AA Ep. 185 - *Tomorrow's F-35: Cooling is Key – Transcript*

Heather "Lucky" Penney: [00:00:00] Welcome to the Aerospace Advantage podcast. I'm Heather "Lucky" Penney, your host and a senior fellow at the Mitchell Institute. Here on the Aerospace Advantage, we speak with leaders in the DOD, industry, and other subject matter experts to explore the intersection of strategy, operational concepts, technology, and policy when it comes to air and spacepower.

So, if you like learning about aerospace power, you're in the right place. To our regular listeners, welcome back. And if it's your first time here, thank you so much for joining us. And as a reminder, if you like what you're hearing today, do us a favor and follow our show. Please give us a "like" and leave a comment so that we can keep charting the trajectories that matter the most to you.

The F 35 is one of the most impressive combat aircraft ever developed. Yeah, it's been in the news for some negative reasons as of late, given the delays and the challenges associated with TR-3 Block 4 upgrades, but guess what? This too shall pass. After all, we are really redoing the entire insides and capabilities of this aircraft. Versions flying operational missions [00:01:00] today, particularly the three F variant, they've revolutionized what it means to fly and fight in the information age.

And they are kicking ass, you know, just ask any pilot who's deployed in the jet to a forward AOR. The reason for this is simple. The jet is a massively capable information machine. It can collect a ton of data through its sensors, integrate inputs from off board actors, process all of that into actionable information and team with a wide array of assets across the battle space.

And all of this happens real time. With incredible speed and dynamic agility. What a lot of people may not realize is the impact of all of this processing power on the aircraft. Sensors and processing, take a lot of electricity and all of that produces a lot of heat. You know, just think about your computer, whether or not you have a laptop or a tower, there's a fan in there that works to cool your hard drive and airplanes need to cool themselves too. Keeping the F 35 at the cutting edge of performance demands, regular capability insertions that involve both hardware and software.

It's just like your smartphone or your [00:02:00] personal computer. You can only stick with an initial version for so long before an upgrade is essential. And as we continue to add more capability to the aircraft, that means sensors and demand for processing will need more power and more cooling. So you won't be surprised.

The F 35 is a massive ecosystem. And so if one part of the aircraft is upgraded, there are going to be other downstream effects. So today we're going to discuss how the aircraft is evolving, what this means for the systems. And look, this isn't negotiable. the nation needs the F 35 to have TR 3 Block 4 capabilities.

And while the journey to get there can be a little frustrating, the end effect for the war fighter and for our nation will be well worth it. In fact, given where our adversaries are headed, this is essential. We have to remain committed to the TR Block 4 because this translates into a crucial combat advantage, not just for our pilots, but the entire joint force.

And the good news is that we've got tremendously smart people involved with the program and they're pressing hard to ensure that the jet remains [00:03:00] capable and relevant for decades into the future. To help me explain this journey, I've asked Mitchell's Executive Director, Doug Birkey, to join me today. He wrote a report last summer explaining how the F 35 is evolving, why this is occurring, and what that means for the aircraft from an enterprise perspective.

Douglas Birkey: Hey, Heather. Awesome to be on the podcast with you today and really congrats on your new leadership role here. Doing great.

Heather "Lucky" Penney: Oh, thank you so much. And I really enjoy it. We've got great content, great guests, and great listeners. So it's an incredible honor to be able to bring this, these issues to them. So thank you.

Bring us up to speed. What's going on with the F 35 and PTMS?

Douglas Birkey: So big picture, the F 35 is a very long journey. I remember when I was just beginning my career, NOVA on PBS did a special about the selection and the competition between the prototypes and all that. I mean, this is obviously a multi decade process.

And what's really, really crucial to understand is that the jet that you see flying today, [00:04:00] it's fundamentally different than the jet you saw 10 years ago. And the jet you'll see 10 years from now is going to be very different. The outline looks the same. I mean, if you just take a picture of it, it's going to be pretty hard to discern it.

But fundamentally, the guts of it, change radically.

And that's by design. That's a good thing. It allows it to really keep on step with the threats and evolve and we're in the major cycle of that right now. And so, you know, it's... iPhones! They all look about the same, but what I had, you know, two decades ago versus now, it's totally different product and it's the same way with these aircraft.

