



Metis

Interview

“What degree of human involvement should there be in the use of force?”

Paul Scharre on weapon autonomy and the human role in future warfighting

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Fig. 1 British soldiers with captured German Goliath remote-controlled demolition vehicles (Normandy, 1944).

Source: wikipedia.org | Photo: US Army

Interview

Paul Scharre on weapon autonomy and the human role in future warfighting

After multiple tours to Iran and Afghanistan as an Army Ranger, Paul Scharre played a key role in establishing policies on emerging weapons technologies at the US Department of Defense. In particular, he led the working group that drafted Directive 3000.09, the Pentagon’s 2012 policy on autonomy in weapon systems. With “Army of None”, Scharre also published a widely popular book on autonomy in weapons systems. The interview was conducted by Metis Head of Research Dr. Frank Sauer in March 2021 via Zoom. This transcript was slightly redacted.

Sauer
Getting a conceptual handle on what weapon autonomy is seems to be less of an issue than it used to be. But it remains important to first make clear what it is that we are talking about. Because there still are two competing approaches. The first approach is often coupled to the effort of delineating between “old” – automatic – and “new” – autonomous – weapons and to define the latter as a category of weapons characterized by specific new capabilities such as assessing a situation, making decisions, and learning, almost like a semi sentient machine attacking humans – notice how I am not saying Terminator?

The alternative, much simpler, functionalist approach is to define weapon autonomy as nothing more but the selection and engagement of targets without human intervention. I have a strong suspicion which one of these two viewpoints you choose to adopt. But, to get our conversation started, let me ask: how do you conceptualize weapon autonomy – and why?

Scharre
This is a topic that I have strong feelings about. The terminology is challenging. If you put ten engineers in a room and you ask them to define autonomy, you’re going to get a dozen different answers. I’ve certainly been a part of discussions internationally

at the United Nations (UN) where you see people heatedly disagreeing about autonomous systems. And then you listen to what they’re saying – and they’re talking about different things!
The term autonomous weapons conjures a wide variety of visions in people’s heads. When some people say autonomous weapons, they are in fact envisioning the Terminator. You can’t get through a discussion about autonomous weapons without that coming up. Other people are thinking of something much simpler: a ‘Roomba’ with a gun on it, effectively. And I would like to say that both of those are problematic, but for very different kinds of reasons. They are probably both a bad idea, but there are problems that come from



“My personal view is that trying to make distinctions about definitions for autonomous weapons along this spectrum of “intelligence of machines” is largely a fruitless exercise.

autonomous systems that are not smart enough, and then there are problems that might come from systems that are very sophisticated.

So, I think this distinction between automatic, automated and autonomous is real in the sense that people use those terms to refer to different levels of sophistication of machines. They refer to something very simple as automatic – something that might have a very clear linkage between input and output. A tripwire is an example. Next, they would use the word automated to refer to more complex systems – something like a programmable thermostat in your home. You set in some parameters, and then it performs a function. Finally, they tend to use the term autonomous

to refer to goal-driven systems. Take an autonomous car as an example. It is still, of course, obeying its programming, it's not engaging in free will or becoming alive, but it has more capacity to take inputs from its environment and make “decisions”. That is a loaded word when it comes to machines. But it means that the machine is making choices based on its programming guidance and environmental inputs in order to accomplish a goal.

My personal view is that trying to make distinctions about definitions for autonomous weapons along this spectrum of “intelligence of machines” is largely a fruitless exercise. I've observed that people tend to use the word “autonomous” to refer to things that don't exist yet or that seem a bit mysterious. And then, once we build them and you

are able to look under the hood, the same people say: “Well it's not really autonomous, it's just automated, it's following this programme”. All these things are following the programme! We're not building machines that are coming alive!

This is why I definitely come down on the side of a functionalist definition of autonomous weapons. Instead of talking about the supposed “level of intelligence” of the machine, we are really talking about what the functions are that it is performing. In particular, we must ask if it is performing the functions of searching for and selecting targets to attack on its own. Here, I prefer to envision a decision-cycle according to which an autonomous weapon would be one able to complete that entire cycle on its own: to sense the environment, identify targets, make decision whether or not to attack and carry out the engagement. These are obviously weapons still built by humans; they're still designed by humans. We're not talking about robots building robots on their own and running amok. Instead, this would be weapons that would be launched by humans and put into the battlefield environment for some purpose. So, there is, at a broader level, still human involvement. But that involvement is changed in significant ways that is certainly worthy of discussion. And we have seen this unfolding internationally over the last couple of years, as various actors have been very engaged in the question if it is a good idea to begin crossing that line to build autonomous weapons.

