Courtney Bradley (00:14):

I would like to now introduce our first speaker, Samantha McCue. Samantha McCue is the flight test lead for the XQ-58A unmanned aerial vehicle, designed and built by Kratos Defense and Security Solutions. Samantha holds a bachelor's of science degree in aerospace engineering from the University of Illinois, and a master's degree in engineering systems management from Texas A&M.

During the first five years of her career, Samantha worked for NASA, UTC Aerospace, Cimarron and Boeing, and focused on human space flight programs. In 2016, she joined 5-D systems as a systems engineer, during the initial design phase of XQ-58A. Since 2016, she has served as the Integration and Test IPT Lead and Flight Test Director for the XQ-58A as well as other Kratos unmanned vehicles.

Outside of her engineering works, Samantha owns and manages two boutique fitness studios in Austin, Texas, actively participates in University of Illinois' aerospace engineering department advisory board, and loves any opportunity to travel and eat good food.

Today, Samantha will be talking about a new way of doing business, involving the XQ-58A, and trends in the aerospace industry.

Samatha McCue (01:49):

All right, thank you for the introduction. I apologize, my video's not working. It's not stable enough. So I don't want you to look at my frozen face the whole time here.

I did a little intro slide about me, which is going to be a very much repeated of what was just said. I wasn't sure what kind of an introduction there would be. I guess the highlights are that I was born and raised in Illinois, went to school at Illinois, and only moved to Texas when I started working after my undergrad degree. Moved to Houston, Texas, to work on manned space flight stuff. Started working with Cimarron, and was full-time contracted to work on the Boeing Commercial Crew Program.

From there, I actually transferred and started working for Boeing after a couple years. And then, after some time with Boeing, I really just found that the pace of the work and the level of responsibility that I was able to get at Boeing, in such a big organization, it was really hard as a young, hungry, excited engineer, at that time, at that program, for me to really have a meaningful impact.

So I started looking for other opportunities and looked at smaller companies. And that's what led me to Austin, Texas, which is where I am located now. And I work for a company called 5-D Systems. We're a small services company and we focus primarily on unmanned aerial systems. So that can mean a lot of things. Obviously, the drones, UAVs, are making the news all the time now in all kinds of realms. But we do work on, primarily, unmanned tactical planes that have their own purpose, for different Department of Defense branches. We'll talk a little bit more about that in a second.

I have been actively involved with the aerospace engineering department since I graduated. And I love Illinois, Illinois is still home to me, that's where all my family is. So I try to get back as often as possible. Some of these programs and things that are listed on the right are the things I've been able to stay involved in and keep me connected to campus and to the department since I've graduated.

On the bottom right there is a picture of me at one of our factories, looking at a target drone. Which a lot of people don't really know about, but target drones are essentially drones that are used for target practice for manned aircraft; so pilots in fighter jet style planes, or really anything. If they're doing any kind of practice they want to have things that imitate other weapons that might be coming at them or they'd be running down. So we build drones to imitate or simulate those kinds of things. And that is one of those. Which is why it's bright orange, because you want to be able to see it for training purposes. So this was a few years ago, and this was in one of the factories out in California.

So today's an interesting discussion. It's not directly tied to space work, however it is definitely my passion and it always has been. What I do now is certainly a little tangential to that. But the idea of unmanned efficient vehicles, to do as much as possible and continue to push the edge of science and technology, is something I'm passionate about. And that's something I still get to do at my current job.

So what I'm going to talk to you about today is something called the XQ-58A, the Valkyrie drone. It's something I've been working on for about the last five years. I apologize that some of these slides, they're a little bit cookie-cutter. And the reason is there's only so much that is available for public release. So I took as much as I could. And there's other things that I'd love to show pictures of. I wasn't allowed to.

I'm actually going to skip two slides ahead to give you an idea of what I'm talking about. So down here on the bottom right is the XQ-58A aircraft. To give you some scale for it, so it's about 30 feet long and a 27 foot wing span. It puts it, over here on the top left, next to an F-16, which is something some people might have reference to how big that is. But it's a fairly large plane. When people think about drone aircraft, a lot of times they think about the quadcopters that people fly around in their backyard, or they think about small things that we fly. They really don't think about drones that are the size of manned aircraft. And those are very much becoming a reality now.