And this isn't a new thing. I mean, look at F 16. The F 16s that first flew in, in the early 80s were totally different than what came off the line in the late 90s, you know, with a block 50 or something like that. And now look at block 70, I mean, it's unbelievable what it can do. But again, the outer mold line looks roughly the same.

And so, when you look at the F 35, you can differentiate that [00:05:00] talking about the different "blocks." And so right now, the major one that you're going to see on a flight line is called "3F" and it's an insanely capable version. You talk to the operators, they are very, very impressed with it. But folks know that we've got to keep pace with the threat.

We want more capabilities inserted onto it and it has to do with everything from the sensors, the processing power, the, you know, electronic warfare capabilities. More and more things that have gone a long time, but that's delineated right now is TR 3 and Block 4. And make it simple, TR 3 is a, hardware insertion that drives a lot more capable software and associated systems.

It's really under kind of the block four nomenclature.

Heather "Lucky" Penney: The TR3, that's the actual processor, right? So that's, that's gongulating all the information and the sensors that the Block 4 sensor suite and capabilities put into the aircraft.

Douglas Birkey: Exactly. [00:06:00] And so that's in play right now. There's obviously been negative news on it because it's behind the curve and the services have been very vocal about it.

And I got it. We're all frustrated about that. However, I also know this too shall pass and we're going to see those aircraft on the line flying operational missions and they're going to absolutely kick butt. And it's essential we get those upgrades, but there's a proviso with that. It takes more power.

And it's just like what we see going on in civil society, that with AI coming online and electric vehicles and all these demands in the civil power grid, it demands more. And you add more systems onto a jet that are more capable and more voluminous, in actual number, they will demand more power. You create more power, it creates a cooling issue, because obviously heat is a byproduct there.

And so you've got to dissipate it somehow. And so, just to kind of help scope it a little bit, the jet was originally [00:07:00] designed with a requirement of 14 kilowatts. We are well beyond that now. And they've been using kind of Band Aid approaches to deal with it, but it's time for a holistic reset. And the JPO knows it.

And they just came out with a request for information from industry and others to look at different solutions. That's really kind of the state of play these days.

Heather "Lucky" Penney: Yeah, that's amazing. Thank you very much for that breakdown. I mean, when it comes to processing power, the more software lines of code, the more gonculations you need to do, the more electricity it's going to require.

And like you said, that's going to drive more cooling. So thank you for that. And for our listeners, we're going to include a link to Doug's Block 4 report in the show notes. And if you haven't read it already, it's important background because you can't talk about the program if you don't understand the TR-3 Block 4 upgrades.

As Doug said, this is basically a new jet on the inside. So, you know, I'm hearing in the media, like, "Hey, come on, have we have, why haven't we gotten through all these teething issues?" Well, the teething issues with the jet itself is just fine, but because it's a [00:08:00] whole new jet on the inside, there's still some learning that's going on there.

And Doug did a great job in breaking this down at the unclassified level.

Douglas Birkey: So, Heather, you know, I kind of danced around it, but a key element tied to our episode today is a concept called SWAPC. Can you break it down for folks?

Heather "Lucky" Penney: Yeah, you bet. So, SWAPC, if you Google this, everyone thinks Swap C is size, weight, and power and cost.

But really, I think we should consider it size, weight, power, and cooling because these are physical attributes that have to be designed in, right? So traditionally we think of aircraft design as only having to concern (ourselves with are) range and speed and thrust and maneuverability and altitude and payload.

Yes, those are physical things that have to be designed into the aircraft, but as sensors and electronics become ever more important to aircraft performance and warfighter effectiveness, SWAPC has to be designed in from the very beginning. So do we have enough room for the generators? Do we have enough power to be able to power all the electronics? Do we have, [00:09:00] uh, you know, enough cooling to make sure that all those electronics and sensors are maintained at the very appropriate levels so that they can be effective throughout the entire regime of the flight envelope? Whether or not that's, you know, supersonic and going super fast maneuvering at nine G's or sitting on the ground in a hot pacific environment waiting to take off. We need to make sure that they don't cook and shut down. Right? I mean, we all know what it's like when our, when our phones overheat and shut down and we can't do anything with them. And we need to remember that cooling for a jet isn't just as simple as like using the ram-air.

