**CRAIG:** Hi, I’m Craig Smith and this is Eye on AI. Regular listeners to the podcast know that I’m interested in the geopolitical implications of artificial intelligence. The most pressing of those implications is the competition between the US and China to integrate AI into their military capabilities.

That matters because dominance in the technology not only means victory in any future war, but more importantly, likely guarantees the longevity and global influence of the governments that wield it. Already, China is exporting its AI-enabled surveillance technology - which can be used to quash dissent – to client states and is espousing an authoritarian model that promises economic prosperity as a counter to democracy, something that the Soviet Union was never able to do. Western liberal democracy may not be the end of history that Francis Fukayama foresaw.

This week, Robert O. Work, former Deputy Secretary of Defense and recently co-chairman of the National Security Commission on AI, talks about that competition; about the evolution of so-called algorithmic warfare, about the development of lethal swarm technology and the dangers of autonomous control systems that could inadvertently trigger war.

Secretary Work is one of the best placed people to talk about these issues. I’ve had him on the podcast before and hope to have him again as this story unfolds.

I hope you find the conversation as important as I did, and I’d love to hear your thoughts. Please email me at craig@eye-on.ai.

**BOB:** From 2009 to 2013, I was the Undersecretary of the Navy. And I spent a lot of time watching the technological trend lines in the Western Pacific, as it pertained to the people's liberation army Navy, the PLAN and the technological trend lines were not good.

**BOB:** I left in 2013 And I came back in 2014 as the deputy secretary. I said, if I come back in, I'm going to try my best to get the department really focused on this emerging military technical competition. I spoke with all of the Cold Warriors that I could talk to Harold Brown, Bill Perry, Paul Kaminski, Andy Marshall.

**BOB:** And that's where I first learned the term offset strategy. And the Cold Warriors thought of it in those terms, the, they constantly thought about offsetting the Soviets. So, I came in and I had a sense that was what I would like to try to do. And I started talking with Secretary Hagel and I said, sir, we've been in the Middle East. We've taken our eye off of the big competitors out there. We're steadily, and now in my view, acceleratingly losing our military technical superiority, which isn't a good thing. That's the basis of our military strategy since the end of World War II.

**CRAIG:** When you were out in the Pacific at the very beginning of this, looking at the PLAN what did you see specifically that gave you concern that said, wow, we better pay attention to what China is doing.

**BOB:** Well, it all really boils down to missiles. The Chinese said, look, we're not going to try to compete, head up against the US air force. They're too damn good. It's too expensive to go into an all fifth gen force. It's hard to train the pilots. Very difficult. So, we're going to go with missiles and the Chinese are now the best missileers in the world.

**BOB:** And not only are they good missileers they just have a lot of missiles. So, there's this big disparity in magazines. They can afford to fire a salvo of 10 missiles whereas because of our small salvo size, we maybe could only afford to fire a salvo of two missiles.

**BOB:** Land and sea

**BOB:** Their land-based missiles have longer range than most of the sea-based missiles. So, they have missiles now that can target aircraft carriers beyond the range that our airplanes can sustain large number of sorties. So, it's primarily the missile threat that really causes a problem to the joint force because the missiles can attack American bases throughout the region, and they can attack ships moving into the region and they just have a lot of advantages. The other thing that Chinese did, and this just goes to how good of a competitor they are, when they were looking at the U S they said, hey, the US has a lot of interceptors that are good for Indo atmosphere. They have interceptors that can shoot down airplanes. They're really good.

**BOB:** The Patriot missile.

**BOB:** And so, the Americans have a lot of endo-atmospheric interceptors. And they have a lot of sensors that scan the atmosphere for threats. They also have a lot of sensors and interceptors for space. The SM-3 missile can knock down ballistic missiles traveling through space. So, the Chinese said, there's this area called near space, which is above the altitude that an aircraft can fly, but below the altitude that a spacecraft can remain in orbit. And that is the domain for hypersonic weapons. So, they said we are going to move into that domain. We will gain an advantage because the Americans don't have sensors or interceptors for that domain. And we will essentially cause them a problem that they're going to be very hard pressed to solve.

**BOB:** And they were exactly right. So, they have a lot of numbers of them. They're very good.

**BOB:** And we're playing catch up.

**BOB:** The other thing that's really concerning about the Chinese is we're coming across 6 to 7,000 nautical miles of Pacific Ocean. And we have to bring our battle network with us, all of the links, all of the sensors, all of that.

