

Aerospace Nation: Augmented Reality

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SPEAKERS

Robert "Otis" Winkler, Ric Hunter, Oriana Pawlyk, Gen (Ret.) Mike "Mobile" Holmes, Lt Gen (Ret.) Dave Deptula, Dan Robinson, Valerie Insinna



Lt Gen (Ret.) Dave Deptula 01:05

Well good morning ladies and gentlemen, I'm Dave Deptula, Dean of the Mitchell Institute of Aerospace Studies, and welcome to our latest installment of our ongoing Aerospace Nation series. Today I'm pleased to host a top notch panel put together with the help of red six, to discuss airborne augmented reality and the role innovative technologies can play in addressing the Air Force's pilot training challenges. With that, I'd like to welcome retired general Mike "Mobile" Holmes, Mr. Robert "Otis" Winkler and Mr. Dan Robinson. I'll have a bit more on their background shortly. But first, I'd like to set the scene relative to our topic, and why it's so important. Now, everyone out there understands why military training is in crisis today. For many years, the Air Force has failed to produce and retain the number of highly skilled pilots needed to meet our national security requirements. years of focus, senior leader attention and evolutionary change has simply not been up to the challenge of solving the pilot shortage. We're essentially still training our pilots the same way we did 60 years ago. Even as we've seen the emergence of pure competitors. The gap between how we train our combat aviators, and how they'll need to fight against modern adversaries has continued to grow wider. The T seven innovative training processes and technologies from efforts like pilot training next, and unit level innovation, they all hold promise for addressing these challenges. In part. However, fielding an employee in the T seven is going to take many years, many of the training techniques appearing are immature, and those that are ready may still overcome the reality of an air force that by and large is pretty risk averse, resistant to change. And on top of all of that

resource constrained. And guess what budgets are only likely to become tighter. We've already seen that in the news. So without significant changes to both the way we train our pilots, and the technologies we use in pilot training, we'll continue to face shortages and a widening readiness gap. Now one of the most hopeful technologies that looks to have promised in solving both pilot shortages, and the readiness gap is what's known as airborne augmented reality. Less than two years ago, flying a real aircraft with or against synthetic rendered aircraft. For within visual range training was the stuff of science fiction, and movies. But now, one startup has shown that tanking with an augmented reality tanker flying with augmented reality wingman, and even flying against an augmented reality bandit controlled by advanced artificial intelligence is not only possible, but it's a reality. As you might imagine, there are obvious implications for how the Air Force should train our pilots. So with that as some context, let me introduce our panelists. First known to all of you, General Mike "Mobile" Holmes recently retired or transitioned, I should say, after a 39 year career in the US Air Force. He last served as a commander of Air Combat Command and guided it during a period of critical change. Post a transition or during transition. He now serves as the chairman of the board for red six, a tech startup that fields the world's first The augmented reality system that works outdoors to include during airborne training in fighters. Mr. Robert Otis Winkler is probably best known as a professional staff member of the Senate Armed Services Committee. But he also served the US Air Force as a legislative affairs liaison, and has extensive experience as an operational director from forward basis to the Pentagon to DARPA. His background in engineering and airpower on top of his legislative chops, make him uniquely qualified to weigh in on this conversation. And finally, Mr. Dan Robinson is the CEO and founder red six. Prior to that he was a Royal Air Force tornado pilot, and the first non American to fly the F 22. He spent three years flying Raptors with the Air Force before getting his MBA at Georgetown. He worked in finance, and then turning around a UK based company, and accomplishment that earned him UK director of the Year honors from the Institute of directors. So what I'd like to do to kick us off is hand the mic over to general Holmes, for some opening thoughts, followed by each of our other speakers. And while you're listening to General Holmes and the others, feel free to raise your hand using the function on the app, submit a question in the q&a window anytime during the discussion. And we'll get to those questions in the second half of the hour. So with that mobile, let me shake the stick and hand it over to you.

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Gen (Ret.) Mike "Mobile" Holmes 06:33

Thanks, Dave. And thanks to the Mitchell Institute for bringing us all together with your audience. It's great to virtually see everyone out there. Know both the Trump administration's national defense strategy and the Biden administration's new national security guidance column do D to focus on preparing operators to deter or fight peer

threats. And those peer threats are represented by China and Russia. To do so, we're going to have to improve both the quality of the training that we give those operators and the quantity of the training that all operators and we're talking mostly today about our airmen receive. The quality of that training is limited by the availability of air and ground training assets that accurately replicate those peer threat systems. And although improvements are being failed that every day, the threats presented a red flag for young aircrew members resemble 1980s Warsaw Pact threats more than they resemble the capabilities of 2020, China and Russia, then the quantity of training is limited by the difficulty of maintaining and operating our aging aircraft fleet and the increasing costs of maintaining those fleets and operating. And the relentless ops tempo our operators continue to face combines to limit training opportunities. So we're short both in the quality of training we're giving our operators and the quantity of training. You know, Lieutenant Holmes 40 years ago, flew more than 225 training sorties a year, about 350 hours a year. Today, Captain home slantsixgames and DC guard is lucky to fly 120 of those a year and almost half of those are flown in red air providing training support for someone else. So the Air Force has worked as hard. But there aren't any magic efficiencies that are going to allow us to take our current Training Systems and return to find 225 events a year. So we're running out of our ability to squeeze more efficiency out of the system we have. And so we're going to have to change the way that we approach training. Now ATC is pursuing developments in our basic pilot training they started with up next and they're now flying and up to 2.5 with the goal of making pilots better and faster. And ACC looked at concepts like rebuilding the forge to try to train experienced fighter pilots better and faster. And I think part of what we recognize and learn is that the future of this new training system will be live, virtual and constructive. There's still no substitute for live training. If you're going to learn how to max perform an airplane up against the limits of its flight envelope. If you're going to work on the basic skills if you're going to teach people to perform under risk, if you're going to validate that your aircraft and weapon systems actually work. There's no substitute for continuing live training. But you're going to have to add virtual training because you can overcome the challenges of limited maintenance capability. And Virtual Training is putting real people together to fight in virtual environments. And you can repeat things over and over you might get 10 radar presentations in an hour instead of two. You know in an actual airplane. You can operate at a different security levels. So China and Russia are watching everything you do. And you can practice things frankly in the sound that aren't safe to practice in the airplane can struck the event ads in AI driven computer generated threats. So that you can combine those things together, you can bring computer generated threats either into the virtual environment or into the live environment. And you can work on basic skills, or you can add the components and make large force training hard and expensive. So training pilots better and faster, requires a mix of all three. And what I'm excited about doing with red six is that they're working in all three of those areas to make the future real faster. You know,

we have to train pilots better, and we have to train them faster. And I'm going to steal all the dance thunder of exactly how they're doing it. But that's the context here. We're operating.