Sure, that's fantastic if you're at 45, 50, 000 feet where the air is super cold and you're going super fast, you've got a lot of it. But the fact of the matter is most of this cooling doesn't come from ram air. It comes from bleed air off the engines because we also have to make sure that we've got the right volume all the time at the right, uh, temperatures all the time. To be able to cool those avionics and processors that are buried deep inside the aircraft that don't have access to that ram air.

So given [00:10:00] that context, we'd like to do is we'd like to bring in Matt Pess, Chief Engineer on the EPACS program at Collins Aerospace to talk about how they're looking at solving this challenge.

Matt Pess: I'm excited to be here. Thank you so much for having me.

Heather "Lucky" Penney: Matt. Thank you. So can you talk to us about your perspective regarding power and cooling and its impact on mission capability?

Matt Pess: Sure. So Collins has been in the business of power and thermal management since the 1940s. I think one consistent trend we've seen is that these incredible airframes really outlast the original mission capabilities. So, to keep those aircraft outfitted with the latest capabilities for service men and women, those mission systems and weapons have to go through a series of upgrades.

As Doug mentioned, the current F 16 is not the same one that came off the line in the 80s, and that happens over the life cycle of a program. These new capabilities often need more power that generates more heat that needs to be addressed and on an aircraft that isn't changing size. [00:11:00] So, this trend continues today, of course. Secretary of the Air Force Frank Kendall recently emphasized a sense of urgency during his congressional testimony. Is that our security community needs immediate and significant capability modernization to keep pace with the growing military capabilities of near peer adversaries. I think, you know, the increasingly complex threat environment really requires upgrades to today's platforms as well as those legacy systems so that they can remain relevant.

And in the past, we could sometimes take decades to develop these new capabilities and respond. But today, these changes need to be developed, they need to be tested, they need to be fielded much more quickly, just to stay ahead of our near peers in that evolving threat environment.

So that advancement from our adversaries was really the backdrop for where my team and more broadly, the entire aerospace and defense industry is [00:12:00] focusing on its efforts to help the global security community stay ahead of the curve.

One example we're focused on is enabling critical warfighting capabilities on the F 35 by proposing an upgraded power and thermal management system, PTMS, we call the enhanced power and cooling system, or EPACS. And that's a system that would more than double the platform's current cooling capability.

Douglas Birkey: Now, I really appreciate that. Would you mind walking us through what we've been looking at in this journey? I mean, I mentioned the 14 kilowatt stat, you know, from the beginning of the program, but the Joint Program Office, they came out with a new set of requirements. Can you walk us through and kind of help us understand the growth curve?

Matt Pess: Or so the JPO and the Services have indicated they're looking for solutions to address somewhere between 62 and 80 kilowatts of cooling capacity. And that should accommodate all future upgrades to the platform. A change has really become necessary [00:13:00] now to enable those new capabilities that are already slated to be added to the F 35 in the future.

It's not clear yet how or when the JPO may implement all of that growth. But a system like PTMS that's so integrated with the aircraft operation, it's not as easy as just upgrading it with each incremental mission package upgrade. And by the way, that growth is not specific to F 35, right? Just about all major commercial and military aircraft experience the same kind of growth demand.

They want to add mission capability. They want to increase performance, add features on the commercial side, adding in flight entertainment options. We see that throughout the life cycle of every aircraft.

Heather "Lucky" Penney: You know, and that's just really incredible growth. Whether or not you're looking at it from the military perspective, like many of our listeners are on the commercial side, which we all have experienced by flying commercial aviation that kind of mission capability [00:14:00] to support enhanced, sensors and other capabilities is really just amazing.

And from a military perspective, that's important. That is crucial to warfighter effectiveness and survivability. From the F 35 perspective, this means that it has the potential to radically boost its capabilities. And not just with Block 4, but for future growth, as we learn and develop more electronic warfare suites, enhanced radar capabilities, improved processing, and so forth.

But this also means that we need to keep up with the SWAPC.

Douglas Birkey: Now, and it's, again, I keep foot stomping this, and you just said it, Heather. TR-3 Block 4, it is such a huge step function in, in growth. And, you know, people are going to love it when they see it when we get there. And it's hard to describe it because it's very, very classified and that's a challenge we ran across writing the report and we tried to break it down and kind of macro buckets, but we've got to get there.

