfortunately, this authority has never been used as the DOD Comptroller refuses to execute it. The DMA is very similar budgetary authority to that which Chairman Gallagher has proposed in his FIRES Act. To the degree Replicator drones become munitions, FIRES Act authority could also be used if Congress were to adopt it. The FIRES Act is exactly the kind of budget authority that needs to be established if Congress and the DOD are really serious about meeting the threat from China.

To get on contract quickly, DOD should primarily use OTAs either through the CSO, the OTA consortium model, a direct OTA, or a newly configured OTA arrangement specifically designed for Replicator. Any such OTA should allow for an initial but time-limited competitive prototyping phase of just a few months so a follow-on production OTA could be awarded and executed in time. For any traditional contracts, Undefinitized Contracting Actions (UCAs) and sole source Competition in Contracting Act (CICA) waivers would need to be considered.

Ultimately, multiple programs and solutions and a rhythm of new capabilities should be created. Next generation Phase II and III Replicator programs could be established as MTAs to begin delivering operational prototypes to be tested in 3–5-year time frames so as to be ready for a subsequent ramp up to an 18–24-month production when needed.

Operational feedback is essential for this program to be successful. At the end of the day most of these capabilities would primarily be software driven. Iterative serial prototyping with adaptable, agile software modifications need to be a pillar of the program. Ultimately, these systems need to be able to be updated as fast as an iPhone or what was reported with the commercial Starlink system when it was jammed by the Russians in Ukraine. The Subcommittee may want to review the progress of the Autonomy Prime effort in AFWERX as well as other efforts both in DOD and the commercial market designed to achieve a continuous software updating system.

In addition, DOD and Congress should establish a different measure of success for these systems than for a traditional MDAP. Oversight criteria is a key driver of behavior and

innovation. Unfortunately, the traditional Director of Operational Test and Evaluation (DOTE) oversight criteria of operational suitability and effectiveness determined by a group within an outside testing bureaucracy is not the right criterion for the types of systems being contemplated in Replicator. Operational usefulness or having the operators themselves evaluate the usefulness of these systems over what they previously had may be more appropriate. The key takeaway for the commercial world is that software is never done so there is no final rigid operational program to test. Testing needs to be continuous and it is going to be the operators who need to drive the necessary software changes to ensure that these systems not only continue to perform but continue to improve. Software has been "eating the world" (in the words of Marc Andressen) for the last few decades and driving changes throughout the commercial market. DOD has been impervious to this trend and the old rigid DOT&E testing model will not work with software. It is long past time to adopt software commercial practices, technology, and testing approaches. If this is done on Replicator, it truly could offer a playbook that could be applied to many other future systems and technologies.

Conclusion: The objectives of Replicator can be achieved. It will take money, a culture change, and a leveraging of existing acquisition authorities. A bespoke industrial base can be built up to support the program but that will take time and DOD will likely continue to be dependent on fragile supply chains. Anything broader will take a whole of government approach like the US is taking with semiconductors and funding authorities comparable to those in the CHIPS Act to build a commercial industry that could support a US or allied- controlled supply chain.

Thank you again for the opportunity to testify on this important topic and thank you for your many years of service and support for our warfighters and national security. I welcome any questions you may have.

William "Bill" Greenwalt
Nonresident Senior Fellow
American Enterprise Institute

William C. Greenwalt is a nonresident senior fellow at the American Enterprise Institute (AEI), where he focuses on the expansion of America's defense industrial base and defense management issues. Issues include technology-transfer reform, defense acquisition and procurement reform, technology policy and innovation, and the civil-military integration of US and allied commercial and defense industrial bases. Dr. Greenwalt is also a founder of the Silicon Valley Defense Group.

Before rejoining AEI, Dr. Greenwalt served in senior positions at the Department of Defense, in Congress, and in the defense industry. As deputy under secretary of defense for industrial policy, he advised the under secretary of defense for acquisition, technology, and logistics on all matters relating to the defense industrial base. In Congress, he served as a senior staff member for the Senate Armed Service Committee, the Senate Governmental Affairs Committee, and the House Appropriations Committee. In the private sector, Dr. Greenwalt worked for Lockheed Martin and the Aerospace Industries Association.

Dr. Greenwalt has a BA in economics and political science from California State University, Long Beach, an MA in international relations and defense and security studies from the University of Southern California, and a PhD in public policy from the University of Maryland.

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Hearing Date: 10/19/2023

Hearing Subject:

Can It Work? Outside Perspectives on DOD's Replicator Program

Witness name: William Greenwalt

Position/Title: Nonresident Senior Fellow

Capacity in which appearing: (check one)

● Individual ○ Representative

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2023

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
None			

2022

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
None			

2021

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
None			

2020

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
None			

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2023

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract, grant, or payment
None			

2022

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract, grant, or payment
None			

2021

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract, grant, or payment
None			

2020

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract, grant, or payment
None			

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

Organization or entity	Brief description of the fiduciary relationship
None	

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 past 36 months, please provide the following information:

2023

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

2022

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

2021

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

2020

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

Center for a
New American
Security

OCTOBER 19, 2023

TESTIMONY BEFORE THE HOUSE COMMITTEE ON ARMED SERVICES SUBCOMMITTEE ON CYBER, INFORMATION TECHNOLOGIES, AND INNOVATION

Can It Work? Outside Perspectives on DOD's Replicator Program

Obstacles and Opportunities for Transformative Change

BY

Paul Scharre

Executive Vice President and Director of Studies
Center for a New American Security

I. The Opportunity of Attritable, Autonomous Systems

Chairman Gallagher, Ranking Member Khanna, thank you for the opportunity to testify today.

The Defense Department's Replicator initiative has a bold agenda: to field thousands of attritable, autonomous systems in 18 to 24 months.

This effort is not only valuable, it is necessary if the U.S. military is to reverse its decades-long death spiral of rising costs and shrinking quantities for major weapons platforms.

If the U.S. military is to deter and, if necessary, defeat the People's Republic of China in a military conflict in the western Pacific, the United States will need large numbers of low-cost attritable systems to generate the mass necessary to prevail in a conflict.

For decades, the U.S. military has seen rising per-unit costs for its ships and aircraft. These rising costs have forced tradeoffs in quantity, and the result has been a shrinking force. U.S. military assets are individually capable but are in insufficient number for the scale of a conflict against China.

We have seen in Ukraine the scale of violence and casualties that are possible in an interstate war and the possibility that such a war could drag on for months or even years. To give a sense of scale, the level of casualties that both sides have seen in Ukraine would render the U.S. Army combat ineffective in a matter of months.

The U.S. military will need a range of platforms, including expensive capital assets such as aircraft carriers and stealth bombers, but it also will need complementary low-cost uncrewed systems to bring greater mass. We have seen in Ukraine the value of such an approach.

Both Russia and Ukraine have fielded large numbers of low-cost drones, flooding the skies with sensors to find and track enemy ground targets. These drones have not replaced the role of infantry and artillery, but they have changed the dynamic on the ground. Troops must take greater efforts to conceal themselves from aerial drones, which can be used as spotters for artillery strikes. Forthcoming analysis by my CNAS colleague Dr. Stacie Pettyjohn has assessed that this persistent surveillance has hindered both sides' ability to mass forces for surprise attacks.

Moreover, the low cost of these systems enables their replenishment, even if individual systems are not survivable. According to analysis by Jack Watling and Nick Reynolds of the Royal United Services Institute, Ukraine is losing 10,000 drones a month.[1] Yet it is able to reconstitute those forces by using cheap, commercially available drones. Russia has been able to produce extremely inexpensive military drones, saturating the skies above Ukrainian forces. At around $100,000 apiece, the Russian Orlan-10 is so inexpensive that Ukrainian defenders don't bother to shoot it down, since doing so would require expending scarce medium-range surface-to-air missiles and Russia has deep reserves of drones.[2]

This is a way of fighting that the U.S. military does not have in its current force. But it is part of U.S. history. In World War II, at the height of production, Allied factories were producing over 3.5 times as many tanks and airplanes as the Axis powers.[3] Today, the war in Ukraine has strained the defense industrial base's capacity for munitions production.[4] For the United States to be ready for a conflict with China, it must be able to produce forces at greater speed and scale than it has done to-date.

II. Obstacles to Success

Replicator is a test of the Defense Department's ability to generate the types of systems it needs, in the quantity it needs them, and at the speed required to deter China. The Pentagon's bureaucracy is likely to face challenges along all three of these dimensions.

Low-cost attritable platforms and autonomous systems are both paradigm-busting concepts inside the Department of Defense. These concepts have supporters, including the Department's current leadership, but they challenge the Pentagon's traditional ways of doing business. Keeping an acquisition system low-cost – which is essential if the platforms are to be procured in sufficient quantities – will be especially challenging, since the default instinct of the DoD's acquisition system is to add requirements and increase survivability, which will raise costs and threaten the success of such an effort.

Even if DoD can be disciplined about system requirements, it will be challenged to move at the speed that is required. Many military and intelligence officials have warned about the pressing danger of Chinese military aggression against Taiwan. Even if DoD succeeds in its goal of fielding thousands of systems in 18 to 24 months, by then at best it will be 2025. The clock is ticking. Replicator is an important step, but it is one the DoD should have taken a decade ago. Speed is now essential. One of the clear lessons from the wars in Iraq and Afghanistan is that the military bureaucracy can move quickly when needed to rapidly field capabilities. DoD did so with a host of essential capabilities for the war: intelligence, surveillance, and reconnaissance aircraft; counter-improvised explosive device technologies; and mine-resistant ambush protected vehicles. Yet each case required direct intervention by the Secretary of Defense to circumvent traditional requirements and acquisition processes that were too slow and not focused on urgent needs. Similar senior-level attention by Department leaders will be required for Replicator to succeed, along with Congressional support.

The DoD has had recent successes in breaking the mold and moving quickly. The Defense Innovation Unit in particular has brought in commercial technologies in a matter of weeks and months, not years and decades. But too often these innovation success stories have been small-scale, bespoke solutions to one-off problems. To field thousands of systems, DoD will need to operate quickly at scale, something it has often struggled to do. When DoD has attempted to scale solutions, it has often run into obstacles, including outside the Department. The $10 billion JEDI cloud computing contract was mired in protests and lawsuits that wasted three and a half years and ultimately led DoD to scrap the contract. Obstacles to change exist not just inside the Department but also in the broader defense ecosystem, including contracting rules that incentivize companies to take a scorched earth approach when they don't win contracts.

III. A Catalyst for Change

Replicator is essential not just because of the capabilities it aims to field, but because of the path it is blazing through the morass of institutional red tape. Speed and scale of acquisition and new warfighting paradigms will be needed not just for autonomous systems but across the force if DoD is to transform itself rapidly to counter a rising China. If successful, Replicator can train the institutional muscle memory needed inside the defense establishment – not just in the Pentagon but in industry as well – to move quickly, experiment with new concepts, and scale production.