Flipping back to the history of this plane, I work for, like I said, a small company named 5-D Systems. But I've been contracted full-time, since I started with them, to work for Kratos, which is a company that is based out of California. And they have been a target drone company for a long time and began development of this aircraft in July of 2016. And I actually started in June of 2016. My first week on the job was working on this platform.

The idea with this is that you're creating a drone that can do something that other drones do not them. And you're trying to create this ability to have a runway independent ... meaning, you don't have to roll down a runway to take off and you don't have to land on a runway, but you can quickly support new payloads or new technologies that you want to try out in a more low cost sort of a way.

One of the big problems that the military has right now is a lot of the big planes that everybody knows about and sees on the news, they cost a lot of money. And a lot of times those things are very, very old. So in order to make a change, it takes thousands of engineers and lots of dollars to do so. But what everyone's learning is maybe that's not the best way to do it. And so this plane, this UAV, the idea is: how do you create something that is the right size? It can deliver different kinds of payloads, or maybe weapon systems if that's what you need, in a quicker fashion than having to build this brand new, very expensive fighter jet, for example? And the obvious benefit is that you don't have a man in the cockpit. So you're not risking someone's life when you send this thing out to go on a mission somewhere.

As is mentioned, we began development of this plane in July of 2016 and we flew our very first flight in March of 2019. So that's very fast by, I guess, military government organization standards. I was with the program from the beginning and able to be the flight test director for that March flight. And I have been for all the flights since then. It was very, very exciting.

A couple of key buzzwords in here I just want to point out, is one main difference with this aircraft is that it is meant to be a long-range, high-speed, and very maneuverable plane. So there are drones ... and we'll see this on the following pages ... that they go really, really, really high, but they go really slow. There are smaller drones that can go a little bit faster, but they have to stay lower. The capability that this drone has is far above and beyond of anything that we have operational right now.

And to give you a feel for that, here, on this next slide, you can see some different unmanned aerial capabilities that exist and things you might have seen pictures of in the news. The left-hand side,

it's talking about altitude; so let's say zero to 50,000 feet. Which is in the realm that we fly in the aircraft world. And on the bottom is air speed, so from super slow guys all the way to Mach 1. There's a lot right in this very slow lower end, but there's not much as you start to get higher and faster. And that's where this vehicle is positioned to be.

It's a very interesting concept because it doesn't have landing gear like some of these items do down here, which make them runway dependent. And that makes our operations sometimes more complicated. I'll talk a little bit about how we do that in a second. But it also provides us an advantage, because there's a lot of situations where runways have to go to manned aircraft or you don't have enough runways to do all the things you want to do in a mission scenario. And this drone is not reliant on that. We launch with rocket motors and we land under a parachute and landing airbag system. So it's a pretty cool concept.

Just going to give you a little bit of more of an idea of what that looks like. So from a overall perspective, this is an actual photo of one of our flights, you can see that we're on a launch rail. So there's a metal rail that ends right back here. And we strap, basically, two motors to either side of this plane, rocket motors. In addition to having our engine at full throttle essentially, we have these two rocket motors that are attached to the plane. Those stay with the plane until they completely burn off, they're solid rocket motors. Once they're done, they fall away and the plane continues to fly out.

So for those of you that are interested in any kind of rocket systems, whether it's for aircraft or spacecraft or anything, everyone knows those are pretty difficult systems to tune, because once you start them they don't stop, you're going to burn until all of your fuel or material, whatever it is, is gone. And so this is a particularly interesting problem because a lot of people who fly airplanes don't know anything about rockets. And this system brings the two things together.

Kratos, as a whole, interestingly enough, a lot of the target drones do launch with RATOs, we call them, those are the rocket motors. So they have a lot of experience in this area. So transitioning to a RATO powered takeoff for this plane was a fairly simple thing for Kratos to do. Other companies have tried it and it can get difficult, because if you're not familiar with how you set the angle and the power and those kinds of things behind it, you can have a really bad day if you don't have it going the right direction.

That's the takeoff. When it's flying it's controlled from a ground station, just like most all other unmanned systems. So there is a pilot, or we call them the remote control operator, that sits on the ground. And he or she is piloting the aircraft.