Now in the commercial side, I mean, can you imagine the impact on something like this when [00:15:00] everybody all of a sudden wanted to plug in their cell phone?

Heather "Lucky" Penney: Yeah, you know, the power generation is huge. And also we need to remember that Block 4 isn't just a single insertion of capabilities. This will be a continuous insertion and upgrade of software and sensors and processing and so forth to enhance warfighter capability on the F 35 for quite some time.

So that's going to require a lot of power, which also then means a lot of cooling. Let's be clear. We're talking about cooling today, but the more power we have and the more sensors we have, that also then means we've got a lot more heat energy that we need to manage. So Matt, how do we understand this in terms of the volume of what actually needs to be done?

What the problem is here, you know, you've got a light bulb. That's a couple of kilowatts. How many degrees Fahrenheit? I mean, put us in a context that we can really understand what the demand is from TR Block 4 going from where we are today, which is roughly 30 kilowatts. And remember, the F 35 started out about [00:16:00] 14 kilowatts, but now we're making a massive jump up to 80 kilowatts, 62 to 80 kilowatts.

So what does that mean in terms of the demand on the power thermal management system?

Matt Pess: I think it's probably best to start with what's being cooled and how. So on, on any platform, there are avionics, electronics, weapons. Most importantly, often a person, they all need a certain temperature. In the case of the pilot they also need a certain pressure to operate properly. So there's two primary types of cooling on an aircraft. We've got air cooling and liquid cooling. The crew station, the low power avionics, things like displays, NAVCOM, radios, those are primarily air cooled, and it's really not where the growth in the coolant happens on a platform.

The real change is in the liquid cooled avionics. So these are things like radar, electronic warfare systems, high speed data links, the aircraft flight control computers, like the [00:17:00] upgrade that we were talking about earlier. These systems draw and, you know, especially in the case of the radar and electronic warfare, they emit a lot of power.

As a result they generate a lot of heat. That heat has to be removed or the equipment itself can overheat. So how do we remove that heat? If you imagine the heating system in a house with hot water radiators, so you have a furnace that's putting heat into the water. That water then gets pumped around the house and the radiators in each room, dissipate that heat into the room to warm them up.

If you, essentially are pulling heat out of the water with those hot water radiators, and that's the ram cooling that we were discussing earlier. On an aircraft, the avionics or the furnace, they heat up the liquid. It's pumped around.

It gathers up heat from all the different avionics, and it finally ends up in the PTMS.

The difference is we can't just dissipate that heat into the air. Doug mentioned ram air [00:18:00] is not sufficient for cooling when the aircraft is on the ground. With tight temperature windows that we have to hit for the avionics per the mill standards. So we have to put a refrigeration cycle on the aircraft that cools the liquid.

But unlike your home air conditioner, most aircraft PTMS use air as both the power source and as the working fluid. So for some context, right, we're talking about the future of the F35 needing 80 kilowatts or so of cooling. The air conditioner for an average house is about 10 kilowatts. So to meet the new demand, we're talking about the equivalent of eight central air conditioners from a cooling standpoint.

That's you can see why that would be a challenge to put on an aircraft.

Heather "Lucky" Penney: That's incredible. And clearly we can't fit eight furnaces onto an F 35 or shove that into the avionics bay. So, can you paint a picture for people so they can understand the full enterprise of what's at play within this process?

Clearly the heart of aircraft [00:19:00] power generation is the jet engine. Because that then drives all the various components on the accessories case, like the generator, which produces the electrical power. And then that power is consumed by the mission systems, which in turn need to be cooled. But that's very simplistic, and you're the technical expert.

Can you walk us through at a more granular level? And you give us a really great analogy of how that works. But can you actually describe the basic system of how all this comes together? Because you've got the power and the cooling integrated onto a single component, right?

Matt Pess: Yeah, so you said it right.

The, the engine is the primary power source for everything on an aircraft. Electrical, pneumatic, hydraulic, it's all taken off the engine in some way. So, in order to cool all of that equipment on the aircraft, the PTMS takes that energy in the form of high pressure air, "bleed air" from the engine. So, the engine provides the power and the PTMS generates the cooling.

On commercial platforms, the [00:20:00] environmental control function here, it's the largest energy consumer, other than generating thrust on the aircraft. And of course, that's the primary function of the engine. But that environmental control system can account for up to 6 percent of the total fuel burned by the airplane.