Is it possible? The United States mobilized for and fought the entirety of World War II in six years.[5] Today, the average time from program start to initial operational capability for major defense acquisition programs is 11 years.[6] The United States can move faster when the moment demands it. Nor are these episodes confined to our distant past. With government support, U.S. industry rapidly scaled vaccine production during COVID to produce over 100 million vaccines per month by the end of 2021.[7]

Despite repeated warnings from intelligence and military leaders, the U.S. defense establishment is not on a war footing today. Replicator is a chance to change that dynamic, and Congressional support will be essential for this vital effort to succeed.

Thank you.

Appendix A: Additional Reading

Lauren Kahn, "Scaling the Future: How Replicator Aims to Fast-Track U.S. Defense Capabilities," War on the Rocks, September 20, 2023, https://warontherocks.com/2023/09/scaling-the-future-how-replicator-aims-to-fast-track-u-s-defense-capabilities/.

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Paul Scharre, "Robotics on the Battlefield Part II: The Coming Swarm," (Center for a New American Security, October 2014), https://s3.us-east-1.amazonaws.com/files.cnas.org/hero/documents/CNAS_TheComingSwarm_Scharre.pdf.

Appendix B: Curriculum Vitae

Paul Scharre is the Executive Vice President and Director of Studies at CNAS. He is the award-winning author of *Four Battlegrounds: Power in the Age of Artificial Intelligence.* His first book, *Army of None: Autonomous Weapons and the Future of War*, won the 2019 Colby Award, was named one of Bill Gates' top five books of 2018, and was named by *The Economist* one of the top five books to understand modern warfare. TIME magazine named him in 2023 as one of the "100 most influential people in AI."

Scharre previously worked in the Office of the Secretary of Defense (OSD) where he played a leading role in establishing policies on unmanned and autonomous systems and emerging weapons technologies. He led the Department of Defense (DoD) working group that drafted DoD Directive 3000.09, establishing the department's policies on autonomy in weapon systems. He also led DoD efforts to establish policies on intelligence, surveillance, and reconnaissance programs and directed energy technologies. Scharre was involved in the drafting of policy guidance in the 2012 Defense Strategic Guidance, 2010 Quadrennial Defense Review, and secretary-level planning guidance.

Prior to joining OSD, Scharre served as a special operations reconnaissance team leader in the Army's 3rd Ranger Battalion and completed multiple tours to Iraq and Afghanistan. He is a graduate of the Army's Airborne, Ranger, and Sniper Schools and Honor Graduate of the 75th Ranger Regiment's Ranger Indoctrination Program.

Scharre has published articles in *The New York Times, The Wall Street Journal,* CNN, *TIME, Foreign Policy, Foreign Affairs, Politico,* and *USA Today,* and has appeared on CNN, MSNBC, Fox News, NPR, and the BBC. He has testified before the House and Senate Armed Services Committees and has presented at the United Nations, NATO, the Pentagon, the CIA, and other national security venues. He holds a PhD in war studies from King's College London and an M.A. in political economy and public policy and a B.S. in physics from Washington University in St. Louis.

Appendix C: CNAS Independence Policy

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Endnotes

[1] Jack Watling and Nick Reynolds, "Meatgrinder: Russian Tactics in the Second Year of Its Invasion of Ukraine," (Royal United Services Institute for Defense and Security Studies, May 19, 2023), 18, https://static.rusi.org/403-SR-Russian-Tactics-web-final.pdf.

[2] Konrad Muzyka, Konrad Skorupa, and Ireneusz Kulesza, "Rochan's Report: Ukraine Counteroffensive Initial Assessment (June-August 2023)," Rochan Consulting, September 2023, 77, https://rochan-consulting.com/wp-content/uploads/2023/09/Ukraines_counteroffensive_initial_assessment_SEP23.pdf.

[3] Paul Kennedy, *The Rise and Fall of the Great Powers: Economic Change and Military Conflict from 1500 to 2000*, January 15, 1989, 353-355.

[4] Stacie Pettyjohn and Hannah Dennis, "Precision and Posture: Defense Spending Trends and the FY23 Budget Request," (Center for a New American Security, November 2023), https://s3.us-east-1.amazonaws.com/files.cnas.org/documents/Budget2022_Final.pdf; Stacie Pettyjohn and Hannah Dennis, "Production is Deterrence: Investing in Precision-Guided Weapons to Meet Peer Challengers," (Center for a New American Security, June 2023), https://s3.us-east-1.amazonaws.com/files.cnas.org/documents/Budget2024_Final.pdf.

[5] Thomas Morgan, "The Industrial Mobilization of World War II," *Army History*, 1994, 31-35, https://www.jstor.org/stable/26304207?typeAccessWorkflow=login.

[6] U.S. Government Accountability Office, *Weapons Systems Annual Assessment: Programs Are Not Consistently Implementing Practices That Can Help Accelerate Acquisition, June 2023, 28*, https://www.gao.gov/assets/gao-23-106059.pdf.

[7] Chad Bown, "The U.S. Was Quick to Produce COVID-19 Vaccines. Then it Fell Behind," (Peterson Institute for International Economics, June 21, 2022), https://www.piie.com/blogs/realtime-economic-issues-watch/us-was-quick-produce-covid-19-vaccines-then-it-fell-behind.

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 House of Representatives for the 118th 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), and contracts or grants (including subcontracts and subgrants), or payments originating with a foreign government, received during the past 36 months either by the witness or by an entity represented by the witness and related to the subject matter of the hearing. Rule 11, clause 2(g)(5) also requires nongovernmental witnesses to disclose whether they are a fiduciary (including, but not limited to, a director, officer, advisor, or resident agent) of any organization or entity that has an interest in the subject matter of the hearing. As a matter of committee policy, the House Committee on Armed Services further 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 past 36 months 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 24 hours before the witness appears to the extent practicable, but 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: 10/19/2023

Hearing Subject:

Can It Work? Outside Perspectives on DOD's Replicator Program

Witness name: Paul Scharre

Position/Title: Executive Vice President and Director of Studies, CNAS

Capacity in which appearing: (check one)

● Individual ○ Representative

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

N/A

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 past 36 months and related to the subject matter of the hearing, please provide the following information:

2023

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
HDTRA1-23-C-0037	DoD, DTRA	$261,790.43	Escalation Management in F

2022

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
HDTRA1-22-P-0024	DoD, DTRA	$186,012	Escalation Management in a
HQ0034-21-P-0092 (	DoD, OSD, ONA	$204,728	Wargaming Information in th
HQ0034-21-P-0091 (	DoD, OSD, ONA	$174,286	China's Anti-Access Strateg

2021

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
FA7146-21-C-B015	USAF, SAF/CDM, OCE	$706,874	Developing a National Indus
HQ0034-21-P-0092 (	DoD, OSD, ONA	$323,085	Wargaming Information in th
HQ0034-21-P-0091 (	DoD,OSD, ONA	$139,153	China's Anti-Access Strateg

2020

Federal grant/ contract	Federal agency	Dollar value	Subject of contract or grant
FA7146-20-P-0921	USAF, SAF/CDM, OCE	$784,468	Developing a U.S. National T

Foreign Government 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 a foreign government, received during the past 36 months and related to the subject matter of the hearing, please provide the following information:

2023

Foreign contract/ payment	Foreign government	Dollar value	Subject of contract, grant, or payment
Partnership Agreeme	ROK, Ministry of Foreig	$150,000	Artificial Intelligence & Emer

2022

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

2021

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

2020

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

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

Organization or entity	Brief description of the fiduciary relationship
N/A	N/A

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 past 36 months, please provide the following information:

2023

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

2022

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

2021

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

2020

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

DOCUMENTS SUBMITTED FOR THE RECORD

OCTOBER 19, 2023

October 17, 2023

Chairman Mike Gallagher
Ranking Member Ro Khanna
Committee on Armed Services
Subcommittee on Cyber, Information Technologies, and Innovation
United States House of Representatives

RE: Hearing: "Can it Work? Outside Perspectives on DOD's Replicator Program"

Chairman Gallagher and Ranking Member Khanna,

As an organization that represents the uncrewed systems and autonomy industry, and the defense industrial base, the Association for Uncrewed Vehicle Systems International (AUVSI) welcomes the opportunity to provide written testimony in advance of the Subcommittee's hearing on the Department of Defense's Replicator Program.

First, to answer the question the hearing title asks, "Can it Work?" Yes, the Department of Defense's (DoD) Replicator Program can work, and in fact must succeed. We are confident that it will work if DoD properly taps into the significant subject matter expertise AUVSI and our members have and takes feedback from industry on how to ensure the program keeps up with their technological pace.

AUVSI strongly supports the announced goals of Replicator to overcome acquisition challenges and swiftly field capable, advanced autonomy tools. We know that the program can succeed; however, to accomplish the goal of rapidly integrating many thousands of uncrewed and autonomous systems in support of the warfighter in the next 18-24 months, and then sustain and grow those supply lines, much work must be done to support the domestic manufacturing base. We have attached our recently released white paper from our Partnership for Drone Competitiveness effort (Appendix A), which is a coalition of drone manufacturers and component suppliers urging the federal government to adopt policies to level the playing field against subsidized foreign competition, largely from the People's Republic of China. Our effort also urges the federal government to take immediate, resolute action and invest in our domestic drone manufacturing industry to help level the playing field. The national security and economic challenges articulated in the paper, and the policy solutions we advocate for, are focused on the Uncrewed Aerial Systems (UAS) industry; however, they are not unique to the aerial domain. The very same concerns, as the paper calls out, can be extrapolated to other areas of autonomy in the ground and maritime domains. AUVSI supports the Replicator initiative for an additional reason as it will serve to provide a DoD strategy and expectation for the Services to aggressively pursue full scale integration through the budget.

Accordingly, there are two primary areas of focus we wish to comment on 1) the value uncrewed systems provide in defense missions, and 2) the need to strengthen domestic manufacturing to support the warfighter technology demands of 21st Century warfare and to ensure the success of the Replicator Program, and beyond.

The DoD faces an urgent need to integrate unmanned systems rapidly and at scale in the new era of strategic global competition.

As we have watched around the world, including on the battlefields of Ukraine and Israel, the role of uncrewed systems – ranging from sophisticated platforms designed for warfighting to commercial off-the-shelf platforms modified for Intelligence, Surveillance, and Reconnaissance (ISR), targeting, or strike missions – has changed the nature of warfare in the air, on the ground, and in the water. Consequently, DoD leaders need to rethink the tools in our warfighters' toolboxes. Low cost, attritable unmanned platforms in the air, maritime, and ground domains are playing an important role in present-day warfare and can play a much larger role in our national policy of strategic deterrence. The U.S. has taken some steps in the right direction. Task Force 59 in U.S. Central Command (CENTCOM) and more recently Task Force 49 in U.S. Southern Command (SOUTHCOM) have demonstrated that there is a path towards rapid integration and operationalization of proven, capable tools. Compared to the evolving pace of technology maturation, and the required agility operational demands place on the warfighter to meet emerging threats on the battlefield, however, it is clear much more needs to be done to expand the acquisition and integration of uncrewed and autonomous stems.

