Adam Kress:

Hi everyone, and welcome back to another episode of Aerospace Unplugged. I'm your host, Adam Kress. On today's episode, we'll be diving into a topic that maybe you've never heard of, but it's the sort of thing that is always around you and even though you might not see it, you definitely feel its influence. What I'm referring to are human factors, and my guest today is one of the world's leading experts in human factors when it comes to aviation and piloting.

So what do I mean when I say human factors? Well, it's a field of study that focuses on how people interact with products, systems and environments. In many ways, it's a study of how humans navigate through the physical world. Specifically in aviation, human factors can refer to a variety of different things from cockpit design to accident investigations and of course, pilot training. Those are just a few. At the core of this study in aviation is how humans interact with aircraft and flying as an activity.

Now, I promise you there's way more to piloting and flying than you've ever had the time to think about, but my guest today has made an amazingly impressive career studying exactly these things. My guest today is Thea Feyereisen. She's a distinguished fellow at Honeywell Aerospace Technologies. Now, her title needs a little bit of explaining because Thea, as they say, is kind of a big deal. Now, distinguished fellows represent the most prestigious technical rankings at Honeywell. They're reserved exclusively for individuals who have made extraordinary contributions to the company and push the boundaries of technology on a global scale. Thea is one of just two distinguished fellows within Honeywell's aerospace business and across all of Honeywell, Thea is the first woman to achieve this top honor.

Adam Kress:

Now on top of her honors within Honeywell, Thea has received numerous external accolades as well, including the Society of Women Engineers Lifetime Achievement Award. She's also a fellow in the Royal Aeronautical Society and was recently elected into the National Academy of Engineers. I've had the pleasure to work a lot with Thea over the past few years, and I couldn't be happier to have her on the podcast today. Now look, listening out there if there is any doubt who's got the biggest brain on the podcast today, I give up. It is not me. It is very much Thea and Thea, welcome and thanks for joining me.

Thea Feyereisen:

Thanks for having me here, Adam.

Adam Kress:

All right. So let's dive into human factors here. But before we do that, you've quite obviously had a very distinguished career. You've been at Honeywell for about 30 years, but I like to ask all my guests, how did you first get into aviation and how'd you fall in love with it?

Thea Feyereisen:

Well, to answer that, Adam, I need to take you back a long time ago in a galaxy far, far away. I was just eight years old when my older brother took me to my very first movie, a sci-fi movie. Maybe you've heard of it, Star Wars. Hope you've seen it.

Adam Kress:

I thought that's where you were going. Yes.

Thea Feyereisen:

Well, that movie forever changed my life. It also changed my hairstyle for the next year. I wore those fashionable twin buns of Princess Leia. And then fast-forward when I was 16, I went and saw a movie called Top Gun, another one I'm sure you're familiar with.

Adam Kress:

Yes, very much so.

Thea Feyereisen:

And so that really sparked my desire to become a pilot. Unfortunately, due to my eyeglasses and my poor vision, I couldn't become a naval aviator. But I did pursue a civilian aviation career and learned to fly just north of here in Prescott, Arizona at Embry-Riddle Aeronautical University. And that started me on my aviation path.

Adam Kress:

Awesome, awesome. Yeah, you can't underestimate the power of movies, I suppose.

Thea Feyereisen:

Yeah. Yeah, yeah.

Adam Kress:

So I want you to try to explain in layman's term what human factors is. What does it mean to the everyday person, and then what does it mean to pilots?

Thea Feyereisen:

Right. Well, you kind of gave a pretty good explanation there. Human factors is the study of humans as part of a system. So you can find human factors in various fields from healthcare, medical devices to sporting events, gaming industry, et cetera. Obviously, my specialty is in the aviation and even within aviation there's a lot of different areas from crew resource management to training.

So I specialize in flight deck human factors, and that really looks at the pilot, the pilot's role on the flight deck and how they use the systems. How to improve safety, reduce pilot workload, improve task performance, et cetera. So yeah, human factors is really the study of pilots on the flight deck and how we can improve the safety systems for that.

Adam Kress:

Is the term and the study of human factors common among pilots? Is it something they're always thinking about? Or is it experts like you who come to them and say, hey, have you thought of this? Have you thought of that?