So, as a result, particularly on commercial, the energy efficiency of that system is the priority. And that wasn't always the case on military platforms since on legacy aircraft, the bleed was not very expensive from an overall aircraft trade. And the cooling needs weren't as large. So often they prioritize the smallest volume system that they could possibly come up with.

As we look towards future platforms or the upgrade that we're discussing on F 35. PTMS capability is starting to become a real driver of aircraft performance. So efficiency has become much more important. So, what does that mean? Our goal is always to [00:21:00] limit the energy. So for PTMS, for EPACS, that is bleed air, and that's something we've done for decades in our commercial programs.

But the other side, as you mentioned is electrical power. So what's generating all the heat that we have to remove? It's the electronics. They're doing processing, they're doing power conversion, communication, radiating, and they're all doing that at a certain efficiency. So when we talk about efficiency for electronics, we're really talking about how much of the electrical power they take in is converted into useful work.

Emitting power in the radar, for example, but since no electronics are actually 100 percent efficient, any energy that's not converted to work turns into heat. And that's the heat that we need to remove with the PTMS. And if we don't, then the temperatures in that mission equipment will rise, they'll exceed the limits that they were designed for.

They might exceed the limits of the electronics that they're based on. We get degraded [00:22:00] performance. We could even get damaged systems. But like PTMS, the electricity to power those systems is also drawn from the main engine via the generators. The power and thermal management system is really doing multiple functions on the aircraft.

In the case of the F 35, they've combined the functions of emergency power, main engine start, and thermal management, and that's really what we're getting at for the F 35 PTMS. That's a little bit different from some other aircraft.

Heather "Lucky" Penney: So you've got the emergency power, the starter, and the thermal management.

So is the generator a different component?

Matt Pess: Yeah, so the main engine generators are still the primary electrical source for the aircraft. And those are mounted, as you said, on the main engine gearbox.

Douglas Birkey: Okay, so I just want to clarify here for everybody to understand. [00:23:00] PTMS, this is a pretty common thing throughout military aircraft and civil, is that right?

Do I have it straight?

Matt Pess: Yeah, so while there's a number of ways to do PTMS the most common for aircraft is the reverse Brayton cycle, we commonly know it as an air cycle. An air cycle works by taking high pressure air from the engine. Conditions it using heat exchangers, expands it in a turbine. That expansion is what generates the cold air and in a tactical aircraft we use that air to cool the pilot and the forced air cooled electronics directly, but it also conditions the liquid.

It's an oil called PAO on military platforms. That's then fed to cool the liquid cooled avionics, but it's not unique to the F 35. Every platform military or commercial, has a system, which provides some or all of these functions. The thermal management functionality of the PTMS is often referred to as environmental control systems.

Like I said, the F 35 is unique in that it also [00:24:00] combined into that one system, the emergency power and main engine start functionality. On most other platforms, those functions for main engine start and emergency power are provided by an auxiliary power unit, an APU. Which is usually located somewhere else in the aircraft, but it ultimately provides another source of electrical power, bleed air, sometimes both. For when the main engine is not running things like ground maintenance actions when the main engine is off.

And we've been fielding and integrating APUs like that on aircraft since the 1950s.

Heather "Lucky" Penney: Thanks, Matt. I mean, like that's really helpful for a lot of our listeners who are pilots. So really understanding the function of the

PTMS or the EPACS and how that's differentiated from an APU that they may be more familiar with is super useful.

Douglas Birkey: Dude, I don't know when you sleep at night. That is so complex and the engineering challenges that I'm very impressed. But wow, you talk about a multifaceted [00:25:00] tool. You've got the Swiss Army Knife of a component there in the jet.

So, anybody that's been reading that, the headlines recently, saw that the GAO is coming out with various reports on F 35 and they've talked about long term cost and position of really failing to address the thermal management challenge. And they've pegged a cost of 38 billion across the lifetime of the aircraft in terms of reduced component lifespan and increased maintenance and all that.

I just want to flush it out a little bit more and how this can help get after it.

Heather "Lucky" Penney: Well, yeah, exactly. Because the JPO knows that this is a major issue. And that's why they've requested a request for information from industry to look at solutions to accommodate the cooling growth that we've talked about for future versions of the F 35.