Accordingly, the United States must quickly adapt our own approach to acquisition, procurement, integration, and tactics, training, and procedures. No longer is the traditional model of building exquisite platforms that costs many tens of millions or billions of dollars on a long lead time with a multi-year budgeting process the only solution that works for all our current challenges. Instead, DoD leaders must leverage existing authorities and tools – like the Defense Innovation Unit (DIU), Other Transaction Authority (OTA), and the Joint Rapid Acquisition Cell (JRAC) – to bring advanced technologies to the warfighter faster.

Further, having a robust manufacturing and production capability with depth and surge capacity hinges on clear DoD direction, such as multi-year block buy contracts, and an identifiable and stable portfolio funding. When industry has that type of guaranteed stability, its risk calculus for leaning forward with capital investments will change dramatically, allowing for enhanced domestic manufacturing capacity to meet the growing DoD demand.

Currently, as many DoD senior leaders have acknowledged, the DoD has struggled to find a meaningful path toward integration of uncrewed systems at scale. The Replicator Program has the potential to help close this gap, overcome acquisition challenges, and enhance the ability of the Combatant Commands to meet the demands of their ever-evolving missions. AUVSI welcomes DoD's stated Replicator goal to greatly increase the number of uncrewed and autonomous systems and swiftly integrate them into the force. If implemented effectively, this would be a real paradigm shift for the DoD and will boost the ability of the U.S. to arm our allies and enhance our own warfighters capacity to meet the demands of 21st Century missions.

For Replicator to succeed, and to maintain and grow the program, Congress has a strategic imperative to strengthen the domestic industrial base and rebuild a domestic component supply chain.

The United States has lost the advantage in our industrial base to China. Presently, with significant demands to assist in the arming of allied partners, including Taiwan, Ukraine, and Israel, it is no secret that supply lines are overwhelmed and our manufacturing capacity lags behind requirements. Further, and far more disconcerting, as multiple unclassified war games have demonstrated, the U.S. lacks the ability today to field the volume of platforms and weapons

required to compete in the South China Sea; nor is our industrial base robust enough to support rapid rearming. Meanwhile, from small drones to highly capable warships, China is building at a pace that is not only leaving the U.S. behind but is putting us at such an alarming disadvantage that it requires immediate national attention and a whole-of-government effort to address. Their ability to undercut U.S. competitors due to their heavily subsidized nature must be stopped. The current uncrewed systems industrial base is not sustainable with only prototyping and subscale experimentation that seems to be the norm in DoD. The Department must move swiftly toward choosing scaled production of specific systems and companies in order to build out and preserve industrial capacity and capability.

This challenge is perhaps most acute in the drone industry. China – through its Made in China 2025 policies – has strategically supported their drone industry with subsidies and flooded the U.S. with subsidized drones and drone components to the detriment of U.S. drone manufacturers and the domestic component supply chain. The PRC's strategic investments have developed a robust internal industry for drone manufacturing in China and have also allowed the PRC to project their influence abroad and use their monopolistic position to put U.S. manufacturers at a near impossible disadvantage by flooding the global market with subsidized drones. This has resulted in an emerging series of threats to the United States — including threats to national security, to the nation's position as a global leader in aviation, to its aviation workforce, and to its democratic values and fundamental principles of human rights. For the purposes of this hearing, however, the most salient point is that the U.S. may currently lack the domestic industrial base to entirely meet the goals of the Replicator Program. It may be possible, with significant effort, to rapidly integrate many thousands of uncrewed and autonomous systems in the next 18-24 months; however, maintaining that pace, scaling production levels to increase the velocity, and backfilling the loss of attritable systems will require significantly greater attention and policy changes.

AUVSI accordingly challenges the U.S. government to take resolute action to level the playing field for U.S. uncrewed system manufacturers and their component suppliers, and specific recommended actions can be found in the white paper in Appendix A, including manufacturing tax incentives, loan guarantees, and firm demand signals, like the Replicator program. Additionally, we urge the U.S. government to work with its partners/allied nations to ensure they consider similar aid to support their domestic manufacturers and component suppliers to generate a stronger, more secure global supply chain.

The success of our policy of strategic deterrence and our agility, and success, on the battlefield is predicated on the rebuilding of our industrial manufacturing capacity. Replicator can galvanize progress in U.S. military innovation and technological integration. Replicator must succeed. The stakes are too high for the program to fail. AUVSI and our member companies are working diligently to ensure that the uncrewed and autonomous systems industry is doing everything it can to meet the goals or the program; however, success requires government actions to build the industrial base we currently lack.

AUVSI encourages the Committee conduct oversight on the following topics:

- We are 8 weeks into Secretary Hicks's announced 18-24 month timeline. When will DoD provide a detailed plan to Congress, industry, and other stakeholders?
- How will Replicator engage the Defense Innovation Unit to field and invest in dual-use commercial and defense systems?

- How will DoD ensure that funding spent on Replicator does not deplete funding available to other uncrewed systems programs?
- Uncrewed systems by their nature are low-cost and attritable. Accordingly, backfilling systems lost in battle (or even in training) is as important as fielding initial capabilities. What is the plan for ensuring the long-term success of Replicator, as simply fielding initial systems is not sufficient to meet mission success.

Thank you for the opportunity to submit comments and to work with the Committee in support of programs that deliver the benefits of autonomy to warfighters.

Very Respectfully,

Michael Robbins

Michael Robbins
Chief Advocacy Officer
Association for Uncrewed Vehicle Systems International (AUVSI)

Appendix A: Partnership for Drone Competitiveness White Paper

Whitepaper: AUVSI Partnership for Drone Competitiveness

For 120 years, since December 17, 1903, when Orville and Wilbur Wright launched the first crewed flight on a hill in Kitty Hawk, North Carolina, the United States has been the world leader in aviation.[1] The U.S. leads in commercial, business, and general aviation manufacturing and has a total aviation workforce of more than half a million people.[2] But there is one segment of the aviation industry that the United States does not lead: uncrewed aircraft systems (UAS) and domestic drone manufacturing and operations. While the U.S. has been content to maintain leadership of traditional segments in the aviation industry, China understood the tremendous economic and national security implications of uncrewed aviation and took aggressive measures to dominate the global UAS manufacturing and technology market.

In 2015, China launched "Made in China 2025," a ten-year whole-of-society effort to invest in key industries, primarily in the technology area, to ensure China's world leadership and market dominance.[3] In a distinct role reversal with high-tech capitalist economies in the West, China has removed red tape to development while enabling sophisticated market mechanisms to spur rapid growth. While much of the discussion on Chinese government involvement in the industry has centered around direct subsidization, the scope of their support is far greater. No Chinese company or investment firm is free of Chinese Communist Party (CCP) involvement. The CCP has used its influence to:[4]

- Direct investment firms to invest heavily in drones and component parts;[5]
- Direct banks to provide low-interest loans to industry participants;
- Direct companies to build Chinese domestic supply chains;
- Direct companies to buy domestically to meet domestic market share targets;
- Direct companies to spend a high percentage of their revenue on research and development;
- Direct companies to partner with high-tech industry to ensure an end-market; and
- Direct state-owned companies to acquire and transfer western technology.[6]

While this infrastructure has developed a robust internal industry for uncrewed systems in China, it has also allowed them to project their influence abroad and use their monopolistic position to put U.S. manufacturers at a disadvantage by flooding the global market with subsidized drones.

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[1] 1903-The First Flight - Wright Brothers National Memorial (U.S. National Park Service) (nps.gov)
[2] https://datausa.io/profile/naics/aircraft-parts-manufacturing

[3] https://www.csis.org/analysis/made-china-2025
[4] Made-in-China-Backgrounder.pdf (isdp.eu)
[5] https://www.washingtonpost.com/national-security/2022/02/01/china-funding-drones-dji-us-regulators/
[6] China Bought Italian Military-Drone Maker Without Authorities' Knowledge - WSJ

This is an illegal trade practice the U.S. Department of Commerce (DOC) labels as "dumping."[7] In 2019, the U.S. Undersecretary for Defense, Ellen Lord, highlighted this challenge, noting, "We don't have much of a small UAS industrial base because DJI dumped so many low-price quadcopters on the market, and we then became dependent on them."[8] More recently, former Secretary of Homeland Security, Chad Wolf, wrote that, "Chinese drone dumping presents a challenge not only to U.S. competitiveness, but more importantly, to our national security."[9] This monopolistic position has also created barriers to the development of U.S. supply chains for the autonomous industry by effectively excluding them from the largest markets. The results of Chinese drone dumping have been devastating to the U.S. drone manufacturing industry. Chinese drones account for more than 90% of the consumer market,[10] 70% of the enterprise market (drones used as industrial tools),[11] and 92% of the first responder market.[12]

From the perspective of U.S. competitiveness and security, incentivizing U.S. leadership in the drone industry represents a strategic imperative in a market long characterized by state-subsidized companies based in China that have access to virtually unlimited, free to low-cost capital. As this paper will lay out, China has used its monopolistic position to flood the U.S. with subsidized drones, distorting the marketplace in favor of Chinese drones, stifling competition, and inhibiting new entrants. Further, by preventing access of U.S. component manufacturers into industry supply chains, China is able to stifle U.S. development of critical technology in autonomous systems. This has resulted in an emerging series of threats to the United States — including threats to national security, to the nation's position as a global leader in aviation, to its aviation workforce, and to its democratic values and fundamental principles of human rights.

AUVSI accordingly challenges the U.S. government to take resolute action to level the playing field for U.S. drone manufacturers and their component suppliers. Additionally, we urge the U.S. government to work with its partners/allied nations to ensure they consider similar aid to support their domestic drone manufacturers and component suppliers. Together, the United States and its allied nations can effectively level the international playing field and spur robust competition with certain companies that are tied to our collective foreign adversaries. This paper sets forth the case for action and offers concrete policies to ensure U.S. companies can compete and win in the marketplace. Many of the suggestions in this paper would apply to small UAS, but the same lessons learned can be applied to larger UAS as well.

Further, the policies will enable change for markets beyond drones, including other autonomous and uncrewed vehicles, as well as other emerging technologies, which often use many of the same components and technology stacks. Lastly, consistent with AUVSI's standing as an international

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[7] https://www.trade.gov/us-antidumping-and-countervailing-duties: Unfair foreign pricing and government subsidies distort the free flow of goods and adversely affect American business in the global marketplace. Enforcement and Compliance, within the International Trade Administration of the Department of Commerce, enforces laws and agreements to protect U.S. businesses from unfair competition within the United States, resulting from unfair pricing by foreign companies and unfair subsidies to foreign companies by their governments.