**BOB:** And the Chinese and the Russians have continental-based battle networks. And the only way we can compete with them is if we have space systems and a lot of them. Chinese and Russians know this, so they're spending a lot of money on counter space capabilities. This is another thing that the Chinese have spent an enormous amount of money on, and they want to knock down our space constellation because they know if they can do that, they're going to be able to really give us a run for our money.

**BOB:** So, we fight operation allied force in Serbian Kosovo. And at the end of the war, the Serbian army, if you remember just drove home. It was underground, the whole war and never got hit.

**BOB:** And the Chinese said, isn't this interesting the Serbians gave up and their army wasn't attrited.

**BOB:** That's when the Chinese started saying we're moving beyond attrition warfare to a new era of what they referred to as systems confrontation; confrontation between their operational system and the American operational system. And their theory of victory is what they refer to as system destruction warfare.

**BOB:** Essentially, they say, look, we're not going to worry about the exchange ratio in air-to-air combat or sea combat or, whatever it might be. We're going to go after the American battle network because if we can blow apart their battle network, they won't be able to operate and they won't be able to achieve their objectives and we'll win.

**BOB:** That is their theory of victory. So, every single link or communication system we have is covered by a Chinese jammer. They do all sorts of cyber intrusions. And they put them all under one commander and this commander just looks at the American battle network and says, how can I break it apart?

**BOB:** So that's another big worry, because I don't think we train enough to fight and survive in that type of environment.

**CRAIG:** What's your biggest concern about Chinese use of AI? Is it weapons systems? Is it autonomy? Is it a command and control, surveillance, coalition building, in other words, exporting their stack to smaller countries?

**CRAIG:** Is it spying and cyber warfare?

**BOB:** I would say all of the above, but the two things that I worry about most in terms of the actual military technical competition is, one: They put a lot of emphasis on swarms -UAV, UUV, USV- swarms of unmanned systems. And they continue to train in large numbers.

**BOB:** We're talking scores maybe up to a hundred. And so that worries me because we test, but we haven't really shown the ability to employ these types of swarms in a combat scenario.

**CRAIG:** Are these small drones are these Predator- style drones? Are these armed or could they be armed? And certainly, if they're swarms there's a level of autonomy, but are these wingman swarms, flying along with a lead human, or are they purely autonomous?

**CRAIG:** And are they lethally autonomous from what you understand?

**BOB:** Yeah, I believe they got their hands on and have exploited the Israeli Harpy missile. The Harpy is a loitering lethal autonomous system. It goes over an area, if it sees a radar that is within its library, it automatically attacks the radar.

**BOB:** And so, they certainly have those. I know they're experimenting with small drones and the Harpy is, that's not a giant system. I would say, eight or 10 feet long, something like that, but they're experimenting with the whole area. And they've talked a lot about swarming under sea vehicles. They know that we have an advantage in undersea warfare, but I haven't seen any reports on their success there and how it's working. But they're exploring all of them.

**BOB:** Now, the other thing I worry about is a lot of people, when they talk about autonomous weapons, their mind generally immediately jumps to the Terminator. And that's not the kind of system that I worry about. The kind of system I worry about is a control system that can autonomously order either a preemptive or a retaliatory attack.

**BOB:** Those I think are very destabilizing and could lead to flash wars, just like we see flash crashes on the stock exchange. And if they were associated with nuclear weapons, that would be extraordinarily dangerous. So, to me, that is the worry. And that would be the area that I think the US should sit down with China and Russia and say, look, if we're going to have an arms control agreement on any of this stuff, let's start here.

**BOB:** Neither of us wants to get into a war because an autonomous control system made a mistake and ordered a preemptive strike because it thought the indications and warning was, hey, these guys are ready to hit us, so we better hit them before they hit us. So that's the thing that I worry about the most. The swarms, I know the Chinese are working on them.

**BOB:** I don't know if they're working on autonomous control systems in this regard. I know they talk a lot about command and control, AI command and control and I'm certain they're working on it, but this is one of those things you won't know until you're actually in a war. You might not know how good they are until you're actually in the competition itself. So, it's very difficult for us unless we get some type of intelligence hit.

**BOB:** Garry Kasparov, he was the world champion chess player beaten by Deep Blue.

And after that, he went through a period of soul and really started to say, where is this leading us? And so, he went through a period of centaur chess, a chess machine that nominated moves to the human, and then the human would decide, and it was a combination of human intuitiveness and creativeness, and the machine's ability to just to crunch numbers and provide stuff.