Thea Feyereisen:

So I think it's common. I think one of the misconceptions that everyone thinks they're human so that they know about human factors. But it really is a scientific discipline. It merges both psychology as well as human physiology, human cognition, et cetera. So I think pilots are familiar with the term human factors. It certainly has gotten more attention in recent years for sure.

Adam Kress:

Okay. So I'm sure you've worked with not hundreds, I'm sure thousands of pilots over the years, and you could lump them as a group. Oh, okay, they're all pilots, but you're going to have extremely varied group of individuals within there. So how do you try to apply this science to what is an extremely varied group of people?

Thea Feyereisen:

Yeah. Well, the first thing is you can't design for the average pilot. There's no such thing as an average pilot. You can ask pilots themselves, they all say they're above average. Just kidding. But what we do do is design for a range of pilots and various demographics. So whether that's age demographic, cultural, ethnicity demographics. So we look for a range.

Air force, they have a guideline where they design from the 5% female to the 95% male in terms of physical ergonomics, which is a part of human factors. But really, you need to design for a wide range of skills. Pilots have to take a physical, so you can assume certain characteristics in terms of vision and cognition. So that helps us narrow the range that we have to design for.

Adam Kress:

Okay. So I'm curious to learn more about the intersection, I guess, between human factors and technology. Because as we've all seen over the past however many years now, everything is on a screen. Lives are dominated by touching a screen and having that screen do things for you. So have advancements in technology actually changed human behavior here?

Thea Feyereisen:

Yeah, absolutely human factors is impacted by technology. When we saw within the last couple decades, the ride adaption of cell phones and touch screen technology, we didn't use to have touch screens in the cockpit. We had physical buttons and physical knobs. And so pilots now go into the cockpit and expect to be able to touch things and manipulate things. And so we've seen introduction of touch screens in the cockpit.

Thea Feyereisen:

And there weren't really guidelines or best practices for touch screens in this turbulent environment of the flight deck. And so we had to go back to school really and redesign and really look at how to interact with touch screens in the cockpit. Needed protections from inadvertent activation or errors. For example, like for a landing gear, landing gear is a physical knob. You pull it out, you extend it down. There's multiple actions there. You can't just put landing gear down button on your test screen display. That could be a problem. If you have to get up in the middle of a flight, go to the bathroom and you accidentally touch the display, you don't want to be deploying your gear at Mach 0.9.

Thea Feyereisen:

So you need to have additional rules, additional guidelines when you introduce this new technology, like touch screen technology onto the flight deck.

Adam Kress:

Yeah. Do you see with pilots, again, maybe just like the rest of society, like generational differences with their comfort level with all the touch screen technology? And is that changing?

Thea Feyereisen:

Yeah. So if you remember, we need to design for a range of capabilities and experiences. So if you bring in a 25-five-year-old, they're going to have more experience with manipulating windows or direct manipulation on the displays compared to maybe a 60-year-old, right? They're still talking about getting up to change the television back in the day when we didn't have remote controls. So it's a different mindset really towards the technology, and you really need to support a wide range of demographics and expectations for when they go on to the flight deck.

Adam Kress:

Okay. I want to shift a little bit towards safety and how this all plays into improving aviation safety. Now, Honeywell, I know, recently published a new white paper on aviation safety and it referenced a statistic and a statement from you. And I want to read that real quick. "Human error is the cause or contributing factor in up to 80% of aviation accidents and incidents. We need a relentless focus on safety to understand human limitations and provide aids to make people more aware and give them time to correct mistakes."

Adam Kress:

So unfortunately of late, we've seen this highly unusual spat of aircraft incidents and accidents. So I'm curious to know what your perspective is looking at it through the human factors lens. And is there any reason to believe that any of these incidents are interrelated?

Thea Feyereisen:

So when we look at human factors or accidents in a safety-critical system like aviation, I like to bring forward a model called the Swiss Cheese Model that was introduced by James reason. We lost him earlier this year, but he's well known in the field of human factors and human error. And what we learned from the Swiss Cheese Model is that it is critical to have multiple layers of safety protection. And so think of them as layers of cheese, layers of Swiss cheese that have holes in them.