[8] https://foreignpolicy.com/2019/08/27/pentagon-seeks-to-counter-chinas-drone-edge/

[9] https://www.foxnews.com/opinion/next-front-china-economic-war-out-this-world

[10] https://www.reuters.com/article/us-usa-china-tech-dji-insight/game-of-drones-chinese-giant-dji-hit-by-u-s-tensions-staff-defections-idUSKBN2AZ0PV

[11] Ibid

[12] https://www.droneresponders.org/2019-chinese-uas-technology

organization, the recommendations in this paper will open supply chains for electronic components and rare earth materials that can be utilized by other international drone and electronics markets outside the United States that are also struggling to compete with subsidized Chinese competition and its dominance of the global electronics supply chain. AUVSI encourages the U.S. government to coordinate these activities with allied and partner nations, consistent with Washington's approach to semiconductor reshoring, to generate a "stronger, more secure supply chain."[13]

THE CHALLENGE

China Flooding the U.S. Market with Subsidized Drones

As noted, the flood of inexpensive drones into the U.S. has resulted in Chinese drones accounting for more than 90% of the consumer market, 70% of the industrial drone market, and 92% of the first responder market. These figures account for all Chinese drones in the United States; however, one drone company in particular dominates the U.S. and global market. Shenzhen-based Da Jiang Innovations, or DJI as it is commonly known, has been a major beneficiary of the "Made in China 2025" policy and the resulting subsidies. Accordingly, DJI is the world's largest drone manufacturer, and has a dominant share of the U.S. and global drone market. According to a 2020 report from the Center for the Study of the Drone at Bard College, in 2020 DJI alone accounted for 77% of the U.S. hobby drone market and 90% of the commercial drone service provider market.[14]

In a February 2022 report, *The Washington Post* found that DJI's investors included at least four Chinese investment firms with close ties to the government of the People's Republic of China (PRC).[15] The company's investors include "China Chengtong Holdings Group, which is directly administered by Beijing's State-owned Assets Supervision and Administration Commission, a ministerial-level organization tasked by China's State Council to manage the country's state-owned enterprises."[16] According to the *Post* report, "Other funds that list DJI as an investment include the Shanghai Venture Capital Guidance Fund, which is administered under the Shanghai Municipal Government. Guidance funds in China mix state assets with private funds to advance Beijing's industrial development goals in emerging industries. A Chinese-language S&P global report released in March 2021 says that state-run Guangdong Hengjian Investment Holding invested in DJI alongside SenseTime, which was also added to a U.S. sanctions list in December 2021 by the Biden administration over alleged human rights abuses in Xinjiang.[17] SDIC Unity Capital, a fund administered by the State Development & Investment Corporation, a state-owned investment holding company approved by China's State Council, also lists DJI as an investment on its website."[18]

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[13] https://www.foreignaffairs.com/united-states/industrial-policy-china-perils

[14] https://dronecenter.bard.edu/files/2020/03/CSD-Public-Safety-Drones-3rd-Edition-Web.pdf
[15] https://www.washingtonpost.com/national-security/2022/02/01/china-funding-drones-dji-us-regulators/
[16] Ibid
[17] https://www.washingtonpost.com/technology/2021/12/10/us-investment-ban-sensetime/
[18] https://www.washingtonpost.com/national-security/2022/02/01/china-funding-drones-dji-us-regulators/

Threat to U.S. National Security

In testimony before Congress, the Alliance for American Manufacturing (AAM) testified that "The United States reliance on China, in particular, for critical supply chains is a significant danger for our economic and national security."[19] China's dominance of the global drone market poses multiple challenges for the United States; accordingly, the Partnership for Drone Competitiveness concurs with the threat assessment by the AAM and lays out the details below.

Supply Chain Control

In addition to controlling much of the world's drone production, China similarly controls much of the component supply chain as well. The U.S.-China Economic and Security Review Commission warns of the risk this reliance on China poses for U.S companies, noting that companies should build more resilient technology supply chains.[20] A recent article in *Foreign Affairs* about the semiconductor industry observed that "the United States' reliance on foreign sources that are vulnerable to global rivals for semiconductors and other critical goods carries significant national security risks."[21] That logic applies equally to drones – a sector that, like semiconductors, has "become overly concentrated in China or in countries that are vulnerable to Chinese influence."[22] This supply chain control is not a theoretical challenge; this poses a massive threat to U.S. national security now. As AAM observed in Congressional testimony, "We should no longer question whether China will weaponize its supply chains and our reliance upon them to its advantage."[23] A *War on the Rocks* post wrote, "Supply chain interdiction in the open market can achieve desired outcomes without kinetic action or politically fraught sanctions."[24] The post goes on to note that, "The Department of Defense should view supply chain interdiction within the open marketplace as an effective weapon of war."[25] *Lawfare* observes, "A foreign adversary dominating the world market could deny the U.S. effective drone support in warfighting or potentially disable U.S. drones in a conflict."[26]

This supply chain threat as it relates to drones is not theoretical; this is happening in real time in the ongoing war in Ukraine. As the New York Times recently noted, "More than any conflict in human history, the fighting in Ukraine is a war of drones. That means a growing reliance on suppliers of the flying vehicles — specifically, China."[27] The article goes on to state that this reliance "has given China a hidden influence in a war that is waged partly with consumer electronics."[28] The Department of Defense (DoD) has recognized this problem, noting that the

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[19] Testimony of Scott N. Paul, President, Alliance for American Manufacturing Before the Energy and Commerce Subcommittee on Innovation, Data, and Commerce, Hearing Entitled "Mapping America's Supply Chains: Solutions to Unleash Innovation, Boost Economic Resilience, and Beat China" September 20, 2023:
https://d1dth6e84htgma.cloudfront.net/Scott_Paul_Testimony_IDC_Hearing_Supply_Chains_2023_09_20_1_6b75d3cfee.pdf

[20] https://www.wsj.com/articles/congressional-u-s-china-commissioner-warns-of-global-tech-supply-chain-risk-ae49ad2d?mod

[21] https://www.foreignaffairs.com/united-states/industrial-policy-china-perils

[22] Ibid

[23] https://d1dth6e84htgma.cloudfront.net/Scott_Paul_Testimony_IDC_Hearing_Supply_Chains_2023_09_20_1_6b75d3cfee.pdf

[24] https://warontherocks.com/2023/05/the-art-of-supply-chain-interdiction-to-win-without-fighting/

[25] Ibid

[26] https://www.lawfareblog.com/us-reliance-chinese-drones-sector-next-chips-act

[27] https://www.nytimes.com/2023/09/30/technology/ukraine-russia-war-drones-china.html

[28] Ibid

"replenishment rates for unmanned aerial delivery vehicles are neither capable of meeting surge demand nor achieving affordable mass."[29] Former U.S. Secretary of Homeland Security Chad Wolf was more blunt in his assessment of the current situation, noting: "This Chinese drone dumping is a threat to national security."[30]

PRC National Security Laws

The U.S. government has raised multiple security concerns associated with Chinese drone companies, which are obligated to comply with China's national security laws.[31] As the former Director of Operations at U.S. Indo-Pacific Command, Rear Admiral Mark Montgomery, observed recently, "this National Intelligence Law of 2017 obliges PRC drone companies to provide whatever information they gather. This could include flight logs, users' sensitive data, and drone operators' geolocation."[32] Further, PRC policies require Chinese companies to install backdoors, or what the Chinese Community Party refers to as "reserved interfaces," in software to allow the government access to data collected.[33]

A 2017 Homeland Security Intelligence Bulletin noted that "since 2015, DJI has targeted a number of U.S. companies in the critical infrastructure and law enforcement sectors to market its UAS" and "the Chinese government is likely using information acquired from DJI systems as a way to target assets."[34] In 2019, the Cybersecurity and Infrastructure Security Agency (CISA) released a memo reinforcing the serious security risk associated with PRC drones. The memo stated:

> "The United States government has strong concerns about any technology product that takes American data into the territory of an authoritarian state that permits its intelligence services to have unfettered access to that data or otherwise abuses that access. Those concerns apply with equal force to certain Chinese-made UAS-connected devices capable of collecting and transferring potentially revealing data about their operations and the individuals and entities operating them, as China imposes unusually stringent obligations on its citizens to support national intelligence activities. Security professionals should mitigate these risks in the same manner that they would any other connected technology."[35]

Montgomery added additional context noting, "Numerous PRC-made drones have been detected in restricted U.S. airspace, including over Washington, D.C., despite DJI's claim that their drone design includes geofencing restrictions to avoid sensitive locations. Drones made by Autel Robotics, another prominent manufacturer, do not even have geofence restrictions."[36]

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[29] https://www.diu.mil/work-with-us/submit-solution/PROJ00507

[30] https://www.foxnews.com/opinion/next-front-china-economic-war-out-this-world

[31] https://www.wsj.com/articles/china-adopts-sweeping-national-security-law-1435757589 / Article 7 of National Security Law of China states "All organizations and citizens shall support, assist, and cooperate with national intelligence efforts in accordance with law, and shall protect national intelligence work secrets they are aware of."

[32] https://www.defenseone.com/ideas/2023/08/extend-pentagons-ban-chinas-consumer-drones/389363/

[33] https://www.pointebello.com/insights/reserved-interfaces

[34] https://info.publicintelligence.net/ICE-DJI-China.pdf

[35] https://content.govdelivery.com/attachments/USDHS/2020/06/03/file_attachments/1465486/Industry%20Alert%20-%20Chinese%20Manufactured%20UAS%20%2820%20May%202019%29.pdf

[36] https://www.defenseone.com/ideas/2023/08/extend-pentagons-ban-chinas-consumer-drones/389363/

In 2019, the United States Congress prohibited the DoD from purchasing drones made by companies based in China in Section 848 of the Fiscal Year 2020 National Defense Authorization Act (NDAA).[37] In 2022, in Section 817 of the Fiscal Year 2023 NDAA, Congress expanded Section 848 to prohibit private companies working with the DoD from using insecure drones in the performance of federal contracts.[38] In the same legislation, Congress directed the U.S. Coast Guard to transition their drone fleet to secure systems within 90 days.[39] Congress is also considering legislation to mandate the Federal Communications Commission (FCC) to list DJI on the List of Equipment and Services Covered by Section 2 of The Secure Networks Act, which consists of companies deemed to pose an unacceptable risk to the national security of the United States.[40] That action is supported publicly by at least one FCC Commissioner. [41]

In addition to Congressional action, the administrations of both President Trump and President Biden have taken actions to address security concerns from Chinese drones. President Biden has continued implementation of Executive Order 13981, initially issued by President Trump, which makes it U.S. policy to "prohibit the use of taxpayer dollars to procure UAS that present unacceptable risks and are manufactured by…foreign adversaries, and to encourage the use of domestically produced UAS."[42] In October 2020, the U.S. Department of Justice (DOJ) banned the use of agency grants for purchasing Chinese drones, citing national security concerns, noting the drones are "subject to or vulnerable to extrajudicial direction from a foreign government."[43] Also in 2020, the Department of Interior (DOI) grounded all Chinese drones in its fleet, noting cybersecurity risks.[44]

Specific to DJI, in July 2021, the DoD labeled the company as posing "potential threats to national security" in a statement dedicated to the Pentagon's concerns about DJI.[45] In October 2022, the DoD identified DJI as a "Chinese military company" operating in the U.S. under Section 1260H of the Fiscal Year 2021 NDAA.[46] The Section 1260H list catalogs companies that the DoD believes contribute to the modernization goals of the People's Liberation Army, ensuring its access to advanced technologies as part of China's military-civil fusion strategy.