**BOB:** And as he went through this, he went through a period of time where the centaur chess guys would always beat the supercomputer and when I say always, I think that it was like 70% and would always beat humans alone. And his hypothesis was that weak humans with strong algorithms would always beat strong algorithms alone or strong humans with weaker algorithms.

**BOB:** DARPA said, let's test this hypothesis. And they took a series of players and they referred to these players as human players and the human players had an average of nine years of military experience. Then they would go against the expert players and the experts were guys with 29 years average military experience. And they gave the inexperienced guys an AI called Brainstorm. Storm is a stochastic campaign model that we run. And it says, how many airplanes will they lose? How many airplanes will we lose, and simulates a campaign. And they made an AI that would nominate courses of action to the players, and they played 30 games and it turned out that the inexperienced players with AI won 14 games and the experienced players with 29 years of experience won 16.

**BOB:** So essentially the rookies played the experts to withdraw using AI. And that's what both, I think the US and China see is, this is how AI will help us.

**BOB:** What we said is what will happen is when you move to algorithmic warfare, what you'll start to see is a new type of battle network, which we refer to as a human machine collaborative battle network.

**BOB:** And we said, this thing is going to make more rapid sense-making of high volume, heterogeneous data, more rapid perception of the operational environment more rapid development of a common operational picture shared more quickly throughout the force, more rapid development of course of actions and plans, more rapid force, wide recognition and understanding of the commander's intent and more rapid, more relevant decisions.

**BOB:** So, after talking with Secretary Hagel for about a period of two months, I came in, in May of 2014 and by November 2014, Secretary Hagel announced the Defense Innovation Initiative, or DII. He didn't say these words, but he basically said, look, we've got to turn the direction of this huge ship of state called the Pentagon. And we need to start looking more at our large state competitors. And we really have to start worrying about the loss of technological superiority.

**BOB:** Secretary Hagel doesn't get a lot of credit. I get too much credit. He doesn't get enough, but he was the one who announced it. And there were seven lines of effort.

**BOB:** And the first line of effort was strategy. Second line of effort was operational concepts.

**BOB:** The third line of effort, we referred to as a competitive strategy to achieve and maintain technological superiority. That became known as the third offset strategy.

**BOB:** The fourth line of effort was war gaming.

**BOB:** The fifth line of effort was DOD intelligence community collaboration.

**BOB:** Sixth, and I might've gotten a fifth and sixth mixed up, but it was called information capabilities management. And the way we referred to that, is we would reveal capabilities that we were developing, if we wanted to have a deterrent effect. And then conceal for war-fighting effectiveness, if we wanted to keep the capability secret so that if war erupted, we'd have an advantage in the first week or a month of the war.

**BOB:** Then the seventh was building stakeholders because at that time in 2014, nobody was talking about great power competition. In fact, you couldn't even get anybody to say the words. So, we knew that we had to go to the White House and the Hill to really convince them we need to do this, and we need your help in doing it.

**BOB:** Secretary Hagel left, Secretary Carter comes, and he adds an eighth line of effort. He'd gone to the West Coast, and he saw all of the innovation that was going out there and dual use technologies and he came back, and he said, look, if we're going to have a strategy to gain and maintain technological superiority, we're going to have to exploit the commercial sector.

**BOB:** And so, when he came in, we had DIUX, the Defense Innovation Unit, all of these rapid capabilities office, and all of these things to really start going after commercial sector, dual use technology like AI, quantum, and all of that.

**BOB:** Now, the way it turned out, Craig, is that the third offset strategy became shorthand for line of effort three. And it soon became shorthand for the whole defense innovation initiative, which to this day I regret, there was a lot in the defense innovation initiative that was going on, that people just lost sight of. And they said, oh, this is just another thing called transformation. This is going after technological silver bullets and the technology aspect of it was only one of what ultimately ended up in eight lines of effort.

**BOB:** So, when we started working on the third offset strategy, there was just so much going on in all these different technologies. I would get a brief on quantum, and they'd say, man, if we lose the quantum race, we're doomed. And then I get a brief on synthetic biology. If we lose this race, we're doomed. And AI, et cetera.

**BOB:** So, I went to the Defense Science Board, and I said, look, you've got to help me make sense of this, of all of these technologies. What are the one or two technologies we really need to pay attention to? And they came back and said, it's not even close: AI enabled autonomy.

**BOB:** That is where the department offense has to dominate or, it risks losing its military technical superiority, because we know the Chinese are headed after this in a big way.

**BOB:** This was 2014, early 2015.

**BOB:** And AI became central. And we started thinking, okay, let's take this to its logical conclusion. And we started to refer to an AI enabled joint force and the changes that would bring about. And we started thinking of that in terms of algorithmic warfare.