When we're ready to land, depending on what mission we're doing, this bottom left picture gives you a feel for how we do that. So we go from flying in a straight and level orientation, just like it shows here in the middle, and firstly, we initiate recovery, is what we call it, in that we have a drone chute that comes out, which is this smaller parachute. And that smaller parachute basically takes it from level flight to a nose down position. And it's going to basically go straight towards the ground, nose down. The drogue is going to get it under control in that configuration to slow it down a little bit, until we get it down to the altitude where we want to deploy the main parachutes.

And then three main parachutes come out. And you can see that, it all comes out of the top of the aircraft. And when that happens, then the plane goes into a level orientation. So it goes horizontal to the ground. A short time after that we have two small airbags that come out at the very bottom. You can barely see them in this picture. And those airbags basically arrest or help soften the landing when we do get to the ground. So the idea is really, anywhere you have a flat, flatter, flat ground, you could land this plane. It doesn't need to be anywhere near an airport, necessarily. So that has a lot of advantages for different mission scenarios.

And then to even take it one step further, the shipping concept of what this has looked like, is it's almost like a drone in a box. So you have this trailer that the vehicle sits on, you take the wings off and the tails off, you can put everything in there; you have all your tools, everything you need. You can literally pull it out of the trailer, put the wings on, and go. So it's not near the same level of involvement of maybe prepping a manned plane or something like that.

Next, let's try to talk a little about what it does. So as far as performance is concerned, it's a pretty cool airplane. For the people who ... if you think about maybe what a Southwest flight does, you go cross country, something like that, it's the longest you're going to fly. This plane was designed with a mission radius in mind of 1500 nautical miles, so which comes out to a max endurance of greater than 10 hours. That's a long time, without refueling, without doing anything else. In addition to that, having to go very fast. So a dash speed of Mach 0.86, and be able to do 6 G maneuvers. That's pretty crazy.

The mission radius here, that I mentioned before, of 1500, that's with two SDBs. So those are small diameter bombs in the weapons bay. If you don't have those then it says the mission radius here is greater than 3000 nautical miles. So that extends it quite a bit.

We do have multiple areas in the plane as well, where you can hold different kinds of payloads. And a lot of the work we're doing right now is around: we have this plane and we're now putting new sensors and technologies on it to try to do other cool missions.

So if you look up front here, in this top left picture, there's multiple bays where we can put payloads, about 400 pounds worth. We also have an area down here in the weapons bay that can have a lot more, so about 1200 pounds. And then if you wanted, you can also put payloads on the wings, either close here and here, near the body of the plane or out on the wing tip. And you can have a decent amount of payloads there.

So the idea is this is kind of like plug and play. So if somebody comes to us and says, "Hey, we want to be able to put a bunch of cameras all over the plane and take pictures of this." Sure. We can go do that. If they want to do something else with something in the weapons bay, that's possible. But there's a lot of options. We like to think about it as a modular vehicle. If somebody comes in and has a certain need, we're able to find a place to fit them and provide them the power they need and can go from there.

The only other thing that is important to point out is this third bullet here on this page is kind of a big deal, we'll talk about it in a couple slides, is that the Valkyrie, or the XQ-58A, is a concept that is meant to really operate in conjunction with, or in concert with, manned aircraft. So, sure, it can go do its own mission, and that's great, you can do numerous things with it on its own, but there's also very much a desire to have these planes be like wingmen for manned aircraft that are in the air.

So let's say you have one fighter jet in the air. You might have two to four to six of these drones out in front, doing surveillance or other kinds of operations. So you're providing not only situational awareness for the people, the actual manned people in the aircraft behind, but maybe you're also providing some protections and things like that. So it's a really cool concept. It seems futuristic that we have drones and manned aircraft flying next to each other. But that future is becoming closer and closer, as we develop these systems that are more robust and more reliable and better tested.

I have a video I'd like to share when I'm done. I'm going to skip it for now because I don't want to mess up my sharing. But I do want to pull up ... there's a launch video that you can watch that's pretty cool, from one of our operations that we did couple months ago.

So one of the key things ... I know that a lot of these talks are very much space focused. But when I was asked to participate in this, I was excited to do so. Coming from a space background, I did the space side of things in senior design and I was very much interested in human space flight, always

wanted to be an astronaut, those kinds of things, I wasn't sure how I was going to like the aircraft side, especially unmanned aircraft side of things, when I started working on it.