“I definitely come down on the side of a functionalist definition of autonomous weapons.



Sauer

So if we focus on the functionality of the system – or the “system of systems” because functionality might be distributed, that is, the sensor and the shooter platform might not necessarily be the same asset – then the discussion about weapon autonomy becomes one about how to shape that functionality and human involvement rather than about defining a distinct category of weapons?

Scharre

Yes, I 100% agree with that. And indeed, that is a great point: it need not be a single platform or weapon that we’re talking about! It could be a system that is distributed. And that is what makes it trickier. The decision could be distributed as well.

There are situations today where you have a single person looking down the barrel of a rifle, making a decision about whether to use lethal force. But then there are other situations. If you look at a modern military launching a cruise missile from a ship – that use of lethal force decision is quite distributed. You have targeteers planning out various targets and making decisions, then those get approved, they get on the target list. Then there’s a decision to actually launch the strike, then you have people on the ship that are planning out the strike and a commander who authorizes the launch. And in the end, it might be somebody else who is actually pushing the button to launch the weapon. So, when you ask who is responsible, then there are still people responsible today. But it may not be one single person. That authority may be distributed – which definitely complicates the issue

when we think about autonomous weapons today.

Sauer

*Why are militaries pursuing weapon autonomy?
Could you run us through the main advantages of having increased weapon autonomy?*

Scharre

Let’s be clear, the main advantage is military effectiveness. That’s why militaries are interested in investing in increased autonomy in weapons systems. And I want to draw attention to the fact that I am using the term “increased autonomy in weapons systems” – which is a bit fuzzy and ambiguous – rather than “autonomous weapons” per se. Because when I look around the world at the investments that militaries are making, we see every major military investing in increased autonomous functionality

in robotic platforms, in weapons systems, in defensive systems. Because there are many, many advantages. At the same time, I am hard pressed to point to development programmes that are clearly designed to cross the threshold to fully autonomous weapons that would be targeting on their own. There are some examples of things that have already been around, like the Israeli Harpy loitering munition, and there are certainly at least thirty countries that have supervised autonomous weapons systems for defensive purposes like Aegis or Patriot or even active protection systems for ground vehicles to shoot down incoming rockets. But currently, while a lot of the development programmes look like they are heading down a path towards greater autonomy, it’s either unclear how far they are going to go and whether they go to “full autonomy” or if they tend to walk up to the line but perhaps not cross it.



Fig. 2 IAI Harop (or IAI Harpy 2) at Paris Air Show 2013. | Source: wikipedia.org, Photo: Julian Herzog



Fig. 3 "A Long Range Anti-Ship Missile (LRASM) launches from an Air Force B-1B Lancer during flight testing in August 2013." | Source: wikipedia.org, Photo: DARPA





Sauer

Let's talk about this "line" and no one seeming particularly keen to cross it. There is a lot of debate about the legal implications, the ethical risks, the political risks of operating weapons autonomously.¹ Which one of those weighs the heaviest on your mind in terms of where weapon autonomy could go wrong?

Scharre

I am most concerned about strategic issues. I think that they're relatively understudied compared to other issues. There has been a lot of writing about the legal issues surrounding autonomous weapons. The conversation today has a focus on laws of war compliance and humanitarian concerns in part because of the way the issue has been brought to the fore internationally. That was originally Christof Heyn's report as a Special Rapporteur for extrajudicial killings in the UN and his very influential report in 2013 that helped raise the issue, in addition to influential and significant work by the humanitarian disarmament community, for example

the Campaign to Stop Killer Robots, Human Rights Watch, Article 36 and many others. They put this issue on the agenda internationally in the UN. And this really put the humanitarian disarmament concerns front and centre. Just by virtue of attention, issues surrounding strategic considerations and the risk of instability among states, as you and Jürgen Altmann, Jean-Marc Rickli, Mark Gubrud and others have written about, have received less attention.