Support to Russia

Further highlighting the threat to national security is China's decision to supply Russia with DJI drones, as well as drones from other Chinese manufacturers, to aid Russia's illegal invasion of Ukraine. *The New York Times* noted, "In the year since Russia's invasion of Ukraine, China has sold more than $12 million in drones and drone parts to the country, according to official Russian

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[37] https://www.congress.gov/bill/116th-congress/senate-bill/1790/text

[38] https://www.congress.gov/bill/117th-congress/house-bill/7776/text

[39] Ibid

[40] https://www.rubio.senate.gov/public/index.cfm/2022/2/rubio-scott-cotton-stefanik-introduce-legislation-to-counter-chinese-drones & https://gallagher.house.gov/media/press-releases/gallagher-calls-us-take-swift-action-against-chinese-drone-maker-dji

[41] https://www.fcc.gov/document/carr-calls-review-dji-citing-national-security-risks

[42] https://www.federalregister.gov/documents/2021/01/22/2021-01646/protecting-the-united-states-from-certain-unmanned-aircraft-systems

[43] https://www.oip.gov/sites/g/files/xyckuh241/files/media/document/oiporderfundingdrones.pdf

[44] https://www.doi.gov/sites/doi.gov/files/signed-so-3379-uas-updated-10.6.2020-508.pdf

[45] https://www.defense.gov/News/Releases/Release/Article/2706082/department-statement-on-dji-systems/

[46] https://www.defense.gov/News/Releases/Release/Article/3180636/dod-releases-list-of-peoples-republic-of-china-prc-military-companies-in-accord/

customs data from a third-party data provider."[47] The *Times* highlighted that these sales include "a mix of products from DJI, the world's best-known drone maker, and an array of smaller companies."[48] Showcasing the broader supply chain complications, the *Times* wrote, "American efforts to isolate Russia from much-needed technology and cash have been complicated by China's dominance of the global electronics supply chain. The United States has sought to undercut some Chinese companies through export controls in recent years, but the world remains heavily reliant on China's city-size assembly plants and clusters of specialized component makers."[49] Another *Times* article reported that "Direct drone shipments by Chinese companies to Ukraine totaled just over $200,000 this year through June, according to trade data. In that same period, Russia received at least $14.5 million in direct drone shipments from Chinese trading companies."[50]

China's dominance of the electronics supply chain, including drones, is harming U.S. national security interests, domestically and in Ukraine, and exposes the risk of relying on a strategic competitor for a key supply chain. The United States government — the White House, DoD, DOJ, and Congress — have all deemed Chinese-made drones as a whole, and DJI specifically, as a threat to national security. Accordingly, action must be taken for the U.S. drone market to compete on a level playing field and grow to meet the demand of the U.S. military and commercial industries.

Threat to U.S. Aviation Leadership & Workforce

The U.S. must recognize that, in addition to national security concerns, China's subsidized drone market is harming the U.S. workforce, and ultimately our standing as the global leader in aviation. Drones are already playing an important role in the economy, and that role will continue to grow as drones become indispensable tools used for industrial inspection, lifesaving operations by first responders, and the delivery of products and services. Drones are also critically important to U.S. leadership in a new era of aviation defined by uncrewed and autonomous systems. The drones of today — relatively small systems that fly relatively close to the ground to inspect industrial sites and deliver goods — increasingly employ advanced autonomy technology that, once perfected, will enable much larger uncrewed systems to carry people and cargo. The future of aviation is in advanced automation and autonomy, and the United States must invest in building the knowledge base, workforce, and manufacturing capacity to lead. If we cede leadership in drones and autonomy to other nations, specifically China, we are posturing ourselves poorly on the world stage and opening the door for even greater national security risks.

American drone manufacturers face multiple challenges when competing against subsidized foreign competition. Critical components, rare earth materials, and supply chains outside of China can be difficult to access, and often, if available at all, come at a significantly higher cost due to Chinese subsidization artificially lowering the price of Chinese components. Moreover, with the ability to flood the U.S. with subsidized Chinese-made drones, China has artificially lowered the price of drones, making it challenging for U.S. manufacturers, who compete in the commercial

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[47] https://www.nytimes.com/2023/03/21/business/russia-china-drones-ukraine-war.html
[48] Ibid
[49] Ibid
[50] https://www.nytimes.com/2023/09/30/technology/ukraine-russia-war-drones-china.html

marketplace without government subsidies, to be competitive on price. One U.S. drone industry executive noted that "DJI dropped its prices by as much as 70% in less that a year," driving the U.S. company to end drone production, and to begin making software for DJI drones.[51] This drives sales away from commercial U.S. companies and into subsidized Chinese companies, fulfilling the goal of Made in China 2025.

The Chinese government policies harm the U.S. industry's ability to attract capital, investment, and workforce and ultimately stifle innovation and the growth of the U.S. market. This vicious cycle can be upended through targeted government action, including demand signals, tax incentives, grant programs, and other efforts to level the playing field for U.S. manufacturers. It will be imperative that any potential grant program has palatable and sensible requirements and that the funding is easily and widely accessible.

Threat to U.S. Values & Fundamental Human Rights

In addition to posing threats to U.S. national security and distorting the economic marketplace by flooding the U.S. with subsidized drones, DJI has been alleged to support human rights abuses. The U.S. Department of Commerce placed DJI on the Entity List,[52] and the U.S. Department of the Treasury placed DJI on the Office of Foreign Assets Control's (OFAC) list of Chinese tech firms that are part of the Chinese military-industrial complex.[53] These lists restrict U.S. investments in DJI based on allegations of support of human rights abuses against the Uyghur people. Specifically, the Department of the Treasury noted, "SZ DJI Technology Co., Ltd. (SZ DJI) operates or has operated in the surveillance technology sector of the economy of the PRC. SZ DJI has provided drones to the Xinjiang Public Security Bureau, which are used to surveil Uyghurs in Xinjiang. The Xinjiang Public Security Bureau was previously designated in July 2020, pursuant to E.O. 13818, for being a foreign person responsible for, or complicit in, or that has directly or indirectly engaged in, serious human rights abuse."[54]

It is U.S. government policy to combat forced labor in Xinjiang and strengthen international coordination against this egregious violation of human rights.[55] To be consistent with this policy, and American values, the U.S. must move away from Chinese drones, specifically DJI drones, which have been found by the U.S. government to facilitate human rights abuses against the Uyghur people.

SOLUTIONS FROM THE PARTNERSHIP FOR DRONE COMPETITIVENESS

U.S. Drone Manufacturing Competitiveness & Security

From the perspective of U.S. competitiveness and security, incentivizing U.S. leadership in the drone industry — the focal point of a new era of aviation — represents a strategic imperative in a

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[51] https://www.vox.com/2017/4/14/14690576/drone-market-share-growth-charts-dji-forecast

[52] https://www.bis.doc.gov/index.php/documents/regulations-docs/2326-supplement-no-4-to-part-744-entity-list-4/file

[53] https://sanctionssearch.ofac.treas.gov

[54] https://home.treasury.gov/news/press-releases/jy0538

[55] Public Law 116-145, UYGHUR HUMAN RIGHTS POLICY ACT OF 2020: https://www.govinfo.gov/content/pkg/PLAW-116publ145/html/PLAW-116publ145.htm

market long characterized by state-subsidized companies based in China. AUVSI believes it is essential to advance security and competitiveness in a thoughtful way that respects existing investments while building toward a more secure, sustainable future that puts U.S. interests — including security, the economy, and overarching values — first. By addressing these issues in a measured manner, we believe we can help to balance competing interests and facilitate sound policy.

Leveling the Playing Field for U.S. Drone Manufacturing

U.S. drone manufacturers and their component supply chain have struggled to compete against foreign subsidized competition, which hinders the availability of American-made UAS on the market and impedes workforce growth and investment. Accordingly, the U.S. government must foster a more competitive and fair playing field for U.S.-based drone manufacturers. AUVSI is advocating for specific proposals that would generate demand for U.S.-made drones and supply-side measures that level the playing field for U.S. drone and component manufacturers against subsidized competition and dumping practices.

Bolstering new drone manufacturing capabilities and the associated workforce will require infrastructure and capital expenditures. Providing tax incentives, loan guarantees, and other mechanisms to spur that spending would accelerate growth and development that would have otherwise been delayed or denied. Manufacturer tax credits for the production and sale of certain UAS equipment and components produced and sold in the U.S. would benefit the industry and its competitiveness and would decrease reliance on subsidized, foreign drones.

This has worked in other industries. According to the *Financial Times*, U.S. manufacturing commitments doubled — to more than $200 billion, creating 82,000 jobs — based on the success of tax incentive programs for other industries, including solar panels, semiconductors, electric vehicles, and other clean technologies.[56] In the solar industry alone, since the passage of the Solar Energy Manufacturing Act (SEMA), more than $100 billion in private sector investment has been made into fifty-one new manufacturing facilities in the United States, ultimately representing more than 20,000 additional U.S. jobs to be created and significant capacity added for domestic solar panel production.[57] In a recent hearing on the CHIPS and Science, it was stated that since the law was enacted, along with $39 billion in government appropriations and 25% investment tax credit to spur domestic production of semiconductors, more than $200 billion in additional private sector funding has flowed into the industry in the U.S.[58] Recently, the Energy Department has made $15.5 billion in new funding available to spur domestic battery manufacturing through cost-shared grants and loans.[59] The time has come for the U.S. Government to act

[56] https://www.ft.com/content/b1079606-5543-4fc5-acae-2c6c84b3a49f

[57] https://www.seia.org/research-resources/impact-inflation-reduction-act

[58] Senate Committee on Commerce, Science, and Transportation CHIPS and Science Implementation and Oversight, October 4, 2023: https://www.commerce.senate.gov/2023/10/chips-and-science-implementation-and-oversight

[59] https://www.energy.gov/articles/biden-harris-administration-announces-155-billion-support-strong-and-just-transition

to similarly spur investment into the U.S. drone and component marketplace. The Partnership for Drone Competitiveness supports:

- Manufacturing tax credits: To promote domestic drone manufacturing capacity, Congress needs to develop a tax incentive program for drone manufacturing. This program can leverage the language and model the frameworks of SEMA, CHIPS, the House's Bioeconomy Research and Development Act of 2021 (America Creating Opportunities for Manufacturing, Pre-Eminence in Technology and Economic Strength (COMPETES) Act of 2022), and the Senate's United States Innovation and Competition Act (USICA) on semiconductors and other technologies.
- Loan guarantees: In addition to tax incentives, to promote competitiveness against subsidized Chinese competition, Congress should develop a program of loan guarantees to U.S. drone and component manufacturers modeled around language included in the Advanced Technology Vehicles Manufacturing Direct Loan Program.
- Ensuring critical mineral access: Access to rare earth driven components is a challenge to U.S. drone and component manufacturers. Congress should enact legislation along the lines of H.R. 8981, the Securing America's Mineral Supply Chains Act, from the 117th Congress. It would be highly beneficial to the American drone industry by helping ensure the domestic availability of critical materials that are required in the manufacturing of UAS and their components.

In taking action to level the playing field and promote competition, the U.S. government should also coordinate activities with allied and partner nations to create a stronger, more secure supply chain.

Federal Market Demand Programs

Programs focused on U.S.-made drone acquisition incentives, specifically grants, would signal to investors the market opportunity for U.S. drones, stimulating investment into U.S. drone and component manufacturing. These programs are also fair and market-driven, maximizing public choice, as the government would not be picking winners and losers.