But I've found that there are a lot of similarities in the problems that we're solving on both sides of the fence, both the space flight and the aircraft side of things; whether it's manned or unmanned. And there's some things that I've noticed, just in the last 10 years of being in the industry, that I think are important for everyone to understand, but especially young people that are coming into the workforce in any way. Some takeaways that I hope that you guys can see ... and I'm happy to answer more questions about it ... is that there's lots of different ways and creative solutions to a lot of the problems we're facing right now, whether it's on the aircraft or the spacecraft side.

This slide is totally my thoughts. Has nothing to do with Kratos. But when I think back about the kinds of programs that were a part of the industry in the '50s and '60s and '70s, and even earlier than that, around the different world wars, a lot of the advancements we made were because there was a war going on, unfortunately, and something was needed. Or there were just big budgets because we had just had a war or we were going to have a war. It was like: we have a problem, we have to fix it. And they would throw as much money at it as they could.

That's not the case anymore. It has changed a lot. It has forced not just private companies, but the government and the government entities that manage a lot of these operations, to be more creative, to be more lean, spend money more wisely, and enable rapid technology development. And that's a really big piece of it, because right now technology is developing so quickly that when you get a project on January of a year, by December of that year it's already out of date by a lot. So if we take 10 years to develop the next big thing, that thing's going to be so old by the time it's done that no one's going to want it.

So I think it's important to highlight that, in both realms, there are ways that we've changed how we're doing business. And there's some examples here that I'm sure anyone who follows the news and aerospace news would be aware of. But things like the commercial space flight, the Commercial Crew Program on the space flight side of things. Boeing's here in Nevada, SpaceX, Blue Origin; companies that were competing for NASA contracts, and therefore there was a down select process and they had to do their best to try to win those awards.

Same thing with the Cargo program, once the Shuttle program ended they needed carriers to bring things up to the space station because that was still operating. So they've had multiple private companies that have enabled them to do that at a lower cost. Also, lower cost small and mid-size cargo access to lower earth orbit. So smaller rockets. Not the huge ordeal that is a shuttle launch, but something a little bit smaller. A lot of people think of maybe CubeSats or things like that. But there's all kinds of sizes of things that we're sending into space now, low cost satellite stuff.

And then the last two bullets talk about the realm I'm in now, which is expanding how we're using unmanned systems. So I'm sure a lot of you have seen in the news, we're using drones, quadcopter things, or slightly bigger ones, to do surveys over land, to do safety monitoring over oil refineries and factories. There's just a lot more in the aerospace world now than ever before, because the technology has expanded and people have thought creatively of how they can use solutions for multiple different applications.

So, in my mind, my big takeaway from all of it, learning what I have over the last few years working on these kinds of systems, is that there is not a one-size-fits-all. And more and more, the world is showing us that that's not true and we need to continue to find creative ways to solve problems.

So continue to be creative, use what you learn in all areas of your life and academia to try to formulate these solutions. I think a lot of people think, "Oh, if I'm not studying a STEM field, that I can

never be involved in this kind of stuff." And that's really not true. If something interests you, find a way to participate. There's a lot of times where engineers will get stuck on a problem, and they would never see an obvious or maybe a creative solution to something because that's just not within their realm or their head space. So I think that's important.

What we've done with the Valkyrie aircraft is pretty unique. There's a couple other companies trying to enter that world now, but they're behind the curve. So I think that not just in that arena, but in space flight and aircraft, man and unmanned, there's a lot of room for creativity, because simply the government isn't going to shell out the billions and billions and billions of dollars like they maybe used to, to different programs. So it's important to be lean, to work smart not hard, and just continue to grow and learn as a company and make sure your engineers and the staff that's working on those things is doing so as well.

So I think what I'm going to do ... this is my last slide. I do have a slide in here if you're interested in learning more about the XQ-58A plane. There's a bunch of links. And I'm happy to share these in some way so you can read more about what the plane is and what we're doing.

I'm going to see if I can get the video to play here real quick. You see a plane? Okay. Okay. So this was a little video they put together. We did a flight in January that, basically, we were carrying a payload that was providing communication between an F-35 and an F-16. So it was a pretty cool payload we were carrying onboard our drone. We were flying alongside manned airplanes, which is the long-term goal, and proving out this concept, that it would work.

Now, they put this whole presentation together to talk through what the program was. But I'm just going to show you some quick sections here to give you an idea of the CONOP of our vehicle. So this is the unmanned plane, about to take off. This is our control room. That's me in blue there. Our pilot's over on the right. Gives you a feel for the operations. And here is the launch.