I have perhaps a cynical view about the legal issues, which is to say that I think that countries care about the laws of war about as much as they want to. So you'll have some countries that will pay more attention to issues surrounding compliance with international humanitarian law, and you'll have countries that really don't, and then you have some in the middle that may be more flexible with how they interpret the law but are going to at least be giving lip service to it. And I am not sure that more statements and treaties are really going to change a country already inclined to ignore existing legally binding obligations.

principles is going to be less convincing with Vladimir Putin or Xi Jinping. Appealing to concerns about strategic ability may be an area where there might be some areas of agreement.

Sauer

If you had the power to wave a magic wand in light of these strategic risks and draw specific lines with regard to weapon autonomy, would you consider concepts such as "meaningful human control" or "appropriate levels of judgment" or other such concepts currently being developed helpful in terms of making the use of weapon autonomy less risky?

Scharre

I'm less concerned about the bumper sticker. Sometimes people get fixated on labels, like meaningful human control, appropriate human judgment, necessary human involvement, or any number of other formulations. I am less interested in that. I'm more interested in where the discussion at the Convention on Certain Conventional Weapons at the UN in Geneva has been heading the past few years, namely trying to get past the label and talk about what we think it means.

What degree of human involvement should there be in the use of force? That's valuable because the technology itself is rapidly evolving. Very reasonable people might have very different assumptions about the state of the technological maturity five, ten, fifteen, twenty years from now. I don't think anybody really knows exactly what the future will look like in terms of the reliability and robustness of autonomous systems operating in very complex environments. So, the appeal of focusing on the human element is that in principle it should be unchanging!

The question is not: what *can* robots do? It is: Imagine robots can do anything we wanted, what role should humans still be playing in lethal decisions – and why? I think

“Imagine robots can do anything we wanted, what role should humans still be playing in lethal decisions – and why?”

In contrast, I think the strategic issues are potentially a greater point of purchase between great powers. There is potentially an area of agreement worth exploring. My suspicion is that appealing to humanitarian

¹ See “The security-policy effects of digitisation: Future forms of conflict and conflict management”, Metis Study No. 1 (February 2018).



that is an interesting question worthy of exploration and very relevant from a legal or ethical standpoint. So, from the position of international humanitarian law: what are the minimum necessary degrees of human involvement in lethal decisions? From an ethical angle: where do we really think it's vital to have humans involved – are there morally necessary human decisions?

Finally, it's worth looking at human practice in the past. So even in very complex systems we might have humans physically remote already, and we might ask how we feel about elements of that changing. I would love to see the international community and various experts explore whether there is agreement or whether there are clear differences in points of view, with different camps emerging with different perspectives on the future of human involvement. Ideas about "rules of the road" or "codes of conduct" surrounding autonomous systems and how they might interact in military environments might also be useful confidence building measures for states to explore, and so I don't know that we should put all our eggs in the "human control" or "human judgment" basket. Other things might also separately be worth for states to discuss.

Sauer

Let's put a question mark on weapon autonomy in a different sense. Has anyone truly figured

out how to effectively employ weapon autonomy? For instance, do you consider the recent Nagorno Karabakh experience a glimpse into the future? Is this the most likely way we will see autonomy unfold on the battlefield?

Scharre

Great questions. Let me take those in sequence. I think in terms of how people are employing autonomy, one of the things that I struggled with when I was writing "Army of None" is: when does this story start? It clearly doesn't start today, or in 2012, or in 2009. I started to try to understand how much autonomy already exists in weapons.

Certainly we've had automated defensive systems in militaries since the 1980s that in many cases have autonomous modes of operation where a human can turn a switch and the system will automatically defend a land base or a ship or a ground vehicle with the human in a supervisory mode. They can disable the system or maybe halt its operation, but otherwise it's effectively operating as an autonomous weapon. It'll engage incoming threats, aircraft, rockets, missiles, all by itself. That's been around for several decades. Then there are precision guided weapons. They have a much more narrowly constrained element of autonomy. But there's some autonomy – many of them are fire-and-forget weapons that are intended to

be used to destroy targets that have been chosen by humans. But once released many of them cannot be recalled – they have an on-board seeker, they can sense a target, they have constrained autonomy. You might imagine them like an attack dog with blinders on. Those have also been around for decades. In fact, the first precision-guided weapons date back to World War II.

And even prior to that there were various types of automation in weapons coming out of the industrial age. And so my research brought me all the way back to the American Civil War and to the Gatling gun, where automation accelerated the killing potential, the lethality of troops on the battlefield, in ways that did not reach dramatic effectiveness in the American Civil War but came to fruition during wars of British colonial expansion and then in really violent ways in World War I.