So this is on the verge of being an actual competition, right? You guys, anticipated this challenge and you've been working on a solution that you will propose to the government. Can you walk us through what's in play right now?

Matt Pess: Well, I think it's safe to say that the future is here [00:26:00] already.

The services need to counter an evolving threat environment. A change to an integrated system like the PTMS is not going to happen overnight. And if we don't start the engineering work now, it's not going to be ready in time for those needs. The most recent GAO report indicated that the need for more PTMS capability becomes real in 2029, but the new systems aren't likely to be ready to be fielded until 2032.

So there's a lot of work to be done. And ultimately, we hope this turns into an engineering manufacturing development program quickly. Lieutenant General Schmidt, who's the program executive officer for the JPO for F 35, was asked during a hearing in March, in front of Congress, "What could Congress do to support the PTMS upgrade effort?"

And his ask was relatively simple. He said he needs funding allocated so that he can get Lockheed Martin and the industry to perform the engineering work that's necessary to [00:27:00] solve the problem. I think, you know, it was summed up well earlier by you and Doug, there are constraints on the aircraft, right?

First and most obvious, it needs more cooling. That enables the critical warfighting capabilities for the future threat environment. Second, there's a ceiling on how much power the system can consume from the engine before it starts impacting wear and tear, ultimately adding life cycle costs to the platform.

And, and lastly, and probably most challenging, of course, the aircraft isn't getting any larger. So there's a limited volume to work with. But a desire to add a substantial increase in capability. These are challenges that Collins and my team is familiar with, and we successfully developed solutions for over the last several decades for other platforms.

Heather "Lucky" Penney: Yeah. And Matt to foot stomp for our listeners. I mean, you've got a limited amount of size and weight that you need to fit this new system in, but you're demanding more and more of it in terms of power and of [00:28:00] cooling. So how has Collins approached the development of the EPACS?

Matt Pess: Yeah, as I said, the F 35 isn't the first airframe to need more cooling capacity, more energy efficient systems.

So, the Collins team has been doing this for quite a long time across both military and commercial platforms. On commercial, you know, efficiency means reduced fuel burn, and that can be either increased range or reduced fuel weight. On long haul aircraft the operators really like the reduced fuel weight because it means they can put more passengers or more cargo on the airplane.

On a military platform reduced fuel burn is usually returned as an increase in range, but just reducing the bleed demand, returns power essentially back to the engine. And then the service members can benefit in a number of ways, depending on the need. So you can get more range. Potentially, you can get more thrust, reduced wear and tear on the aircraft, and that reduces maintenance costs and increases aircraft [00:29:00] availability.

So, on both types of platforms, space is always at a premium. So we always have to develop systems which can fit in the smallest possible package. While still delivering the maximum cooling capability, but when we look at, you know, F 35 and other future platforms, all of those same needs are present. We were borrowing proven technologies from prior military and commercial aircraft and really packaging them into a design that can fit into the aircraft.

Support the needs of that platform. I mean, once the urgent need that I mentioned earlier was, became obvious to us, we really focused on just getting started so that we could burn down risk early. Now, when the government is ready to launch a program, we're ready to bring a low risk system that we can really work with Lockheed to integrate onto their platform. And the guiding principle of that development has been to prioritize [00:30:00] flexibility of the architecture and using mature technologies wherever possible to reduce risk.

Heather "Lucky" Penney: That's fantastic that you're looking and making these investments early so that, with your offering, you could potentially, synchronize, your delivery with the demand. You know, and for our listeners, I'd like to really again, say that the increased range as a result of better fuel efficiency is going to be huge.

And it's not just for commercial side, but for the military side, that's especially essential for the F 35, given the kinds of ranges that will be flying over there. Bleed air is air that comes off of the core of the jet engine. And then they use that air to then drive an accessory or drive some other function.

And by taking that air outside of the engine, it's not going out the back of the jet anymore. So it's not producing any more thrust. That's why reducing the bleed air demand is so important to improving fuel efficiency in this kind of increased range.

Douglas Birkey: Hey, Matt, I want to circle back. You talk a lot about the commercial aviation solutions and how that's [00:31:00] coming into the defense space to help drive down risk.

And could you explore that a little bit more? Because I think it's a really interesting element how we're seeing cross pollination between these communities.