L Lt Gen (Ret.) Dave Deptula 10:47
Very good. Over to you, Otis.

R Robert "Otis" Winkler 10:49
Thanks, sir. And thanks for Mitchell for putting us on such an important topic right at the think at the right time for the nation to start talking about this, as as general Holmes said LBC, or live virtual constructive, is widely recognized as the way of the future and that the only way and the only way that's cost effective for us to train against fifth generation adversaries, we spent a ton of money and spent a ton of time developing the virtual and constructive portion of it. As far as dmo distributed mission operations across the fleet. So we can leak simulators with other simulators through from one side of the nation to the other, or even to Europe into the Pacific. And constructive, we spent an awful lot of time as well, we're we're doing virtual red flags out analysis and across with the other services, where we haven't spent an awful lot of time or money is in the live training. And as you as you articulated earlier, we're training people for the like we did the last 60 years red flags have been running for 45 plus years, teaching folks how to prepare for those first five to seven days of a war, but they're training against adversaries from around the same time that they started, we tried to upgrade them as best we can. But the span of a fight in a modern battlefield is such that it's very hard to simulate that from a live aspect. So you you fight against similar adversaries, you get a lot of the same RF transmissions that are coming up to simulate an adversary from the ground. But what you don't see is when you merge with a fighter, or you merge with an adversary, you don't see what the adversary looks like, you don't see how they perform real world, you don't see an S 400 actually launch, you don't see a PI 12 launching when you're 20 miles out, getting ready to merge with an adversary. And that's really, to me, that's what augmented reality. Airborne augmented reality does, it gives you a cost effective way to expand the training and to take what red flag was initially designed for to the fifth generation, and to actually put the pilot in the cockpit, actually flying and having him do mission rehearsals. And I think you can do it from the basic training, as you're articulated with new tankers or with augmented reality wingman, all the way up to mission reversal, you know, right before Oh, if a good friend of mine got a chance to sit down and assume that we're just coming out in the F 16. And essentially do a mission rehearsal flight for his first three missions, in a way if any. He commented that when he actually got there and was flying those first couple of days, it was exactly why it wasn't a sim. I think everybody that's participated in red flag is

very knows that the chaos, the comms, the sensors that you're seeing all mimic what would potentially see in a modern day battlefield with major combat operations. But you're not actually in the fight. At that point, you're not able to do the mission rehearsal. That's what the simulator gave you 20 years ago, and now augmented reality will allow you to do it in the air plus up with what's happening at a red flag, and to give you that real training to prepare our our men and women to go forth and win against a monetary adversary. So thanks for doing this.



Lt Gen (Ret.) Dave Deptula 14:23

Very good. Dan, over to you. Tell us about your magic.



Dan Robinson 14:27

Thanks, General, thanks to Mitchell Institute, and thanks to the CO panelists. I really do appreciate your time. Look, Red 6 was born. I guess the genesis of Red 6 is born during my time on the Raptor. And the reason being is that once I was through the instructor pilot upgrade, if I wasn't teaching, the majority of my time, I guess it would be fair to say was spent flying red air and the notion that we were flying f -22s to provide a red air to me was was preposterous. It's extremely expensive, as a huge opportunity cost to the of individuals that are flying those sorties when we should be doing what we're we're ultimately going to be called to do in a combat environment that's by blue fly blue air. Why would we fly in those sorties as red, it seemed like such a, a massive opportunity cost. And I think critically as well, the threats that we are called to potentially call to go against in the future work, the stuff we were able to train against was simply not representative of modern peer adversaries, such as Chinese j 20, for example. So that was really the driving force and the focus of why I started read six. And it's the final point on China that I'd like to kind of frame. Because once we've been involved in in counterinsurgency warfare in the Middle East, the last 20 to 30 years, there's been a major shift in the global security environment, I think we're all aware of this. And most pressing of that is obviously the transfer to the United States and its allies from from China. I think it's it's incredibly important to remind ourselves that air dominance is not a preordained or natural right, and every domain now is contested from air, land, sea space, and indeed cyberspace. and China are aware ahead of us, they've mandated greater integration and joint development of military commercial technology, and align this to a systematic mobilization of a defense industrial base. And we should be deeply concerned about that. And if we're not, we're wrong, it now appears dangerously close to achieving technical parity, and in some instances, actually technical support superiority to the United States and, and that represents a crisis to us. And when you align this to some of the asymmetric advantages that China enjoys in the region, so extremely mobile defensive systems, the