Conceptually, there's a sharp distinction between weapons where humans are making decisions rather than machines. That seems clear in principle. But when you start to look at the nitty-gritty details of weapons, it gets blurry. I talk in the book about weapons that are the next evolution of increased autonomy like the Brimstone missile or the LRASM that are not autonomous weapons – but they add more autonomous features.

So, I look at Nagorno Karabakh as one more piece of evidence towards the significance of drone warfare and robotic weapons. We've already seen drones and robotic weapons be used in other contexts, for example remote weapon stations and very crude and unsophisticated ground robotics in Syria on multiple sides. We've certainly seen crude home-made drones being repurposed.

But I'm also waiting to hear more details about the degree of autonomy of some of the loitering systems used in Nagorno Karabakh. Because one of the things I found is that oftentimes things are not as autonomous as they are advertised to

“Oftentimes things are not as autonomous as they are advertised to be.”



be – which is really interesting. There also have been claims made by the US military about the degree of autonomy of Chinese systems, some finger pointing if you will, and I'm a little bit sceptical. I have less insight into Chinese weapons developers, of course, but my experience with talking to Western weapons developers in the US or the UK has been that the actual functionality just doesn't add up to the hype on the website. So, I hesitate to make a claim about the degree of autonomy in the systems seen in Nagorno Karabakh.

This also points to what is one of the early misconceptions about robotic systems, in part because of some of the most attention-grabbing uses of drones by the United States in a counterterrorism role. It is this narrative of drones being these

advanced “wonder weapons” that are going to drive the divide between more advanced nations and less advanced nations. Actually, most scholars following this closely saw the opposite, namely that this technology has already widely proliferated to countries around the globe and into non-state groups. And autonomy is actually one of the most accessible components of it! You can buy a DJI drone that has more autonomy than an Air Force Reaper drone. The cost of systems scale with size. A large robotic aircraft that can be used as an intercontinental stealth bomber, that is only going to be in the realm of really advanced nation states. But autonomy itself is fairly accessible. Hence I suspect that it won't be long before we see not only an increase in mass drone attacks – which

we've already seen in Syria – but autonomous mass drone attacks at larger scales being used by non-state groups over the next five to ten years.

Sauer

You were mentioning “hype”. Some argue that the US, China and Russia are in an arms race. But maybe Missy Cummings is right, and what we are actually in is a “hype race”. She makes a great case for why many of the military applications that are currently envisioned and prototyped will end up not delivering on what is promised. In that sense, could we end up in a worst-of-both-worlds-situation in which few of the military benefits actually materialize but the risks of political distrust and military competition become real?



Fig. 4 An X-47B, a technology demonstrator used for testing autonomous operations, conducts a touch and go landing on the flight deck of the aircraft carrier USS George H.W. Bush (CVN 77). Atlantic Ocean, May 14, 2013. | Source: wikipedia.org, Photo: US Navy photo courtesy of Northrop Grumman by Alan Radecki



Scharre

I think it's clear that we're in a hype race, at least when it comes to artificial intelligence (AI). Countries have been more hedging when it comes to talking about autonomous weapons. You don't really see countries standing up and jumping up and down and saying: "We're building autonomous weapons." In part because this is a loaded term diplomatically, because of international discussions.

But when it comes to AI, countries like Russia and China and the US and others are talking a big game. What's interesting is that when you look at what they're actually doing, it doesn't really amount to very much. It's certainly not an arms race in any meaningful sense of the word. The specific definitions vary in the political science literature. But most of them revolve around the idea of increased military spending above normal levels, and different scholars argue about different quantitative thresholds for this. But the amount of money being spent on AI in militaries is a very small fraction of the total defence budget. To the extent that there is any development going on in terms of increased autonomous functionality in weapons or even to "build fully autonomous weapons", that would be even smaller. So, I think it's clearly not an arms race.

AI will nevertheless be significant in terms of its influence on military operations. But most of it is back-end operations. Those are not as exciting in terms of "AI", but there's a lot of value to them. Because most of what the military does on a day-to-day basis looks a lot like what Walmart does. It's moving people and things from place to place. It's what happens at the end that is very different, of course. But defence analysts well understand that the vast majority of what militaries do, even people who are in uniform, is not combat. I suspect that that's where militaries will find the most value in AI: personnel,

logistics, finance, data analytics or intelligence, surveillance and reconnaissance.