Thea Feyereisen:

So example of layer would be selection for the job. Another example of protection or a layer of Swiss cheese would be training. Another example would be operational procedures. Another example would be environmental factors. Is it daytime? Is it nighttime? Is there bad visibility? And so also a really important layer in the cheese, and where Honeywell comes into it, is technology mitigations. Are there safety systems onboard that help prevent these accidents from happening in the first place?

Thea Feyereisen:

And so what happens in the Swiss Cheese Model is you've got all these layers of protection, but if the holes line up, then you have an accident. And so when I look at that, I think of all of these layers of protection that we have, but is the cheese starting to crumble a bit? Are we getting more penetration? Are we getting more holes in our layers of protection?

Thea Feyereisen:

And so I think that's what we need to look at is what is changing in our system? Is it more traffic? Environmental factors of more traffic? Is it changing demographics or experience level? So I think there's

multiple layers that we need to look at. And certainly, this final layer of technology mitigations, are there additional safety systems that we could introduce to reduce the risk and improve human performance?

Adam Kress:

Okay. So like it said in the Honeywell white paper, human error, more times than not, is a cause or contributing factor when something goes wrong in aviation. So is there a line between automating and keeping the pilot in control? Because it seems like there's benefits and drawbacks to each. There's a lot of tasks that are somewhat rote that can be automated that allows the pilot to focus on flying. At the same time, if things get over-automated, then well, maybe we're not paying as much attention as we should. So from a human factors perspective, is there a line to be drawn or does that move?

Thea Feyereisen:

Yeah, I think it moves with technology advancements. I mean, if you look at one of the first automations on the flight deck or the cockpit, was Honeywell legacy Sperry autopilot. For long hours, do you want the pilot hand flying the aircraft? No. Autopilot helps reduce workload and frees the pilot to become more weather aware or planning in advance. And so I think you want the pilot in control, you want the pilot still involved and informed in addition to the Sperry autopilot.

Thea Feyereisen:

Another example would be fly-by-wire. Fly-by-wire still allows the pilot to fly the aircraft, but it provides some envelope protection. And then there's also automation of the information presentation to the pilot. And so I was very involved in our synthetic vision or what we call SmartView product, where that just really created a new display form and all the data was on board the aircraft, but we presented in a natural way. And so it's a 3D display on the pilot's primary flight display. It's very natural, very intuitive. It's like every day is a bright, sunny day. You can see the hazard, you can see where your flight path is. And so I think that's a very clever way of really automating the information presentation, to improve pilot situation awareness, to redo workload. So there's some great examples.

Thea Feyereisen:

Now, you don't want the pilot fully out of the loop and just say, okay, I can't fly anymore. You've got the controls. They're out of the loop. So they need to become what I call informed engagement, informed involvement. You can't just be flying along and not be tracking. And so some of these situation awareness displays are a great way whether the pilot is hand flying or just monitoring the automation that can provide a great aid to the pilot.

Adam Kress:

You started touching on a few Honeywell technologies. Can you give me an example of a product or a technology that you're working on now that uses human factors to help improve aviation safety like you've been saying?

Thea Feyereisen:

Well, my current passion project is for runway safety, something we call a SURF-A for help prevent runway collisions on the runway.

Adam Kress:

Surface alerts.

Thea Feyereisen:

Surface alerts. Yeah, yeah. Yeah. My latest passion is this project to prevent runway collisions. Surface alerts, we call it SURF-A. And it uses a high precision runway database and knowledge of the aircraft position on or near the runway and sophisticated algorithms to alert the pilot about 30 seconds before a collision is predicted to happen on the runway.

Thea Feyereisen:

And so there was a lot of human factors involved in the design and testing of this system that will soon be available. Whether it is the choice of the voices, the intonation, the message sets that you use to the pilots. Making sure that this works for a 25-year-old pilot from India to a 60-year-old pilot from America. So supporting the range. So a lot of human factors testing where we look at performance with what we call treatment A versus treatment B, whether it is different messages, and to make sure that the pilots respond in a predictable manner to avert the accident. So whether that is a go round, if they're on final or application of max breaks, if they're trying to take off.