Hong Kong advantage, this poses significant challenges to the US military. So we need to be ready. And if readiness is fundamentally about preparedness for combat, implicit within that statement is that we have the equipment, the technology and the training, to succeed on current and most importantly, of all future battlefields. And it's this thread I'd like to pull on right now in terms of the code like mobile talk about the lack of quality and quantity of training because despite the the herculean efforts of the aggressors indigenous Friday that we provide, and of course, the private Red Hat contractors, all of which are incredibly important aspects to the solution here. The fundamentals of supply and demand still exist. And I think at max capacity that still exists somewhere in the region of a 75% demand gap. And if we don't change and we don't do something about it, we are going to lose. So the question is, how do we solve that mind as to ODIs and a mobile point LVC training is undoubtedly the solution of the future, I'm going to use LVC or synthetic training interchangeably. But the problem as I saw with RBC is that it's only a 50 cent solution. Why is that? Because it works in the beyond visual range realm. But we all know as combat aviators, that the role of a fighter pilot is twofold right out of range as a tactician you moving chess pieces around the board. But then as soon as you get within that 10 nautical mile, sort of within visual range transition, the role of a fighter pilot changes from tactician to you put a GM shield in and you're going for a fistfight. And at that point, the LVC training system collapses. Why is that? Because there's no way of visually representing synthetic entities within the visual range of the pilot. Why is that? Because so far augmented reality hasn't worked outdoors, or in dynamic environments? Well, it does now. And so with the technology we've developed at Red 6, we have the opportunity now to offer an entirely synthetic training environment, outdoors in the real world to our combat aviators. I'm just going to talk a little bit about augmented reality as an industry because I think it's worth framing the the overall industry as a technology and some of the limitations augmented reality is a more nuanced problem than virtual reality and level set for the audience. Virtual Reality will put a headset on where and an entirely different virtual world, augmented reality is a much more complex problem to solve. Because we seek to put virtual entities into the real world around us seamlessly integrated to the real life surroundings. So we get the best of both worlds, we perceive the real world around us, but we get to interact with synthetic entities. But augmented reality as an industry is really in a fairly nascent state. And so far, augmented reality has been an indoor solution only. So I could put a headset on in the living room and show you a pink elephant on the table. But who cares? And it's one of the reasons it's kind of been slow languished a little bit in comparison to virtual reality. That's not to say we don't think augmented reality is the technology of the future. And I would say that actually represents the single biggest inflection point in how we share and interact our information since computers went to cell phones. But for that to be realized, it has to be ubiquitous in nature. And for it to be ubiquitous in nature, it has to be mobile, which means it has to work outdoors and in dynamic environments. And what we've done at Red six is a

big stepping stone to enabling the technology to work outdoors and in the most dynamic environments three 400 miles an hour at nine G's. And the technology is working well. It started by leveraging one of the technologies that the co founder of the business of red six had actually developed in 2015 and racecars and that they were the first people to connect to race cars on two separate racetracks could real race car drivers in the mind connect these racecar drivers through virtual world. And they raced real race cars blind to the outside world. And the moment I saw that technology, I asked two simple questions. Firstly, is that possible in aeroplanes, when we came back with the SFO period of thinking as we thought we could do it? The second question is, could we do that in augmented reality? Because quite obviously, no one is going to allow fighter pilots to fly 100 virtual reality? And the answer we got back initially was no. And so for the last two to three years, we spent a lot of time solving that precise problem, to the point where now it is working. So what does this mean? It means we operate or we occupy an interesting intersection between Lifeline and simulation. So we get the best of both worlds, we get our combat aviators to experience the real cognitive loads of flying real aeroplanes, but we're able to provide synthetic entities adverse as adversary aircraft. And that allows us to replicate neopia threads, it allows us to provide numbers and it allows us to, to obtain some massive financial offsets. And for all of those reasons, it represents I think, a new paradigm and what is possible for provision of the final thing I closed on is I'd like to say that was the genesis of this was to solve the Red Hat training process, it became readily apparent that this technology has so much application for the physical production of baby pilots all the way through the ATC pipeline, and ATC have been instrumental and looking at innovative ways to change pilot training through ptn and up to 2.5. I think augmented reality offers an incredibly compelling next step to ATC that will allow us to provide or produce more pilots in a shorter timeframe of a higher standard at a dramatically reduced cost. So I'll pause there.



Lt Gen (Ret.) Dave Deptula 22:27

Well very good in and thank you all for helping lay out the foundation of our discussion. So let's get right into some more details about the use of airborne augmented reality for pilot training. Mobile, can you give us a bit more context on the pilot training challenges that the Air Force is facing and the role that augmented reality might play in solving it.



Gen (Ret.) Mike "Mobile" Holmes 22:51

Sure Dave. So you know, the Air Force bases kind of three different challenges within that pilot training, shortage or pilot training challenge. The first is just training enough pilots to meet the Air Force's requirements. We took a holiday from training when we had an artificially high historical retention rate in the early days after Desert Storm. And so our

our pilot cohort is both not big enough. And it's also out of balance. We have more older pilots who we need and not as many younger pilots as we need. Within that there's a shortage in fighter pilots. But within that there's a shortage and experienced fighter pilots, fighter pilots that can lead and teach in squadrons that can also do the jobs that need to be done on the staff and that our air operation centers. Imagine a world with red six technology, were starting a new PT, where you Pt 2.5 is working hard to deliver the content, make the content available to students all the time as part of what they're doing, to use virtual reality to help them learn skills before they get to the airplane. And now with an augmented reality capability. You can bring both of those technologies into the actual airplane. So maybe on one of your early contact rides, you've gone through your accuracy sequence, you've demonstrated proficiency there, and the instructor dials up a formation wingman and starts to expose that student to formation flying early in the syllabus to give them a chance to see it against a augmented reality partner. Imagine an IAFF if on those early BFM rides you could throw it to 27 out there and a 5g turn circle and fly your T 38. around it with augmented reality headsets and be able to see that turn circle and be able to demo to your student what it looks like to go inside the circle and move outside the circle lead and lag and teach those concepts in the airplane while they're trying to figure out the buffet rate on the T 38. And make all that work. Imagine then at an operational unit when I was flying the T 38 as the ACC commander to augment numbers for Raptors in Langley for Raptors would train against maybe four Raptors and 6038. Imagine if those four Raptors could train against maybe for contract red or adversaries, and six or more constructive adversaries that would show up in their cockpit and in the visual environment like Dan talked about, with unpredictability of who they are and where they are and to be able to make all that work. And then imagine in the bigger plane world as a bomber pilot, when I'm having trouble lining up tankers to get the the tanker training squares that I need to keep my fleet current. If I could call up the tanker overhead Barksdale climb out after takeoff, do some transition work, go rejoin on that tanker, move in and out with ready lights that actually work and show me FM in position. So what I'm doing is creating both efficiencies and stories or stories, I don't have to fly anymore. So I can use more of those for blue Air Training, and efficiencies, that I'm not having to spend a portion of my time flying red or all my training can be devoted to blue air. So when Lieutenant Holmes was getting 225 sorties a year and about, you know, half of those be in red air. Now, Captain Holmes could get all 100% of his 120 sorties, blue air, I would start to address that gap that we have.