The military benefits of fully autonomous weapons are probably overstated. I don't think there's zero benefit. But they get this hype and credence, as though they are this game changing "wonder weapon", in part because there are debates about taking them away or prohibiting them. And as soon as you try to take away something from someone, they want it all the more. That's just human nature.

Compare a weapons system that has a high degree of automation but kept a human in the loop for actual target authorization, a semi-autonomous system, with one that is fully autonomous. There are some operational benefits of full autonomy. But it doesn't take humans *that* much time to identify a target and verify it. In ground combat operations we have people, special operators, go into a room and make split-second decisions about "shoot" or "no shoot". They don't *always* get it right. But we can train people to do it reasonably well. And we certainly have systems in existence today like the C-RAM, the counter rocket, artillery, mortar system, where there are humans in the loop, and it has what I would call a dual safety function. That is where you have both automated safeties trying to use automation to weed

out actions that are false positives, but then you also still have humans in the loop so that humans can verify a target visually. One of the things that humans can actually do quite well is quick visual object recognition. I can put a coffee cup in front of you and let you instantly recognize what it is ...

Sauer

... from any angle, independent of its colour or any other features, I will always recognize it immediately. Because I – unlike any machine – know the concept of a coffee cup ...

Scharre

Right, exactly, so it's worth distinguishing between system-1 and system-2 kinds of decisions and what decision you want humans to make on the battlefield. There are some decisions where you are really just asking to confirm: "Yes, that's a valid enemy target. That's a tank, that's an enemy soldier, that's an enemy aircraft." People can make those decisions very, very quickly. There are other more difficult decisions. For example, how to weigh collateral damage. Those things take longer and require more deliberate processes but also can be done in a more deliberate manner through things like setting rules of engagement ahead of time.

“The military benefits of fully autonomous weapons are probably overstated.”



Fig. 5 An example of failure modes in a convolutional neural network: the leftmost image is classified as “banana” with high confidence, whereas the images with modified colour are correctly classified. | Source: Hendrycks et al 2021, Natural Adversarial Examples, arXiv:1907.07174v4 [cs.LG], p. 11

Sauer

Let’s talk about regulation. On page 262 of your PhD thesis ...

Scharre

Oh boy (laughs) ...! You’re getting down in the weeds. You’re getting the award. You’re the only one who read the whole thing!

Sauer

I did read the whole thing! It’s great, and on page 262 you’re saying “All states would be better off if there were no autonomous weapons.” Does this mean that you see the risks, but you don’t see that any of the key players will be willing to tie their hands in a binding regulation in the current geopolitical landscape?

Scharre

Indeed, I don’t think so. There might be different tones coming out of different countries. But I think the US is going out of its way to emphasize an approach towards responsible development of military AI that is very cognizant of legal and ethical concerns, including the risk of accidental harm. The US is very focused on ensuring

that its development is consistent with the laws of war. The US government is not going to support, and it’s been pretty clear about this, a pre-emptive legally binding treaty that would tie its hands, particularly when other major military powers are not going to support such a treaty or, if they did, I would argue cannot be trusted to actually adhere to it. I also don’t see other NATO countries supporting a treaty either.

Sauer

You don’t expect any changing stance in Geneva under the new Biden administration?

Scharre

No, I don’t think so. That’s just speculation on my part. But I doubt it. And, with regard to regulation, people tend to fall into one of two camps. One is, “autonomous weapons are terrible; they will be a scourge upon humanity and if we all just summon the political will, then we’ll be able to ban them.” And then there’s the alternative camp, which says “these bans are hopeless, and they would never work, and wouldn’t autonomous weapons be so great anyway? They

would be wonderful. They would be more precise and more humane!”

It seems like some motivated reasoning all around. There are alternative possibilities, too. It’s possible that autonomous weapons might not be such a great thing, but constraining weapons development is very challenging – and the historical track record on that is a mixed bag. So, it’s possible that we would be better off without autonomous weapons – and weapons of war in general –, but it might be difficult to actually constrain them. It’s also possible that the ban is entirely achievable, but autonomous weapons are not such a big deal. There are multiple possibilities here.

My own perspective is that there’s a lot of value that humans bring to the table when it comes to lethal force decisions. The human brain remains the most advanced cognitive processing system on the planet. We can build narrowly intelligent machines, particularly using some of the recent methods involving deep learning that are very impressive for very, very narrow applications. But they tend to not be very robust – regarding environmental changes, regarding changes



in the datasets. They are very brittle types of systems.