Federal Grants for First Responders

According to a 2019 survey by Droneresponders, 92% of first responders in the U.S. are using drones made by China.[60] This is a direct consequence of China subsidizing the drones, driving down costs, and a program to donate DJI drones to first responders.[61] The Droneresponders survey also noted that 88% of first responder agencies would prefer to use U.S. drones; however, cost is a major factor in being able to transition away from the subsidized Chinese drones to market-based U.S. drones.[62]

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[60] https://www.droneresponders.org/2019-chinese-uas-technology

[61] https://www.newsweek.com/lawmakers-request-federal-inquiry-over-concerns-drones-donated-china-are-being-used-spy-us-1504222

[62] https://www.droneresponders.org/2019-chinese-uas-technology

- Congress should enact a new program designed to help public safety agencies transition from using Chinese drones to U.S.-made solutions. This program could borrow lessons from the Supply Chain Reimbursement Program which "reimburses providers of advanced communications services … incurred in the removal, replacement, and disposal of communications equipment and services produced or provided by Huawei Technologies Company (Huawei) or ZTE Corporation (ZTE)."[63]
    - This new program should be funded appropriately to ensure sufficient annual funding to ensure that a) public safety agencies can begin to replace and upgrade drone fleets, and b) U.S. domestic drone manufacturing can meet demand in terms of both production capability and drone reliability and capability.
- Congress should enhance existing federal grant programs for first responders. Reports confirm that FEMA and other agencies have permitted federal taxpayer dollars to fund the purchase of Chinese-made drones.[64] Congress should ban that practice and ensure that federal grant programs to support first responders are adequately funded to enable state and local agencies to transition to secure, U.S.-made solutions.
    - This should include, among other programs, the Department of Homeland Security's (DHS) Urban Areas Security Initiative (UASI) Program, the Federal Emergency Management Agency's (FEMA's) Homeland Security Grant Program, and grants administered by the U.S. Department of Justice.
    - Critically, these and other federal grant programs for first responders must allow grant recipients to purchase drones. At present, the Justice Department's Bureau of Justice Assistance flatly prohibits the use of grant funds to purchase UAS,[65] as does FEMA's Assistance to Firefighters Grants (AFG) Program. Enabling these programs to support the purchase of U.S.-made drones would significantly benefit first responders.

Federal Grants for Infrastructure Inspection

- Congress should enact the Drone Infrastructure Inspection Grant (DIIG) Act, which would create a $100 million grant program for local, state, and tribal governments to use U.S.-made drones for critical infrastructure inspection and construction projects.
    - The DIIG Act also provides $100 million in grant funding for workforce development programs, coupling with community colleges and four-year institutions, to enable the future workforce required for the U.S. to remain a global aviation leader.

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[63] https://www.fcc.gov/supplychain/reimbursement

[64] https://www.tabletmag.com/sections/news/articles/government-funds-chinese-spy-technology-americas-backyard

[65] https://bja.ojp.gov/program/jag/prohibited-expenditures-associated-procedures-under-jag

  - The DIIG Act would enhance U.S. drone competitiveness by spurring investment in the U.S. drone industry and worker training and provide tangible benefits for infrastructure resilience.
- U.S. Department of Transportation (DOT) programs that enable the use of drones for infrastructure inspection, such as the Every Day Counts (EDC) program, should incentivize the use of U.S. manufactured drones.
- Congress should enact a new program designed to help industrial inspection companies engaged in critical infrastructure inspection transition from using Chinese drones to U.S.-made programs, which could reflect, in part, the Supply Chain Reimbursement Program as mentioned above for first responders. Again, the program should be funded appropriately to ensure that critical infrastructure owners and operators can begin to replace and upgrade drone fleets and U.S. domestic drone manufacturing can meet demand in terms of both production capability and drone reliability and capability.

DoD Programs

DoD programs across all domains have identified uncrewed systems as essential tools for the future of warfare.[66] The potential for DoD investment into these systems, many of which are dual purpose commercial and defense technologies, benefits the warfighting capabilities of the United States. It also boosts U.S. industry, spurring job creation, investment, and advanced R&D. A recent study by the Special Competitive Studies Project notes that to close the deterrence gap and to build the joint-force of the future, the U.S. should purchase "high volumes" of drones, a recommendation AUVSI strongly supports.[67] Nevertheless, as the New York Times recently reported, drone companies, as well as other advanced technology industries "are facing a stiff challenge on another field of battle: the Pentagon's slow-moving, risk-averse military procurement bureaucracy."[68] The DoD must work with industry to overcome the acquisition challenges to get capable tools into the hands of warfighters faster, ensuring a strong U.S. industry for defense and commercial missions.

The recently announced Replicator initiative by Deputy Defense Secretary Kathleen Hicks is a step in the right direction. In an August 28, 2023, speech, Secretary Hicks noted: "... now is the time to take all-domain, attritable autonomy to the next level: to produce and deliver capabilities to the warfighter at the value and velocity required to deter aggression, or win if we're forced to fight."[69] The goal, according to Hicks, is "to field attritable autonomous systems at scale of multiple thousands, in multiple domains, within the next 18-to-23 months."[70] To meet this goal, DoD will have to rely on both traditional defense companies as well as commercial autonomy platforms, which Hicks acknowledged. Accordingly, a significant boost to the advanced manufacturing capacity of the United States will be required. While details on the Replicator program

[66] https://www.nationaldefensemagazine.org/articles/2021/5/28/unmanned-systems-and-the-future-of-war
[67] https://www.scsp.ai/wp-content/uploads/2023/05/Offset-X-Closing-the-Detterence-Gap-and-Building-the-Future-Joint-Force.pdf
[68] https://www.nytimes.com/2023/05/21/us/politics/start-ups-weapons-pentagon-procurement.html
[69] https://www.defense.gov/News/Speeches/Speech/Article/3507156/deputy-secretary-of-defense-kathleen-hicks-keynote-address-the-urgency-to-innov/
[70] Ibid

are forthcoming, the sentiment delivered by the DoD is certainly welcome and, if successful, will help to drive investment and innovation that will be an important element of the transformation of the drone industry.

The DoD has established the Office of Strategic Capital (OSC) "to develop, integrate, and implement proven partnered capital strategies to shape and scale investment in critical technologies."[71] The OSC is designed to "identify and prioritize promising critical technology areas for the Department of Defense" and, importantly, "fund investments in those critical technology areas, including supply chain technologies not always supported through direct procurement."[72] Given that access to capital can be a challenge for the drone and component manufacturing industry, the OSC offers promise to the industry as a tool for overcoming limitations from the private sector. OSC should designate and prioritize drones and drone components as a critical technology and immediately work to fund investments in this area to expand U.S. capabilities and manufacturing capacity. It is imperative that DoD purchases drones of all sizes, at scale, from U.S. companies. OSC should partner with other agencies, like the Small Business Administration, to leverage their tools in the form of loan guarantees, loans, and other mechanisms.

Further, Congress and the DoD should continue to invest in AFWERX, which is "a Technology Directorate of the Air Force Research Laboratory (AFRL) and the innovation arm of the Department Air Force."[73] Multiple AFWERX programs offer opportunities for the drone industry, including AFVentures, which, "invests in emerging technologies to scale Department of the Air Force capabilities, strengthening the US industrial base that empowers Airmen and Guardians by incentivizing private, for-profit investment in national security interests"[74] and Prime, which seeks to "accelerate emerging dual-use markets by leveraging government resources for rapid and affordable fielding."[75]

Enabling Regulations

As noted in the opening paragraph of this paper, the one segment of the aviation industry that the United States is not leading is drone manufacturing and operations. While much of this paper is focused on leveling the playing field in drone and component manufacturing, AUVSI similarly advocates for bold action by the U.S. government to enable drone operations to scale.[76] The U.S. is falling behind other nations in the global effort to safely and efficiently integrate drones – which perform many lifesaving and critical industrial missions – into the airspace. Accordingly, the Federal Aviation Administration (FAA) must take steps to streamline approval processes and minimize the bureaucratic barriers to successful integration. Congress can assist by giving the FAA additional tools, authorities,

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[71] https://www.cto.mil/osc/

[72] Ibid

[73] https://afwerx.com/

[74] https://afwerx.com/afventures-overview/

[75] https://afwerx.com/prime-overview/

[76] https://www.auvsi.org/our-impact/advocacy-initiatives/auvsi-air-advocacy-committee

and resources to accomplish this mission. Such tools should include mechanisms to help the FAA implement 2023 FAA Reauthorization efforts/mandates. Making progress on drone operational integration will spur investment into the drone industry, including manufacturing and workforce development in the United States.

Drone Cybersecurity

AUVSI, through its Trusted Cyber Program Working Group, made up of nearly forty companies in the uncrewed and autonomy industry, has developed a framework for cyber standards for drones.[77] In conjunction with the DoD's Defense Innovation Unit (DIU)[78], AUVSI brought to market the Green UAS compliance program to assess and verify commercial drones to ensure that they meet the highest levels of cybersecurity and NDAA supply chain requirements.[79]

- The Green UAS cleared list of drones meet updated levels of security requirements of the DIU's Blue UAS 2.0 Program. Accordingly, U.S. government agencies should apply Green UAS, along with Blue UAS, to their respective drone acquisition policies to ensure secure drones are available for acquisition. Congress should require this as a best practice of USG agencies and encourage this practice at the state, local, tribal, and territorial level.
- The FAA should incorporate voluntary consensus standards in the uncrewed systems cybersecurity arena like those developed by AUVSI to ensure trust, integrity, and availability of data collected by drones.
    - This is accomplished through a security controls assessment and vulnerability and penetration test.
- Congress should continue to fund the DIU's Blue UAS program to allow the program to scale and incorporate connected drones in the future.

Restrictions and Tariffs on Chinese Drone Imports

Country of Origin Restrictions

AUVSI has developed targeted principles for legislative or executive measures designed to advance the use of trustworthy systems made in the U.S. and allied nations in a responsible, measured manner. Our principles for rational, tailored country of origin restrictions are as follows:

- Ensure any UAS restrictions are reasonably related to national security, cybersecurity, human rights concerns, and target companies whose governments provide significant subsidies and are engaged in other unacceptable practices, such as military-civil fusion. This may include referencing sources such as:
    - The Consolidated Screening List (International Trade Administration), Entity List (U.S. DOC, Bureau of Industry and Security), entities identified by the DoD as military companies from countries of concern operating directly or

[77] https://www.auvsi.org/cybersecurity-working-group

[78] https://www.diu.mil/latest/auvsi-launches-green-uas-cybersecurity-certification-program-for-commercial

[79] https://www.auvsi.org/green-uas

indirectly in the United States, and other such lists managed, maintained, and regularly updated by the U.S. government.

- With respect to components, limit any restrictions to security-critical components (and omit passive components). These types of restrictions are best exemplified by the American Security Drone Act (ASDA), a legislative initiative that limits component restrictions to two components (communications links and the controller).
- Afford end users suitable transition periods for the use of products that may be restricted in the future. This is important operators using UAS manufactured in countries of concern, most notably China.
- Include affirmative measures designed to support a timely, low-friction transition, which may include grants or other incentives to end users or pathways designed to support the domestic manufacturing of trustworthy UAS systems.
    - Following the transition period, those mechanisms must remain in place to foster a more competitive and fair playing field for domestic, United States-based manufacturers.