Lt Gen (Ret.) Dave Deptula 26:17

Well, thanks for that. And I think you make a real excellent point. I'm glad to hear you say that because for too long, some of the programmers up there on the air staff would say, hey, ACC has got their training budget, what they do with it is up to them. Not

understanding that, you know, if 40 or 50% of the training is going to read air. That's that's not an optimal use of butts in those seats, the seats being those fighter aircraft. Anyway, a bit of a follow up mobile. Does the prospect of constrained budgets that we see coming upon us here more rapidly than some of us would like, change the way that we should approach pilot training? I mean, I think the obvious answer is yes. But could you tell us a little bit about how,

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Gen (Ret.) Mike "Mobile" Holmes 27:08

Yeah, well, Brad Webb and Pulse Wills and their teams, I think, are doing a great job looking at new technologies and how to integrate them into up to 2.5, while still holding on to the things that are important for training pilots and seats, and I'm looking forward to the results that they that they're bringing it in. But largely what they're doing again, is that they're making the curriculum available to students all the time, so they can study and move at their own rate. They're being able to pre practice some of those events in a virtual environment, and then their brain in AI to measure a student's performance and watch and help the instructor decide what to work on every day. All those things are going to make not just a cheaper pilot, but a better pilot, I think faster. And then we want to take those same ideas and bring them into the advanced training that happens after ubt. The Thunderbirds now have a virtual reality headset. And before Thunderbird starts their workup in the airplane, they're able to go fly the syllabus sorties that were filmed with a 360 GoPro. And they're able to sit and watch through and think about what it's going to look like and how the picture looks, where they move and how they do it. And they found that if you do that six or eight times before you fly the sortie that your performance increases dramatically on that first look, and it jumps you ahead in training. And those are things I think that we can bring in along with that bring it into the visual part of the airplane is the AI technology to measure a student's performance and help the instructor decide what's the most effective use of this training sortie that we have today.

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Lt Gen (Ret.) Dave Deptula 28:43

Now that's a that's very cogent, and instructive in as you're talking there, I was thinking back to back and way back when in 1981. I went through upgrade training as the EPA teen aerial demonstration pilot. I remember my first backseat ride in in that demo, and I really had my eyes watered. Actually, I was in the front seat. But man I wish that I wish that you know what you just described existed at that time to play through and go through what happened because it certainly would have increased the transition well

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Gen (Ret.) Mike "Mobile" Holmes 29:24

And even at a lower stress level. That first trip you took to the tanker, you know as a as a lieutenant in the airplane in the FT us now and our Flying Training units. Now before student goes to the tanker for the first time we're able again to put them into virtual reality headset with the 360 camera made from somebody doing it they can look around, they can look at the guy on the wingtips. They can look up at the airplane in the boom and they can get over some of that buck fever. Yeah. Of what happens the first time you get

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Lt Gen (Ret.) Dave Deptula 29:52

Yeah, no, that's a that's really impressive. I'm Otis let's turn to your perspectives here for a minute because as a staffer on this Armed Services Committee and someone with extensive operational experience as a fighter pilot, can you tell us a bit how movement toward increased use of live virtual and constructive training is being viewed on the hill and a little bit about what role will airborne augmented reality play within this LVC construct tr and

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Robert "Otis" Winkler 30:22

You know, the not speaking for any in particular folks on the hill, I can tell you that the main focus is we want effective training to make our in this case, our aircrew ready to do what the nation needs them to do, and readiness is of utmost important, I think, widely recognized as one of the most important things that we can give to the men and women that raise their right hand to fight for this country. We can't do that, with one red flag trip a year or one trip to the knitter or to one of the or whether it's up to Alaska, you know, and red flag Alaska. That's not enough to get people the training that they need. And so they're gonna have to do it locally as well. And I really think that that the LVC portion is it helps a red flag but even more importantly, helps in those backyard ranges when they're doing their local training, whether it's adversaries that they're gonna fight against, or ground threat, or even in supportive of forces on the ground, right, if you can do that from in the simulator, prior to going out and flying it live. You get, as general Holmes said, you know, market improvement and performance the first time, just like if you do your flight mission, before you go out and fly it live, you're a lot better off, if you can actually fly the mission in the simulator, push, freeze, redo the things that you missed, that you made mistakes on, your learning is much faster. What I think augmented reality allows you to do is to take all the benefits of the simulator and move it out into the real world. And so those 120 stories that Captain Holmes is getting up in the DC guard like he can, every single one of those stories can be a mission rehearsal sortie that he needs up dialed up to a mission rehearsal sorted that he needs to go when Americans wars, if they need to back down to do more basics, they have the latitude to do that as well. But they can do mission

rehearsal up to and including what you'd see out a red flag. And then when you go to red flag, you you definitely can can step up your game and have every one of those stories, put a lot more tools back in that toolbox and prepare you to go to war.

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Lt Gen (Ret.) Dave Deptula 32:37

Now, Very good, thank you for that no, turn into Dan, as the CEO of a three year old startup, you've certainly accomplished a lot. Have you been able to rapidly advance this technology? And what is it that you'd like to see addressed? Next? So advanced technologies can be fielded rapidly?

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Dan Robinson 33:01

Yeah, it's a it's a great question. I think, as a startup, particularly, when you're, you know, folks in the tech into complex technology or advanced technology, you're always you're always operating against the background of capital constraints, right? We don't have any money. Initially, in the early days, we certainly didn't. And so it was absolutely imperative that we clearly articulated the problem that we were we were trying to solve. When that I suppose articulation came from my own background and experience of, of what it was that really annoyed me and what it was particularly that we wanted to solve and, and having identified an acutely defined pain point, that really allowed us to anchor all of our engineering efforts around solving for that very precisely. I think the next the next aspect to that is really articulating a vision that is bold, that is disruptive that is is challenging, with something that inspires both internal stakeholders and external stakeholders alike. And the vision that we outlined over three years ago, was to create a future in which all warfighters across all domains were connected together in a joint synthetic training environment. In essence, think of it as a large multiplayer game, played outdoors. So a red flag for the Joint Force, but we can partake in that every day of the week, wherever you are to this point. And so having having articulated that vision, it's absolutely imperative that you align every single ounce of your technical focus towards that vision. And that involves saying no to a lot of opportunities that may at first sight appear to be really shiny and compelling to go chase. But it's imperative as a start up that's that's moving add in moving quickly, and it has to be agile, that we stay absolutely focused on the vision that we outlined. And so from a technical and operational perspective, we've known exactly what it is that we wanted to solve and exactly how to tackle it and we've stayed really focused on on doing that and aligned every decision we've taken to achieving the ultimate vision of this joint synthetic training environment. And I've been obviously incredibly lucky to be joined by a fantastic team of, in the early days, the three co founders, we had such a complementary set of skills across both from the operational perspective and into deep tech that enabled us to it was kind of a unique blend that