Look at something like autonomous driving. We can build autonomous cars that do great on a track.

about. There are a lot of risks involved in handing over increased autonomy to machines. And I would certainly like militaries and states to be more cognizant of those risks.

more broadly the military track record of safety – it doesn't fill me with a great sense of confidence, quite honestly. Or you look at Scott Sagan's work on nuclear safety, and it's terrifying! It seems like only by the grace of God or sheer luck that we've not had a nuclear weapons accident or even an intentional use. So, when you look at things like nuclear safety and the track record even in advanced industrialized nations, it's horrifying. And then you think to yourself that people understand that nuclear weapons are dangerous, and that this is actually the system trying its best. So, what concerns me about AI and autonomy is this veneer of superhuman-ness. This perception that the system is better than humans, and this often leads to people overestimating the intelligence and capabilities of systems. I'm glad you brought up Missy Cummings. She does phenomenal work surrounding these issues of human-automation-interactions.

“The human brain remains the most advanced cognitive processing system on the planet.”

But in the real world, there's a lot of risks. The real-world environment is uncontrolled, there are pedestrians and cyclists and so on, and then we have environmental conditions which are challenges for sensors, like rain and snow and sleet, and those are all *real* problems. And the military environment is *vastly* more difficult than that! You have an adversary that is actively trying to undermine your systems. You don't have the ability to map the environment the way that autonomous car companies are doing today. So, I think there's enormous value in keeping humans in the loop and keeping human involvement.

I think it's also worth being cognizant of the reality that there are already narrow military applications like defending against incoming rocket and missile attacks, where we have crossed that line towards autonomous weapons, where humans are now in a supervisory mode. It is quite likely that – over time – that bubble where we cede control to machines slowly expands. That's something to be concerned

When I look at the track record of accidents with automation and autonomous weapons – things like the 2003 fratricide involving the US Patriot missile defence system, but also



Fig. 6 Test shot of a Bundeswehr Patriot surface-to-air missile (SAM) system at NATO-Missile Firing Installation (NAMFI) Crete, October 6, 2016. | Source: Flickr, Photo: © 2016 Bundeswehr/Nurgün Ekmekcibasi



“I remain optimistic, but I do think that we are at a point now in human history where we are dealing with genuinely dangerous technologies.

Sauer

This leads me to my final question. Pandemics, climate change, nuclear weapons, AI – will the human species make it through the great filter?

Scharre

(laughs) Oh, that’s a whole other can of worms! I would recommend Toby Ord’s excellent book “The Precipice”. I think Toby gives humanity a one-in-six chance of extinction in the next 100 years. That’s a little horrifying. That’s basically playing Russian roulette. I don’t know if that’s realistic.

But I will say that I am certainly far more concerned about anthropogenic risks than I am about natural risks like a meteor striking the earth. I worry about things that are caused by how we interact with the environment, like climate change, or technology risks like nuclear weapons or the increased spread of pandemics, whether it’s because of how we treat nature or the way that the world is interconnected or gain-of-function-research in bio labs. These are all the kinds of things that I would like to see more attention paid to. I remain optimistic, but I do think that we are at

a point now in human history where we are dealing with genuinely dangerous technologies. We’ve been there certainly since we crossed the nuclear threshold. I’d like to see more attention paid to those kinds of risks.

Sauer

It’s been great talking to you, Paul. Thanks for taking the time.

Scharre

Thank you, Frank.



Interviewee

Paul Scharre, PhD

Paul Scharre is the Vice President and Director of Studies at the Center for a New American Security. Scharre served as a US Army Ranger special operations reconnaissance team leader and conducted multiple tours to Iraq and Afghanistan. Subsequently, he worked in the Office of the Secretary of Defense at the US Department of Defense, where he was involved in establishing US policies on unmanned and autonomous systems, intelligence, surveillance, and reconnaissance programmes and directed energy technologies. He is the author of “Army of None: Autonomous Weapons and the Future of War”.

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Title image

"A US Marine 1st Marine Division (MARDIV) runs through CS gas during the hike portion of the 1st MARDIV Super Squad Competition at Marine Corps Base Camp Pendleton, California, Aug. 30, 2018."

U.S. Marine Corps photo by Lance Cpl.
Audrey M.C. Rampton

Source: https://www.flickr.com/photos/marine_corps

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