Tariffs

In July of 2018, the United States Trade Representative (USTR) instituted Section 301 tariffs on a broad range of Chinese goods, including drones. The 25% tariffs were reinforced in July of 2022 and specific categorizations were added for different categories of drones.[80] At a minimum, the Partnership supports maintaining the current 25% tariffs. USTR, however, should consider increasing the tariff amount to better blunt the dumping of subsidized Chinese drones into the U.S. market. By DJI's own admission in a filing with USTR, "Market surveys show a majority of the commercial drone products purchased by U.S. residents are still manufactured outside of the U.S. In addition, the majority of drones assembled in the US still use Chinese components. Having additional duties did not have positive effects on domestic manufacturing of drones or downstream products."[81] Accordingly, the 25% tariff should be reviewed by USTR for enhancement to produce positive effects on domestic manufacturing of drones.

CONCLUSION

The capabilities, utility, and life-saving potential for drones are unparalleled, but the inability to scale and grow the market are hampered by stifling international subsidies and bureaucratic roadblocks to enabling regulations. The policies in this paper would help to level the playing field for U.S. drone and component manufacturers, ensuring a key industry remains in America to meet the growing demand from industry and the warfighter.

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[80] https://www.wilevconnect.com/new-import-codes-for-drones-what-you-need-to

[81] DJI in comments to USTR on 301 Tariffs, USTR-2022-0014-00034924: https://comments.ustr.gov/s/commentdetails?rid=DYBJHKW9QR

QUESTIONS SUBMITTED BY MEMBERS POST HEARING

OCTOBER 19, 2023

QUESTIONS SUBMITTED BY DR. McCORMICK

Dr. MCCORMICK. In order to make Replicator a success, Dr. Hicks has said that DOD must rapidly scale and field thousands of attritable autonomous systems by leveraging existing resources. One effective way to do that is to maximize existing DOD programs that have already been tested and are ready to scale up. Do you agree that DOD should leverage existing successful programs, like the Army's Short Range Reconnaissance Program and the Marine Corps' Short Range, Short Endurance Program to rapidly get small, smart, survivable systems to the warfighter?

Mr. CLARK. Yes. The DOD should take advantage of existing systems to achieve the scale necessary for Replicator to succeed. However, the systems chosen will need to be relevant to the operational problem being addressed. If the operational problem is, as DOD officials suggest, slowing or disrupting an amphibious invasion of Taiwan, Replicator should pursue a combination of undersea, surface, and air vehicles. That kind of multi-domain approach would create dilemmas for the invasion force that would require multiple different countermeasures to defeat. For example, by themselves, undersea systems could be swept like mines, surface systems could be defeated with guns, and small airborne systems are unlikely to cause substantial damage to large troop transports. Together, though, these systems can slow and disrupt the invasion and force the invaders to activate defenses that will make them more easily targeted by U.S. and allied long-range anti-ship missiles.

Existing defense programs like the Army's Short Range Reconnaissance Program and the Marine Corps' Short Range, Short Endurance Program could contribute to the counter-invasion effort. Although they are small, these systems would stimulate the enemy's defensive systems such as radars, which will be detectable and can help target U.S. and allied missiles. These small airborne systems can also confuse enemy operational pictures and decision-making.

Most important, because they are already in the DOD inventory, these systems can avoid one of the likely challenges of Replicator, which is establishing training, maintenance, and logistics. In its current plans for Replicator, the Defense Innovation Unit has not addressed how it will support the new vehicles. DOD officials have implied Replicator vehicles would likely be sent to the military services, which will provide for their support. However, this approach risks creating a set of disconnected units that will not be able to integrate into a coherent system of systems, which will be necessary to address the likely operational problems faced by INDOPACOM.

Dr. MCCORMICK. As you know, since the Cold War, the Department has leaned toward developing and fielding expensive, exquisite weapons systems. The ever-increasing cost of these programs, coupled with breakthroughs in technology, have finally forced DOD to instead focus on small, smart, mass-produced platforms, like drones, that offer greater operational flexibility. How do we ensure that Replicator doesn't turn into yet another program for acquisition of expensive, large, long-range systems?

Mr. CLARK. Much of the reason the DOD has gravitated toward expensive and large systems is the way requirements are established for new weapons. The DOD generally defined requirements for new systems by analyzing the needs for U.S. forces to succeed in projected future confrontations. These analyses assume U.S. forces will use a planned set of operational concepts and tactics that are similar to how U.S. forces would operate today. As a result, when threats improve the capability needed to continue current U.S. operational approaches also must improve. To break this cycle, U.S. forces will need to consider alternative operational approaches that can employ less-sophisticated systems.

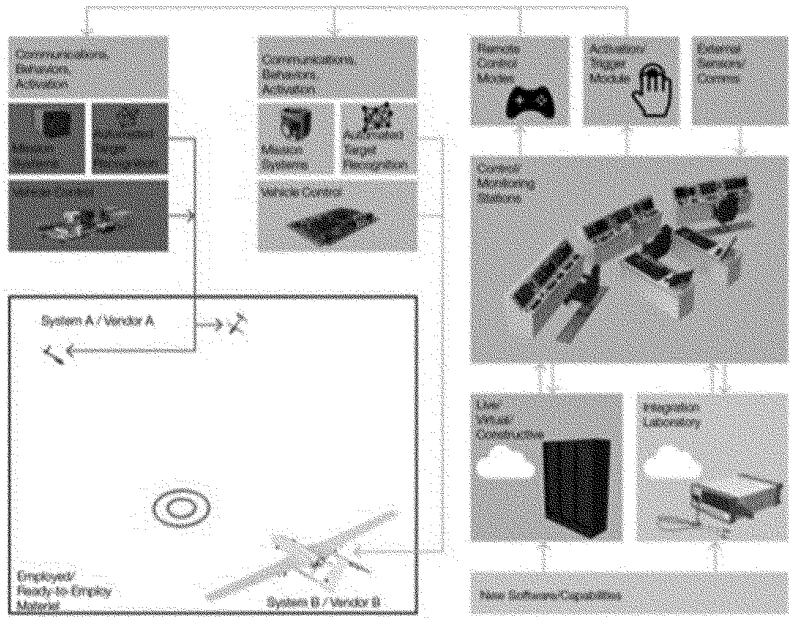
Replicator is attempting to take this path to enable the use of less-expensive systems that can be produced at greater scale. Instead of defining requirements by analyzing future operational scenarios, Replicator is starting with contemporary operational problems and available systems. Instead of keeping the operational concept fixed, Replicator would instead vary the way U.S. forces operate to enable available systems to be effective in addressing the operational problem. By starting with available systems, Replicator can avoid the "requirements creep" of previous defense programs.

Dr. MCCORMICK. Mr. Clark and Dr, Greenwalt, given Replicator's all-domain requirement, it is clear that there will be multiple vendors with different autonomy algorithms, also known as stacks. For Replicator to be successful, the DOD will need to integrate various autonomy software stacks into a single platform backbone to enable continuous integration and continuous development cycles.

1. How is the Department of Defense planning to integrate the autonomy software of various vendors across domains and ensure success of the program?

2. How does the Department plan on ensuring communication and interoperability between these platforms?

Mr. CLARK. The software stack for Replicator will likely end up similar to the figure below:



At the top of the software stack is the software ecosystem, like the iOS system for iPhones or the Windows operating system on personal computers. This ecosystem is shown in gray in the figure above and would incorporate the autonomy and command and control programs for a group of Replicator vehicles. Like iOS or Windows, the ecosystem would establish interfaces between autonomy software for individual vehicles and the ecosystem as well as for software routines in the ecosystem, such as mission planning programs that establish vehicle behaviors. The ecosystem software would also provide a way to build and assess operational concepts through live/virtual/constructive simulations and evaluate the ability of new Replicator units to integrate into the force.

Each Replicator vehicle will have its own vehicle control software and software associated with onboard mission systems such as radios and sensors, including algorithms for automated target recognition. This software is shown in yellow or green in the figure above. To minimize the integration challenges associated with combining Replicator vehicles into a system of systems, the autonomy software within vehicles will likely be vehicle-specific and separate from the autonomy software of the overall ecosystem. Vehicle autonomy software will interact with ecosystem command and control and mission planning software via the ecosystem's government-owned interfaces, but the software for vehicles and the ecosystem will likely be built and maintained by individual vendors.[1]

To address the two questions above:

[1] This approach is described in Bryan Clark and Dan Patt, "Hedging Bets: Rethinking Force Design for a Post-Dominance Era," (Washington, DC: Hudson Institute, 2024), https://www.hudson.org/defense-strategy/hedging-bets-rethinking-force-design-post-dominance-era-bryan-clark-dan-patt.

1) *How is the Department of Defense planning to integrate the autonomy software of various vendors across domains and ensure success of the program?* Replicator will likely use government-owned software interfaces, like that between the Apple iOS operating system and iPhone apps, to allow software from vehicle providers and ecosystem developers to be independently built and shipped. To enable this approach, the government will also need to establish a development environment that enables automated testing of the executability of new software and its integration with the Replicator ecosystem and command and control software.

2) *How does the Department plan on ensuring communication and interoperability between these platforms?* As shown in the figure above, the different vehicles involved in Replicator will interact with each other through the overarching software ecosystem and its government-owned interfaces, similar to how a ride-sharing app on a smart phone can access the contacts in the user's contact list or saved locations in a mapping program.

Dr. MCCORMICK. Mr. Clark and Dr. Greenwalt, the Department of Defense's announcement of Replicator caught many in government and industry by surprise. While Congress commends the Department of Defense's initiative to deploy autonomous vehicles to offset China's advantages, there are questions about the programs ability to validate the safety and trust thousands of drones within two years.

1. Do you believe the Department of Defense can fully test and validate the safety and trust of thousands of drones within two years? If not, how can the testing be accelerated?

2. Should the Department of Defense work with industry to accelerate the testing and evaluation of these drone at scale?

3. Do you believe commercially proven modeling and simulation capabilities could help the Department of Defense stay on timeline?

Mr. CLARK. The Replicator initiative is an ambitious effort that is designed to stress the DOD's ability to deliver new capabilities at scale in an accelerated timeline. However, the Pentagon has succeeded in similar efforts in the past, including the production and delivery of Mine-Resistant Ambush-Protected (MRAP) vehicles to U.S. and allied troops during Operation Iraqi Freedom. Like that effort, fielding new systems at scale will depend on a willingness to use operational innovation to employ available technology, flexible requirements, and abbreviated testing.

1) *Do you believe the Department of Defense can fully test and validate the safety and trust of thousands of drones within two years? If not, how can the testing be accelerated?* Yes. The most significant challenge associated with fielding Replicator could be testing. In large part, this is because the initiative tacitly assumes that tactics will change in response to available vehicle technology and changing operational problems. As a result, comprehensive testing of Replicator systems in representative operational settings will be difficult.