enabled us to go really quickly with novolog resource. I think I'd have to acknowledge the role of the customer in this as well. I think programs such as f works have been incredibly valuable to red six, and they were instrumental in guiding us to that early vector through the maze that is the US Air Force. But as the technology is evolved and matured, that we've made a very concerted effort to stay closely aligned to the needs that have been articulated by our customer, right. And so it's it's imperative as a technology company, that we're not just developing cool tech in a vacuum. But we are aligning it to understand the pain points that the customers experience, and that's fundamental to our success. So I think those are really the reasons we've been able to go so quickly. In terms of challenges, what we're doing is technically really challenging, right, we're right, we're right at the front at the, you know, hitting the limits of what augmented reality is capable of doing. And there are a number of technical challenges. But his you know, previously, there were a lot of unknown unknowns and those one by one, we've ticked them off. So we know how to go do this now. And indeed, it is working. So it's, it's just iterating now and getting better. But the technology sorry, the challenges, I'd like to focus on, I guess, a less on the technological and more on the cultural challenges that we face. This technology is coming, and it's coming quickly, it's going to be very, very difficult to stop it. And by its nature, it's a technology that's extremely disruptive, and that's inevitably going to cause a certain amount of discomfort, right. But that's a good thing, because changes is uncomfortable. And as I outlined in my opening statement, if we if we don't change we are we are going to lose. So aligned to this change, however, are the realities of fiscal and I suppose operational pressures that our warfighters face, because every day quite naturally, they are incentivized to deliver operational capability every fiscal year. And so the challenge is how do we create a culture that allows us to focus on the near term availability of assets. But also, I suppose incentivizes focus on future capability and, and warfighting advantage over a period versus nano involves exploration of cutting edge technologies such as this. And I suppose key to that is, is being bold enough to accept some risks, and prioritize investments in in key technologies such as AR and indeed, AI as well. The final thing I'll talk about is dollars as well, because it's imperative that we we are aligned from policymakers through every aspect of leadership to understand that for companies coming in, that are innovative startup companies, we must be able to support them through the so called valley of death. And that involves a transition between the allocation of research dollars into O and M dollars. And it's it's really understanding from top to bottom that it is these technologies that will transform the future for us. It's it's not spending resources on decades old capabilities, making them ready for employment, we need to understand that it's the it's the battlefields of tomorrow that we need to be focused on. And that involves taking key risks and disruptive technologies such as AI. And indeed, I would say AI and I think as a as an overall challenge. It's that culture of innovation from within the service and up on the hill that, that I had encouraged really to get behind this.

L Lt Gen (Ret.) Dave Deptula 38:51

Yeah, well, that's always been the challenge is the cultural one. As everyone on this panel, and I'm sure many in the audience realize, technology, as you said, Dan isn't necessarily the limiting factor. It's culture. And, Otis, I'm sure you would agree with that. Coming from your position. You don't have to say anything. We all know what it's like. Dan, expanding upon your perspective, you know, you're really one of only a few people in the world who clone against augmented reality bandits. controlled by AI. Can you tell us a little bit, just what that's like? And you mentioned a little bit of it, but where do you see the combination of augmented reality and artificial intelligence going in the future? Yeah,

D Dan Robinson 39:42

It's a really it's a really important question. I think to the first part of the question, what is it like to have flown against an augmented reality band driven by AI? Well, let me describe exactly to the audience what that what that means. We are taking off in our own test airplane at Red Six, we're going up into the sky. And we are meeting a augmented reality Chinese j 20. That is controlled and is acting autonomously by AI. And so one of the questions that we're often asked is how do we control these entities? And really, there's three ways of controlling them. Right? There's there's the scripted way, in terms of giving ourselves pictures such as offensive six case setups that were you know, the way we'd always train fighter pilots through the basic building blocks of BFM. There was virtually so the ability to control the AR avatar on the ground. So imagine a pilot in the ground and I've got a virtual reality headset, flying an avatar up in the sky against a real airplane and the pilot in real airplane sees that avatar is fighting his buddy on the ground. So that's virtually. And I suppose the panacea is ultimately where the court depression lies is. Ultimately, it is driven by artificial intelligence. And so when I go up there, you know, we're engaging in a BFM scenario against a Chinese j 20. That we're seeing that is thinking of flying and acting and making BFM decisions as it would be as if it was a real pilot. And it's playing its best vfm against us. That's to say it understands lead lag, aspect, closure heading crossing angle, energy management, both potential and kinetic. And it is something to behold, it's, it's really pretty incredible to see. And, and what that means is this technology is not a vision of the future. This is here right now. And it's working. It's incredibly exciting. But the second part of the question on AI, I think this represents the first step towards the broader adoption of AI, and AR. And currently, we're working with a commercial partner, that's a part of the the Alpha Dog five trials with DARPA to validate the tactical AI design architecture that is using deep reinforcement learning. But because we're able to use it with augmented reality, to represent it in the real world, we're actually taking those algorithms outside of the simulated world. And this allows us to validate some really important lessons of trust and safety, whilst building a data set, which I think is absolutely unique in the world, and extremely valuable in terms of real pilots and real

aeroplanes flying against this AI, and the sky, up in the sky. So ultimately, I suppose I see a combination of AR and AI expanding throughout the industry to make sure that the overall concept of tactical automation programs such as low wing man, ultimately become a reality. And I think that AR represents an incredibly interesting way for human beings to train and interact with the AI and continue that iteration. Because ultimately, it's about these data sets that we're building. And if we can help AI evolve through sophisticated human machine interface, then this has the opportunity to expand into Well, a few training and even campaign level modeling. And and AR is a really core enabler to validate that that AI, I think the final thing I'd say is that the level of simulation and valid validation is a continuous feedback loop. That allows us to make better decisions faster and more we're ultimately talking about is being able to get inside the enemy's ooda loop, right. So this has direct crossover, not just in the world of training, but to operational programs, such as ABMs, and GRC, too. And it's something that our competitors, particularly the Chinese are taking incredibly serious. The idea that they can model iterate, understand lessons learned feed that back into AI, and evolve, is making their decision making faster and faster. And we need to do the same. And we need to do it better than they are. So it's an incredibly interesting way to validate AI. And I think it's obviously incredibly cost effective to you as well.