**BOB:** Now at the time, the Chinese were talking about intelligent-ized warfare.

**BOB:** They said, we went from mechanized warfare to informationanal-ized warfare, and now we're moving to intelligent-ized warfare. This is the Chinese definition of intelligentized warfare, which we adopted as a good definition for algorithmic warfare: combat operations conducted with intelligent weapons and equipment platforms using artificial intelligence as the core and with technical support from information networks, big data cloud computing, the internet of things and intelligent control. And they said, hey, you're going to have intelligent ordinance, intelligence platforms, intelligent systems, intelligent command decision-making, intelligent logistics, and intelligent equipment support.

**BOB:** And they said, this is the way we will ultimately defeat a US force that's really good using intelligentized warfare. And we actually just stole, we stole their definition of intelligentized warfare, for algorithmic warfare. We thought it represented Chinese thought.

**BOB:** In 2014, AlphaGo defeated a second Dan go player and the Chinese were shocked, but they said this guy was just a second Dan player.

**BOB:** And there are nine Dans. And then Lee Sedol who was a ninth Dan player was going to play this machine and the Chinese were confident Lee will beat the crap out of it.

**BOB:** And when it became clear that Lee Sedol was going to lose, it really shook up the Chinese government, and that was the Chinese Sputnik moment when it came to AI. They said, if AI can do this, a game that we would have never conceived of a machine beating a human, then we've got to pay attention to it.

**BOB:** And that became the impetus for their AI plan.

**BOB:** So, we knew the Chinese were really getting after it. We said, this is what's going to happen. We have battle networks. Now the battle networks have four grids, so they have a sensor grid, and the sensor grid is looking in the battle space and picking up radar imagery, electro-optical imagery, SigInt intelligence, ElInt, electronic intelligence.

**BOB:** It’s massive data coming in. So, you've got the sensor grid and then you have a command-and-control communications and computer grid, or C4I grid, that tries to make sense of that. And then the commander converts that into a course of action and then a plan. And so that's the C4 I grid. Then there is an effects grid, which applies the effects that the commander has said, this is how I want to pursue the campaign.

**BOB:** And then you start it again, you have a sustainment and regeneration grid to keep your battle network going because it's being attacked all the time and you're attacking their battle network. The Chinese actually added a fifth grid. They thought of it in the same way. They call it the information contest station grid, because after the bombing of the embassy in Belgrade on May 7th, 1999, the Chinese really got serious and said, okay, we're going to go after the Americans and we're going to achieve military technical superiority. And they have a program that refers to with 995, project 9 9 5, May 99.

**BOB:** And that was where they started doing everything in hypersonics and space and Assassin's Mace type stuff. Missiles, all of that. And AI becomes increasingly important, especially after 2016 and the Lee Sedol thing. Now what we did to keep the department on track, we established a thing called the ACDP, the Advanced Capabilities and Deterrence Panel.

**BOB:** It was tri- chaired by me, the vice chairman of the joint chiefs and the principal deputy director of national intelligence. And we were watching all seven and then later eight lines of effort and we were trying to get the department to change its orientation. And we would have meetings every four to five, six weeks.

**BOB:** We would bring in people. We would have briefs on what was the realm of the possible with AI, and et cetera. And really it was trying to socialize to all of the senior leaders in the department; we got to change, and if we don't change, we're not going to like the results. So, we had several, what we call special programs.

**BOB:** One program was focused on North Korean nuclear weapons. They were all road mobile, and we said, we want a way to be able to track them and be able to attack them before they launch. And certainly, after they launch, but preferably before. And AI, machine learning, became a central part of the way we were going to attack that problem.

**BOB:** And that program lives on it's still going on. And all I can say in an unclassified way, is it been very successful. And so that was one program. The other program that we started was we knew that our space constellation was going to be brought under attack. If we ever fought Russia or China from the first day of the war, if not before. It might be the initiating shots of the war.

**BOB:** And we said, we have to be able to fight our constellation we have to know when we're under attack, we have to respond to the attack. We have to go after the enemy's capabilities for space attack. And that became known as the JICSPOC, the Joint Interagency and Combined Space Operations C enter. And so, if you think of it, Craig the JICSPOC looked up and it looked at our constellation and it says, Hey, we're under attack.

**BOB:** We got to move this guy and we've got to get this guy out of the way we have to take care of this bad guy's weapon. And then there's a thing called the Joint Space Operation Center in Vandenberg. And it looked down, it was the space looking down, supporting the forces on planet Earth and between the two of them, we felt this is very important.