Matt Pess: Yeah, absolutely. I mean, one of the biggest differences between commercial and military programs, other than the G loads that Heather mentioned.

You know, a military aircraft may fly a few hundred hours a year. Commercial aircraft tend to fly a few hundred hours a month. So when we bring technologies or methods from our commercial programs, we have literally millions of flight hours on those systems in the field. And that really provides a lot of confidence that the technology is proven.

There's always going to be adaptations that need to be made going from commercial to military. Things like vibration, G load. But those are design efforts they aren't really fundamental technology changes. So in general, we're not trying to add technology if we don't absolutely need it to solve the problem.

But when we do, we have a broad [00:32:00] manufacturing and supply base simulation and testing capabilities. That we can draw on, so we can prove out concepts quickly and really test them in real systems to understand their performance. On EPACS, we're leveraging environmental control system technology that we have developed for a platform like the 787.

It's one of the most efficient, energy efficient environmental control systems and service today. So, that's how we're really trying to reduce risk on the program from a technology standpoint. But it also allows us that to leverage that commercial production and supply base so we can deliver more value to the services.

Douglas Birkey: So this notion of risk is obviously huge and you talked about the timelines in play, which really increases the pressure on delivering. So what's your real approach here on reducing it. I get it. We're importing some technologies from the commercial sector, and that's good. You've got lessons learned there that you can pull in, but there are also some very unique things about applying it to a combat [00:33:00] aircraft.

Are we talking about your solution in theory, or have you actually tested this and are testing elements underway?

Matt Pess: We've been looking at this challenge as it's evolved over the past 10 years. Up through about 2020, we're really performing design trades in our model based systems engineering environment.

So using digital twins of similar hardware and control schemes so that we could understand the trade space. You know, based on a limited set of requirements that we had available to us. But those digital engineering tools are really critical for early development to reduce risk, that it allows us to identify potential integration issues.

And hopefully prevent rework at later stages in a program. But ultimately there's no substitute for testing actual hardware in a lab. So we've been testing, you know, the EPACS hardware in our labs for a little over a year now. And that testing allows us to continue to validate the digital [00:34:00] twins, but also really run a broad range of test conditions and try to find the limits of what the hardware is capable of.

You know, EPACS is not on the F35 program, so we're still operating under a limited set of requirements. This testing really provides us invaluable data on where the architecture and hardware is flexible, and we can bring that into future studies. You know, putting this hardware in the lab, you know, has really allowed us to demonstrate that EPACS can meet the need that 80 kilowatts of pooling capacity, and we can meet that across a broad range of operating conditions that are relevant to the aircraft.

The data that comes out of this testing is really going to help us as more requirements become available, because we'll better be able to understand where the challenges that need to be addressed in that integration really are. But the mix of digital and lab testing is really critical to [00:35:00] prove the technology readiness and also be ready to meet those demands for a complex integration.

And that's going to be required on a short timeline.

Heather "Lucky" Penney: Matt, thank you so much. You know, we're getting a little bit short on time. So before we go, I'd like to ask what will success look like for the Collins team?

Matt Pess: Yeah. PTMS is one of those systems that only gets noticed if there's a problem with it. Success for my team at Collins, is developing a system that the pilot and the operators don't even know is there, because it just does what it's supposed to do.

I have a close friend who's a fighter pilot, and I've worked on systems for the aircraft that he flies. I think about if he has to be sent into a hostile environment. Giving our service members the very best tools possible, so that they can prosecute the mission they've been tasked with and most importantly, come home safely. That's success.

Heather "Lucky" Penney: Absolutely, you're, speaking our language. So [00:36:00] thank you, Matt, so much for joining us here today to talk about PTMS and F 35 and the requirements that the aircraft will need for future growth, because frankly, our warfighters need it as well. So thanks again for spending this time with us.

Douglas Birkey: I'd like to add my thanks too here.

I mean, this is a complex one and you really did an awesome job.

Matt Pess: Thank you. I appreciate it.

Heather "Lucky" Penney: With that, I'd like to extend a big thank you to our guests for joining in today's discussion. I'd also like to extend a big thank you to you, our listeners for your continued support and for tuning into today's show.

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And you can always find us at Mitchell aerospace power. org. Thanks again for joining us and have a great aerospace power kind of day. See you next time.