L Lt Gen (Ret.) Dave Deptula 43:56

And that's great. And it's also an area where you can see the results of the application of AI and measure their effectiveness very quickly. And that's important, too. Just real quick. Are you working with DARPA or just capitalizing on the work that they're doing?

D Dan Robinson 44:14

Red 6, we're not working directly with DARPA, but we are suppose working with them through one of the companies that's involved in the alpha Delphi trials, and we're taking the AI algorithms that they're producing, and we're actually validating them up in the public sphere. So we're building an incredibly important data set there. And it's working terribly well.

L Lt Gen (Ret.) Dave Deptula 44:35

Very good now, Otis, in terms of joint training, what do you see is the role for airborne augmented reality and its offshoots in the other domains, India think that technology will have implications for our ability to train with our allies as well.

R

Robert "Otis" Winkler 44:52

So I absolutely you know, pivoted off of what Dan was saying. You know, we've been talking a lot about training and augmented reality and training. And I think examples like Skye Borg and the the efforts that the airforce are doing to provide weather and augmented reality will really will make a difference and provide a cost effective solution and provide game changing benefits in the training environment. But when you think about it, the Joint Force writ large has been doing augmented reality. For the last 20 years, you know, whether it's genomics, whether it's IVs in the army, the idea that we can project information out into the this band of what we're looking at while we're fighting is something that has changed the game in warfighting. And I think that our ability to do that in the fight. Throughout the Joint Force is another added benefit of the player more augmented reality, you can picture a j tag on the ground looking up and trying to get controls in a training environment and seeing an augmented reality aircraft that he can provide, read his normal procedural controls for and to get all of his training squares. But you can also see that in a war in combat, where he's able to look up and actually see the entire airport in the cop with the combined operational picture through his goggles, as as he spans the horizon and he could see what the Ordnance and the fuel remaining, he could reach out and touch each individual aircraft and pull the aircraft that that may be best suited for him. And so for the joint find, I think it has huge, it will pay off huge dividends as well, as well as in training we're integrating with the Joint Force. You know, normally if you go out and you're providing closer support, there's a JPEG on the ground. There's a target, he talks you out of the target. And then you expand your ordinates which is difficult in and of itself. But using augmented reality, you could turn that range into a modern battlefield, that you can have obscuration you can actually have you can actually see troops on the ground moving to contact. Again, just like we talked about and red flag as a joint force will become better when we take and we put a Warfighter regardless, regardless of the domain, into this scenario, live scenario using the equipment that they're going to use in combat, and letting them experience that.

L

Lt Gen (Ret.) Dave Deptula 47:25

Very good. Thanks for that. Mobile really quickly as we wrap up here and move to audience questions. Your work on the fundamental pilot training challenges that are facing Air Combat Command in the Air Force is really given a new sense of urgency to a problem, and one that it doesn't appear to have a single bullet solution. What are your thoughts on how you hope the Air Force will move forward?

G

Gen (Ret.) Mike "Mobile" Holmes 47:50

Well, thanks, Dave. You know, I think this is one of those areas that our Chief of Staff

General Brown would say we have to accelerate or lose. And, you know, there's, you know, the old joke about amateurs think about tactics and professionals focus on logistics, service eight's like me guys who work program, say, you know, amateurs focus on ideas and professionals figure out how to pay for the next the next step here, I think, is to give money into the advanced pilot training program element to go see what's possible and advanced pilot training brain in augmented reality. It's the setup or program element for reforge like concept, so we can figure out the best use of the T seven and the time that we have before we start to deploy it in numbers. And then I think probably pick out one of our legacy kind of fighter platforms to bring augmented reality into that airplane to see what it provides in the training environment and move from Small Business Innovation Research funded contracts into program to record with a program element monitor and somebody who's charged with going forward. And it's not just here for us, right? It's the airforce OSD, the Office of Management and Budget. And then Otis and our, our, our friends on the hill that had the ultimate decision about how we spend our money. It's going to take teamwork among those four elements to go move out and accelerate change.

L Lt Gen (Ret.) Dave Deptula 49:13

Very good. Well, thank you all for your comments. On this fascinating issue, and on behalf of the Mitchell Institute of Aerospace Studies, we wish you all the best in your endeavors in accomplishing your objectives. Now, as before we move to questions real quick, I'd like to remind our listeners that our next event is day after tomorrow, Thursday, March 18, when we'll be hosting Lieutenant Colonel Mike Benitez is in the next edition of our Aerospace Nation series. All right, while we're waiting for a hands, I've got two chat questions from Chris Franklin. First one, are there ways to have low enough latency to have countries 1000s of miles away to train together this kind of as a follow up to question Oh, it is about training with our partners, international partners. And then this second one is a little more technical, but I'll throw it out there now and then you all can decide who wants to answer what this is from Chris to what are the technical challenges associated with moving from parabolic lenses to projecting on the whole visor, like on the f 35? helmet? So over to you guys.

G Gen (Ret.) Mike "Mobile" Holmes 50:36

I think Dan should probably take on both of those. Both latency and the visor challenges are things that Red 6 has worked.