**BOB:** And that now lives on as the National Space Defense Center in Colorado Springs. So, people say, hey, whatever happened a third offset? said Hey, look we started a bunch of stuff, and it actually was living on.

**BOB:** And the last thing I did before I left is I said, I would like, because we weren't catching on, people were talking about AI, but it was very difficult to explain to the warriors, this is how AI is going to make you a better warrior.

**BOB:** So, I got the group together and I said, we need a Pathfinder. To demonstrate to war fighters, what AI could do for them. And I said, I don't want this to be an intelligence project. I want it focused on operational problems. That was harder to do than I thought because Intel and operations are moving closer and closer together but the team came together and said, okay, look, we know we're pulling down thousands and thousands of hours of full motion video from our Predators. And right now, we have seven, three-man teams working 24/7, going through all of that, trying to find indications and warning of impending attacks et cetera, et cetera.

**BOB:** And we said computer vision can do that and would be much better at it. So, the team came in, said, this is what we want to do. I said, makes sense to me, it's close to Intel, but every warrior is going to say, hey, I can make sense of a whole bunch of data. I can then translate it into an effect I want to do. And I can pursue that.

**BOB:** So, I said, it'll work. And they said, what are we going to call this? And I said we're trying to move to algorithmic warfare. So, let's call it the algorithmic warfare cross-functional team. Will Roper was there at the time as the head of the Strategic Capabilities Office. And he said, look, I have already gone to Congress. I have a program called Project Maven, which does the same thing that you want to do. It's a computer vision program. And so, we said, okay, let's call this project Maven. So, the algorithmic warfare cross-functional team and project Maven were one in the same.

**BOB:** It's just, one was easier to say Congress already knew about it and approved it. And so away they went. And they have done remarkable stuff. Started with full motion video. Now it's gone into acoustic intelligence. It's gone into SigInt. It's all about making sense of massive amounts of data and doing it with a computer rather than a human operator or analyst.

**BOB:** So those were the projects that went on. A lot of people say what happened to the third offset. And I'd say, hey, it's still going. It's not going as fast or as far. And as at scale, as we envisioned it, but it's still ongoing. Line of effort, one, strategy, is the 2018 national defense strategy. And that essentially is a defense innovation initiative strategy. It has all of the elements, all of the lines of effort embedded in it. Line of effort two the operational concepts, all of the services have changed their operational concepts. The Navy calls their's distributed maritime operations; the Marine Corps calls their's advanced expeditionary base operations; the Army calls their's project convergence, and the Air Force calls their's Agile Combat Employment, operating without airfields is the way they like to talk about it.

**BOB:** So, all of the operational concepts that we initiated back in the day are now going gang busters. If you looked at the national defense strategy 2018, it says we have to maintain technological superiority. Here are the areas that we're going to do.

**BOB:** And AI and autonomy was one of the central capabilities that the strategy said we pursue. Number four was war gaming. We established a war gaming incentive fund to incentivize war gaming throughout the department. Number five was information capabilities management. Now, when a new capability is formed or created, there is a debate on whether we reveal the capability or do we try to conceal it?

**BOB:** We developed a brief called the overmatch brief, which showed in a very graphic easy to understand way where the United States was vis a vis the Russian and Chinese competitor in 2000.

**BOB:** Then we looked at it again in 2015. And then we looked at it in a projection at 2030, and you can just see how our competitors have caught up with us. And then all of the things that Ash Carter initiated for line of effort eight, with the commercial sector, those things are not going to as fast as everybody likes, but there's a lot more than we had in 2014, I'll guarantee you that.

**BOB:** So, we're both moving forward into this future. It's a hot competition, an extremely intense temporal competition. They are as good as us in these technologies. And that's why it's impossible to tell for certain who's ahead right now.

**BOB:** The Chinese and the American see this, I think the same way. Sometimes we'll be the leader. Sometimes we'll be a fast follower, same thing with China.

**CRAIG:** That’s it for this episode. If you want to take a closer look at the things we talked about today, you can find a transcript of this episode on our website, eye-on.ai. I find that reading transcripts reveal details that the ear misses. As I said at the outset, I think this is an important discussion that the world of AI researchers, practitioners and enthusiasts should think deeply about. I would love to hear those thoughts. Please email me at craig@eye-on.ai and put the word ‘listener’ in the subject line so I don’t miss it.

Remember, the singularity may not be near, but AI is about to change your world. Pay attention.