The DOD is trying to address this challenge by implementing more virtualized testing, in which a simulation using digital models assesses if a new system will be operationally effective and sustainable. Under this approach, live testing is used in part to validate digital models, which are then used to evaluate the viability of various operational concepts and associated systems of systems in which the Replicator vehicles could be employed. This approach could be used to accelerate the testing associated with vehicles purchased under the Replicator initiative.[2]

2) *Should the Department of Defense work with industry to accelerate the testing and evaluation of these drone at scale?* Yes. To support the automation of testing as described above, the DOD could work with industry to build digital models or "twins" of uncrewed vehicles as they are developed that can be used in simulations.

3) *Do you believe commercially proven modeling and simulation capabilities could help the Department of Defense stay on timeline?* Yes. Using model-based system engineering, the DOD could automate some aspects of the testing process.[3] For example, program offices and operational units could use simulation to assess different operational concepts and system of system configurations that address an emerging operational problem. With digital model or twins, testing of the new system of system could be conducted automatically. The simulated test could also highlight areas of uncertainty in the digital model that need to be checked through live testing. By live testing the system against the limited points needed to check the model, the

[2] Director of Operational Test and Evaluation, "DOT&E Strategy Implementation Plan - 2023," (Washington, DC, U.S. DOD, 2023), https://www.dote.osd.mil/Portals/97/pub/reports/DOTE__Strategy__Imp__Plan-Apr2023.pdf?ver=jQHyC5uHXsvM25sYurv5Zw%3D%3D

[3] Undersecretary of Defense for Research and Engineering, "DOD INSTRUCTION 5000.97 DIGITAL ENGINEERING," (Washington, DC, U.S. DOD, 2023), https://www.esd.whs.mil/Portals /54/Documents/DD/issuances/dodi/500097p.PDF?ver=bePIqKXaLUTK__Iu5iTNREw%3D%3D

program office could validate the system's utility in much less time compared to the comprehensive testing usually conducted today.

Dr. MCCORMICK. In order to make Replicator a success, Dr. Hicks has said that DOD must rapidly scale and field thousands of attritable autonomous systems by leveraging existing resources. One effective way to do that is to maximize existing DOD programs that have already been tested and are ready to scale up. Do you agree that DOD should leverage existing successful programs, like the Army's Short Range Reconnaissance Program and the Marine Corps' Short Range, Short Endurance Program to rapidly get small, smart, survivable systems to the warfighter?

Dr. GREENWALT. The Department should first begin consideration for initial Replicator funding those programs that have already been tested and fielded with the operators. For the initial tranche of Replicator programs there is a need to begin with those capabilities that already have a level of maturity and producibility. For a second tranche, DOD should look at the creation of new capability that can be delivered to the warfighter in less than 18 months for testing and evaluation so a subsequent production decision could be made. Finally, there should be plans for additional tranches and additional technologies that could be developed and used in the 3+ year timeframe.

What will be significant to consider for these programs is not just the ability to operate today but to have the flexibility to mix and move in and out different types of sensors and weapons packages over time, so as we are not buying a static technology. For some programs, there will be a need for these platforms to be modular and have open systems interfaces to allow for medium- and longer-term adaptability. For others there may not need to be any upgrades except perhaps for software.

Dr. MCCORMICK. As you know, since the Cold War, the Department has leaned toward developing and fielding expensive, exquisite weapons systems. The ever-increasing cost of these programs, coupled with breakthroughs in technology, have finally forced DOD to instead focus on small, smart, mass-produced platforms, like drones, that offer greater operational flexibility. How do we ensure that Replicator doesn't turn into yet another program for acquisition of expensive, large, long-range systems?

Dr. GREENWALT. To keep that from happening will need effective congressional oversight. Unfortunately, since the end of the Cold War, the type of oversight that Congress has relied on has created incentives for the creation of those expensive exquisite weapon systems in the first place. This is primarily driven by how Congress appropriates funding for large weapon systems or MDAPS and how DOD budgets under the PPBE process.

There is a need for a new paradigm for the types of programs Congress funds that should be time-based. The development process and the evaluation of the success of programs should be limited by time and a fixed budget. There should be a commercial or existing technology preference to fielding systems. Finally, there should be a maximum use of rapid acquisition (RAA), middle tier authority (MTA) and tailored Other Transaction Authority (OTA) projects that are limited by time to development. Production at scale should only be funded when a program is mature, but limited production can happen under RAA, MTA, and OTA authorities. The key thing is not to spend time and money solving problems in production. Rather, a program should either meet its time-based development objectives or be cancelled. Better to write off money spend in development than waste excessive amounts of money in production on capabilities that will never work as advertised.

Dr. MCCORMICK. Mr. Clark and Dr, Greenwalt, given Replicator's all-domain requirement, it is clear that there will be multiple vendors with different autonomy algorithms, also known as stacks. For Replicator to be successful, the DOD will need to integrate various autonomy software stacks into a single platform backbone to enable continuous integration and continuous development cycles.

1. How is the Department of Defense planning to integrate the autonomy software of various vendors across domains and ensure success of the program?

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Dr. GREENWALT. I am not sure how DOD will be doing this. It has many options—establish standards, outsource the problem to a large prime, be its own systems integrator, or rely on its own trusted private integrator as the National Reconnaissance Office (NRO) once did. Regardless, the management and integration of this software will be a significant challenge for DOD.

The problem with each of these options is it requires DOD to be more effective in incorporating not only commercial software and technologies but understanding the best practices of commercial software and information technology trends. The role of a knowledgeable, neutral, and objective systems integrator who does not have

any hardware or software skin in the game may be critical and DOD should take a look at the old NRO systems integration model to achieve this objective.

DOD has been lagging the commercial market in the information technology space for at least three decades. It is a key weakness in the defense acquisition process and is one for Congress to spend time overseeing and being a forcing mechanism to get DOD to incorporate the best practices that exist in the commercial market place.

Dr. MCCORMICK. Mr. Clark and Dr. Greenwalt, the Department of Defense's announcement of Replicator caught many in government and industry by surprise. While Congress commends the Department of Defense's initiative to deploy autonomous vehicles to offset China's advantages, there are questions about the programs ability to validate the safety and trust thousands of drones within two years.

1. Do you believe the Department of Defense can fully test and validate the safety and trust of thousands of drones within two years? If not, how can the testing be accelerated?

2. Should the Department of Defense work with industry to accelerate the testing and evaluation of these drone at scale?

3. Do you believe commercially proven modeling and simulation capabilities could help the Department of Defense stay on timeline?

Dr. GREENWALT. 1. Plain and simple the answer is no. The Department will not be able to do the type of testing that it is used to doing if it wants to move systems faster to deployment. Currently the testing approach revolves around providing a system that has been in development for decades and has been produced at low-rate initial production numbers for several years while the testers provide their inputs unconstrained by time or practicality. That will have to change and the Department and particularly DOTE is not ready for that type of change in testing frameworks. In any new time-based developmental environment, minimally viable products will be the first to go to the warfighter in operational situations. Different testing criteria will be needed for feedback to improve those products over time while DOD benefits from the near-term operational usefulness of these products.

2. Given the lack of internal resources and capabilities in the organic DOD testing community, it may be appropriate to consider contracting with industry for neutral, unconflicted testing services.

3. Yes, the Department needs a new testing paradigm and modeling and simulation can offer a tool to accelerate this testing. It also may need different testing standards. For example, instead of its current operationally suitable standard it may need to substitute an operationally useful standard as defined by the warfighter not the DOTE bureaucracy. In addition, if we test to FAA manned flight safety standards for drones rather than something more realistic and appropriate, we will fall behind our adversaries. M&S and other commercial tools and approaches will likely need to be used at scale if DOD is going to innovate at speed.

Dr. MCCORMICK. In order to make Replicator a success, Dr. Hicks has said that DOD must rapidly scale and field thousands of attritable autonomous systems by leveraging existing resources. One effective way to do that is to maximize existing DOD programs that have already been tested and are ready to scale up. Do you agree that DOD should leverage existing successful programs, like the Army's Short Range Reconnaissance Program and the Marine Corps' Short Range, Short Endurance Program to rapidly get small, smart, survivable systems to the warfighter?

Dr. SCHARRE. To the extent that DOD has existing programs or prototypes that are proven, ready to be scaled, and meet mission needs, of course DOD should leverage these to achieve Replicator's goal of fielding thousands of attritable, autonomous systems. DOD has said that it will prioritize the mission needs of the Indo-Pacific theater, and the urgent need for capabilities to deter and, if necessary, defeat Chinese aggression is clear.

The two programs in question, the Army's Short Range Reconnaissance Program and the Marine Corps' Short Range, Short Endurance Program, aim to provide short-range "back-packable" aerial drones to ground troops for "over-the-hill" surveillance. These are vital capabilities to support ground troops and provide them organic, tactical reconnaissance and surveillance capabilities. The short range of these systems will limit their utility in a China contingency in the Western Pacific, which would be a predominantly air and maritime fight. Small, aerial drones would likely have some value for Taiwanese troops in the event of a Chinese invasion of Taiwan. The war in Ukraine has demonstrated the value of small, cheap drones in supporting ground troops, even in a major interstate war with high levels of violence. However, other capabilities such as mines and anti-ship cruise missiles should be a higher priority for Taiwan's military, as they will be most relevant for defending Taiwan against a Chinese invasion.

Dr. MCCORMICK. As you know, since the Cold War, the Department has leaned toward developing and fielding expensive, exquisite weapons systems. The ever-increasing cost of these programs, coupled with breakthroughs in technology, have finally forced DOD to instead focus on small, smart, mass-produced platforms, like drones, that offer greater operational flexibility. How do we ensure that Replicator doesn't turn into yet another program for acquisition of expensive, large, long-range systems?

Dr. SCHARRE. Indeed, this is a major risk. One of the potential failure modes for Replicator is that DOD is unable to be disciplined in cost and requirements, and systems become too expensive to be purchased in large numbers. There is a natural tension in any program between moving quickly and accepting a "good enough" solution and taking longer to design the ideal system. For major weapons platforms that cost billions of dollars and which the DOD will use for decades, such as aircraft carriers, it makes sense for DOD to take its time to be deliberate in scoping the requirements and design of the system. If DOD applies the same methodical approach—which is valuable in some settings—to Replicator, it will fail. In order to move quickly, DOD will need to accept the technology as it exists today. This will necessarily mean that the systems that DOD fields under Replicator, if the initiative is successful, will be less than ideal. They may not be the ideal solution to meet DOD's needs over the long term. Keeping costs low will force difficult tradeoffs in system design. Moving quickly will mean making do with the state of technology today, not waiting for a future improved version. The end result may be systems that have limited shelf-life and are replaced after a few years. This would be a success. While this is uncomfortable for DOD—and indeed may be uncomfortable for some in Congress as well—these tradeoffs are necessary to meet the urgent need to deter Chinese aggression. DOD will need the support of members of Congress to move quickly, be disciplined in cost and requirements, and be willing to accept the risk of systems that are less than ideal in order to field a "good enough" solution to meet near-term operational needs.

Thank you for the opportunity to respond to these questions.