D Dan Robinson 50:44

Yeah, thanks. They're actually great questions. So the first one on latency, I think the initial when we first founded red six, the aspiration The idea was, look, we we don't just want to create a solution here across the Joint Force, but wouldn't it be fantastic if we could connect allied nations simultaneously into a, an airborne augmented solution? So envision an F 22. Taking off at Langley Air Force Base was the Eurofighter takes off at RAF Coningsby in the UK, they both head out to their airspace, and then they go in, they step into this environment where they, they meet each other in the airspace, and they can either train against each other, or they can train alongside each other. And that was the vision for what we wanted to solve. Now, clearly, there's one rule that is kind of a big rule, and that's the speed of light. So the speed of light is, is obviously difficult to overcome. But there are ways around that. So I would point out point you to games big multiplayer games that exist globally like such as fortnight. And there are a number of techniques that can be employed, such as pose estimation and predictive analysis as to where movements come in. And they're doing those in in multiplayer games, where the movements are much more nuanced and, and rapid. So for example, a soldier crouching behind a desk and of course, they do that successfully. What we're talking about is fighter combat, where the, I guess the predictive ability of the realities of the physical limitations of the aeroplane are a little more predictive. So it's not like an aeroplane is going to snatch instantaneous the advantage to me just to the left, or to the right, we're talking about predictive turn circles and flight envelopes that we understand. So whilst it's a little way off, it's something that we're absolutely aiming towards. The second point on the display technology, there are some fundamental limitations to current income and technologies that that we use in helmets such as the F 35 homers in our Medicare systems, and those are returned to waveguides. And the problem with waveguides is it's very difficult to to bend them. So you have a limited field of view, you could theoretically have a wave of a waveguide, that is this wide, and I'll give you a huge field of view. But to put them on the curve services is very difficult. And then there's an awesome, also a potent cocktail of brightness, resolution, all of the things you have to overcome. And I think stepping away from technologies such as waveguides, and more towards the use of cue holographics is probably the way that we're going to have to go in the future to solve that. And, and that's a, that's an interesting industry in itself with only a real few experts in that field that are capable of doing it. So some some interesting technical technical challenges. But I will say that there are companies out there that are working precisely on those great things.



Lt Gen (Ret.) Dave Deptula 53:36

Very good. Let's switch to our live panelists or audience and Valerie Insinna from defense news.



Valerie Insinna 53:44

Hi, um, thank you all for doing this. I have a question for Otis. I was wondering what questions and concerns do lawmakers have about using augmented reality for training? And what do you think they need to see from the Air Force and from industry in order to get the buy in that's necessary for rolling these sorts of solutions out, you know, in a broad and comprehensive way?



Robert "Otis" Winkler 54:09

So I think what the second part of your question, right, is that what they need, what people need to see writ large is, is proof. Right? It moving from a PowerPoint presentation, off to at least a basic proof of concept to be able to get this done--I think that that is out there. Right. There are examples of this, like we talked about in the earlier, you know, augmented realities is been a part of the heads up display your headaches, and I've asked for a long period of time moving in into a training environment where you're actually projecting images that aren't necessarily there is something that that we're going to have to prove to folks as far as latency as far as, as the ability to to make a difference in training. But I think when when people actually experience this, it becomes hard to argue that I mean, if you will, What are our kids are doing when it comes to augmented reality? In the video games with their plan, that's kind of the expectation when folks show up in the in the military. And I think most of them are disappointed. I know the people I talked to are disappointed when they go on say, Hmm, this isn't exactly what I thought it was gonna be like, you're still doing. You don't even have glass cockpits, right, you're still doing with 1980s technology. And our ability to use augmented reality across the board, right, and to leverage it into training and and operations, I think is something that is easily explained, based on the current culture that we have. We just have to actually go do it.



Lt Gen (Ret.) Dave Deptula 55:45

Okay, very good. How about Mike Boera?



Oriana Pawlyk 55:51

Hey, thanks, Dave. Appreciate it. And I appreciate this whole discussion. I'll say so for the audience. I'm Mike Boyle from lighthouse on the Air Force strategic account executive. Daniel, great to hear you again. You were at the multidomain C to F works. Fusion event. And I was very impressed with what you were talking on stage. Oh, it is always a pleasure to work with you. But this question is for mobile. Given your time now on the outside out of uniform, and with augmented reality in mind and the vested interest that you have, like I have with suns flying fighters today. Has your has your perspective changed at all? From

the seat you were in at Langley to where you are today and what you've learned from Daniel or industry on the outside. Anything changed from your time in uniform? Thanks, and great seeing you all again.

G

Gen (Ret.) Mike "Mobile" Holmes 56:53

Yeah, thanks, Bo. I think I think the biggest thing that embolden our pilot training classmates, by the way, 8208, Columbus, I think the biggest thing I see on the outside is how hard it is to take a good idea that warfighters want, and work it through the bureaucracy and get it to warfighters. And I don't mean bureaucracy in a bad way. But you know, there's a report out published in the last couple of weeks that talks about how we're going to have to change our programming system to be able to go faster, that that I think is absolutely necessary. And I think we're gonna have to work together as a team, both the people still wearing the uniforms, and people still working in civil service and people on the hill and industry to try to figure out together how we're gonna go faster. I mean, I'm working with red six, I'm working with the Rosenberg group, I'm working with several other companies. And what I'm trying to do is work in that space, to help people with good ideas and warfighters need navigate the process. So the warfighters can get them in less than the 20 year period that's kind of proven out by legacy. And I think I see firsthand the problems that they face. And I'd like to work on that.

L

Lt Gen (Ret.) Dave Deptula 58:07

Okay, let's take another one from our live audience. We got a bunch of really good ones on chat. Ric Hunter. Hey, Rick, we're not hearing you. We'll check your system. And we'll come back to you. Let's go over to Oriana. Hi, all

O

Oriana Pawlyk 58:33

thanks for doing this. I know we chatted recently as early as this month. But since that time, I know that Dr. Will Roper joined your board at Red 6. Could you talk a little bit about his role at the company and if he will be reaching out to industry to try to flourish the company a little bit more or what what is his role? Oh, yeah.

D

Dan Robinson 58:54

So thanks for the question. Will robot has joined us is actually joined the advisory board not the the main board of the company. And really, he is there to offer a an absolute unique perspective, I think it will be less around Dr. Roper reaching out directly to industry and certainly not to the to the Air Force, more offering the insight and expertise that he is

renowned for. And I will tell you that he's already added a tremendous amount of value just in terms of the interactions I've had with him. I can't speak highly enough to, to his thinking the way he looks at problems in a fundamentally different way. And he certainly challenged some of my preconceived notions as to how we should go about approaching approaching red six and approaching this technology. So he's, he's an advisor. He's not on the main board, but he's incredibly valuable and has proven to be solid.

L Lt Gen (Ret.) Dave Deptula 59:49
Okay, thanks for that. Ric, are you able to fix your mic problems?

R Ric Hunter 59:53
I think so. Can you hear me?