So it is quick, it is fast. The rocket motors fall away. And then this is a view of us flying. So the drone is in the front there, the XQ-58A, and then you've got the F-35 and the F-22 next to our plane. And you can kind of see that out the view of the other plane. It gives you a feel. There's some other footage in here, but it's mostly just of our operations.

I'm happy to share this link as well, if people want to watch it a little more. This was a really big deal, just because of all the participation that we had from the F-35 and F-22 teams. Flying up with a drone is not a normal thing, especially that close, because of being a newer drone, it's a scary thing to fly next to. So it went really well. We had no issues. But it's a pretty cool video, if you guys want to check that out as well.

Courtney Bradley (23:41):

Thank you so much, Samantha McCue. If anyone has questions, you should be able to unmute yourself now. You may also submit questions in the chat. One of our hosts for the talk will read your question. Also, complete the short poll at this time. It should pop up on your screen.

Heidi Bjerke (24:00):

Samantha, I did have a question. This is Heidi from the University of Illinois. I noticed for the shipping of it, you can ship the drones just in a regular shipping container?

Samatha McCue (24:12):

You can, yeah. And when we ship them to the test ranges and stuff, we just put them on the back of a flatbed truck and it's covered. So I always laugh, that anytime you're driving down the highway and you see a covered truck you never know what's inside. And it's really that simple.

Heidi Bjerke (24:29):

Well, yeah, because I was looking at your diagrams and noticed that it fit. And it looked like a standard shipping container, which is interesting because ...

Samatha McCue (24:37):

Yes. Yeah, it is. And it's-

Heidi Bjerke (24:39):

... just [inaudible 00:24:39]. It saves cost. It's a cost issue.

Samatha McCue (24:42):

Exactly. Yep. So to do special transport and stuff like that, it adds a lot to the operations. So a standard shipping container that can go on a truck or a boat or anything is what they want.

Danielle Ho (24:54):

Hi, my name is Danielle. I'm from NIU. So I know you mentioned that they can be controlled from the ground, through remotes. But is there a chance that it could somehow malfunction? And is there a safety mechanism that would land it properly?

Samatha McCue (25:18):

Yeah, this is a great question. So we call that LOC, so that can mean loss of comms or loss of carrier. And that does happen. And that's actually a common scenario for drones, that if, for some reason, it loses its link with the ground, it usually has a routine that it does on its own. In most cases, it'll fly some kind of orbit pattern and trying to regain the link so it can continue its mission. And if, for some reason, it doesn't, or it can't regain that link, then it does an automated sequence to get itself back on the ground.

So that is definitely an important piece of the safety element of this plane, because we, of course, don't want drones flying around with no one controlling them. So sometimes we fly with multiple data links, if it's critical that we keep control the whole time. So maybe you'll have two or three different radio systems on the plane. But a lot of times we just fly with one, and if we need to use that safety feature then we do.

And we actually tested that out in our last flight, completely and purposely got the link to come down so we could test all that out. And it worked great. So we absolutely do that.

Courtney Bradley (26:26):

Hello, I have a question. My name is Courtney. I'm from Northern Illinois University. I have a question about: how did your experience, working at NASA, and even UTC Aerospace and Cimarron, help you with this mission of the XQ-58A? Because I know that NASA is more, I guess, out of orbit, this would be more in orbit, so I just wanted a little bit details on that.

Samatha McCue (26:53):

Yeah. So I think my experiences at NASA, in all the different varieties of that, no matter what company I was working for, what helped me the most was that NASA is constantly working on big problems and they're dealing with really big systems that have multiple elements. And those kinds of complex systems don't just exist at NASA, they exist in a lot of places. For example, this plane that I'm working on now is a pretty complex system that has multiple elements; there's a ground element, there's a launch element, there's the actual flight itself. Very similar to just like a ... you want to call it a commercial crew space flight issue. They have to handle things on the ground, they have to do a launch from the ground, fly, return to earth, and recover.

So all those phases of the mission, they're obviously different. But we have to think about the same things and learn how to solve problems in a similar way. So I think learning how to be a really good overall system thinker, and think about the big picture and how each piece plays a puzzle of the whole, was one of the major things that I learned from NASA and those experiences and brought to my current job. I think it's helped me a lot with what I'm doing now.

Courtney Bradley (28:04):

Oh, thank you.