L Lt Gen (Ret.) Dave Deptula 59:55
Yeah, we got you loud and clear now.

R Ric Hunter 59:56
Okay. Very good. Very good. My question is deals with debriefing in the LVC environment. I had some 13 red flags, and the F 15. c and program manager for contracted aircrew training at Air Combat Command for a number of years, and we were fielding the admission training centers at that time. I just can't imagine how you debrief in that constructed environment at a red flag. And so I alternate on that.

D Dan Robinson 1:00:29
Yeah, Dave, I'll take that one, Ric, it's a great question. And actually something that we're very busy working on right now inside of red six, because obviously, without without the briefing the data, then there's a little point in going to fly to Saudi. But the system we're working on actually is, enables us to fully reconstruct what we've we've just been up there and done. So I go up there, I fly against a j 20. And a real airplane, I'm trying to get to know bench reality, J 20. I can come down and take that data and analyze it in in ways without going into too much detail right now. But in ways that have never been done before. Because it is absolutely imperative that we take the lessons learned. So we can do all of the root cause analysis that we know and love. And it's such an important part of the debrief. But leveraging the technologies such as AR and VR, and AI, and gathering the data enables us to to get an insight into some of the decision making that pilots make on

a on a daily basis that that we haven't had before. So I would, I would, I would stress to you that the debriefing technology is coming in line with the the augmented reality technology in the airborne environment. And it's going to be just as important, if not more important, and will usher in a new fidelity and new capability and the level of analysis that we're able to do today.

G

Gen (Ret.) Mike "Mobile" Holmes 1:01:51

Eric, if I'll jump in there real quick, you know that a CMI, their combat maneuvering instrumentation range environment that we grew up in at Red Flag, one way to think of that is is a gaming environment and keeps track of all the players in the game. But it only tracked the live players, as you go forward with LBC training, that gaming environment has to expand the track the live and the constructive. And then, as Dan said, you're able to bring back more information because of what you're doing in in the cockpit of the live players and what you're doing and the constructive cockpit, you're able to bring actually more information back that lets you know not just what the airplane is doing, but what the people inside were doing, and where they were focusing their effort that I think offers as a way to debrief better. So it's expanding that gaming environment like like fortnight or like one of the other ones to where you're keeping track of both the live players and a constructive for virtual players.

L

Lt Gen (Ret.) Dave Deptula 1:02:49

Hey, guys, we've come up on our time, but there's really two more questions I'd like to squeeze in here. So if you have about three or four more minutes, let me hit you up with these first one here is from Ted Kreski. Kmart. Is there a role for a flying simulator? In other words, taking a T seven, in perhaps installing hotas displays and simulations so that it functions like an F 35. This would allow less expensive ftu and possibly a companion trainer for ops units. What are your thoughts?

G

Gen (Ret.) Mike "Mobile" Holmes 1:03:26

I'll go first, and I'll let Dan go. But the short version of that is that that's what you're trying to do and reforge. That's what the Israelis do and their fighter pilot Academy is that their Leonardo has constructed avionics, where it simulates a radar radar warning receiver and advanced targeting pod and put those together with a data link between airplanes. And so it's it's kind of a flying simulator, it's not too big a leap to think that you could then change the displays to make it look like the displays of an F 35 or an F 22 or an F 15 or an F 16. So that your reforge students who are training in that airplane or what looks like the airplane, you're going to go fly to key parade and then they go through a short transition

course and move over into the other.



Dan Robinson 1:04:13

Yeah, yeah, sorry. The only thing I would add is actually that technology exists already. And I actually just saw something online this week. That was a demonstration of that, precisely that in the virtual world. And it's you know, it's it's not beyond the wit of man to think that that's that's doable up in the air as well. So I think that technology is actually a little closer than you might expect.



Lt Gen (Ret.) Dave Deptula 1:04:37

Okay, very cool. Here's one from Kurt Dittmer for Dan. The number one killer in aircraft accidents is spatial disorientation, which is hard to simulate in a SIM, does this red six approach where the student is actually flying? finally solve this issue?



Dan Robinson 1:04:54

Yes, it's a great question. And it's the core of why I'm so passionate about what we do ask because my contention was, you know, simulators having a really important role to play. But there's no way that we can emulate the kind of cognitive loads or spatial the risks associated with flying real airplanes. And the beauty of augmented reality now, or airborne augmented reality is that we get the best of both worlds, right, we get to go up, we get to fly airplanes, we get to experience g forces running out of fuel, or, you know, the ability to crash into the ground and get specially did. But we get to do that whilst being extremely cost effective and getting paired up here level threat training, because we can simulate adversaries, I would say that, obviously through the test and evolution of this technology that but safety has been at the forefront of what we're doing because spatial D was, of course of a paramount concern. But I can tell you, it's it's largely transparent, it's simply you know, you are looking out of the cockpit as you would always, and rather than see a real airplane, now you just see a synthetic aeroplane. So it's actually pretty intuitive when you go do a thrill. And it was something that we were we were concerned about initially, but honestly, it's it's not a factor.



Lt Gen (Ret.) Dave Deptula 1:06:04

Okay, I said to but I've got to add one more from Evan Byron. And it's a bit of a philosophical question, but it's a really pertinent one. Here's what Evan asks, How do we address the people in the Department of Defense and congress who do not understand the technologies needed for the future or warfare, which inhibits the ability to integrate

them into the services?

G Gen (Ret.) Mike "Mobile" Holmes 1:06:31

Quick for me it there may be some not understanding. But I think, you know, we have people like Otis up there and there are people out there that do understand a lot of the problems. I think it's less than understanding as it is hidden the I believe button that we can make those technologies work and that we can produce them on time and on budget and get them out there to the warfighter. So notice, are just there. I agree. I mean, the advocacy I don't think is nearly the problem is the proof. And so actually getting the proof and actually doing it, it will go a long way. And I think it's hard to argue, quite frankly.

L Lt Gen (Ret.) Dave Deptula 1:07:12

Okay, well, we've come to the end of this Aerospace Nation event. It's been fascinating. I really appreciate all of you and thanks to Gen Holmes, Mr. Winkler and, Mr. Robinson, to you and to our audience, from all of us at the Mitchell Institute. Have a great aerospace power kind of day.