Adam Kress:

So specifically with SURF-A, what is the experience that the pilot has if they're coming in on approach and suddenly there's something on the runway that shouldn't be? What actually happens in the cockpit?

Thea Feyereisen:

So SURF-A is really what we call third set of eyes in the cockpit. It will detect a potential collision. It provides the pilot an oral alert. For example, if you're coming into land, it will say traffic on runway, traffic on runway. And then it's accompanied by a text message as well. So if there was talking in the cockpit and they didn't hear, what did they say? They can look to see what that message was.

Adam Kress:

It's on the primary flight display?

Thea Feyereisen:

It's on the primary displays, yes. Yes. So then the pilot then as if the person... The jump seater has said, "There's traffic on the runway." So then the pilot decides, do I go around? Do I talk to air traffic control? What is the appropriate maneuver?

Adam Kress:

Okay, so TCAS, traffic collision avoidance system, has been used in aviation for decades to avoid midair collisions. But this sort of technology has not existed in the past. Right?

Thea Feyereisen:

Right, right. TCAS below about 1,000 feet doesn't provide alerts anymore because just the limitations of the technology, it would provide what we call nuisance alerts. You don't want an alert talking to the pilot when there's not a real potential collision. And so this is for on the runway itself. It provides similar to TCAS, very different technology.

Thea Feyereisen:

Another difference with TCAS, TCAS is a coordinated maneuver where if it goes off in one airplane, it'll tell that airplane to climb and it tells the other one to descend. SURF-A works even if the other aircraft isn't equipped with the technology if you're equipped. And so it provides an alert of this traffic situation awareness.

Adam Kress:

Okay. I want to go back to something you alluded to with testing. I would imagine in human factors overall there's a lot of A, B testing. Is this better? Is that better? Or I would imagine A, B, C, D, E, F, G, right?

Thea Feyereisen:

Yeah. Yeah, yeah, yeah.

Adam Kress:

So I mean, in your day-to-day work, and if you think over your career, do you just bring in a bunch of pilots and throw different scenarios at them and say, which one do you like best? Which one resonates with you?

Thea Feyereisen:

Yeah. What we try to do, so we do bring in a bunch of pilots. We do ask them what they think, but we also collect actual performance data. How long did it take them to respond to alert A versus alert B? What was their performance? Did they do the right maneuver? And so there is some subjectivity about it, but there also is objective data collection that you have looking at response time, looking at correctness of input, et cetera.

Thea Feyereisen:

So it is a combination of both subjective and objective measures that we do collect and really narrow design. Sometimes A or B might both work, and so is a cheaper to make than B? It's not precise. There is always some compromises to be made.

Adam Kress:

Okay. I'm curious to know what you have learned in your study of human factors in aviation that you apply to other areas of your everyday life. I get the impression that human factors, people, as they just walk through the world, must look at things-

Thea Feyereisen:

A lot of things drive me crazy. A lot of things.

Adam Kress:

Okay. Tell me that. What are some design things in everyday life that drive you crazy?

Thea Feyereisen:

We talked about touchscreens before, but touchscreens in the autos. It's hard to find a knob to change a radio station anymore. And there's been studies done by human factors in the automotive industry that

say these touchscreens have increased task completion time by three times. I am from Wisconsin and it's cold out there. And to turn on my rear defroster, I want instant access and don't want to go through buried menus. And so I like to apply best crew resource management when I'm driving a car and delegate tasks to my co-pilot to do environmental control.

Thea Feyereisen:

So different applications, whether automotive industry, looking at a new car or even how I design my kitchen and the layout of kitchen to reduce task completion time when I'm making dinner, trying to get dinner on the table. So yeah, as we walk through the world, whether it's your phones, your automobiles, or your kitchen appliances, yeah, I do a lot of research before I bring the checkbook out or digital pay, I guess now is more common.

Adam Kress:

Yeah. Yeah. Are there any particular industries that you think does human factors really well?

Thea Feyereisen:

I think we do it well in aviation. I think in the flight, it's regulated. We have to do it well, and it's becoming more and more regulated, the human factors. So in general, I think we'd lead the industry. You're seeing a lot more human factors in the medical field and the regulation of that. You can imagine the difference between 0.2 millimeters versus two millimeters. So the criticality, so safety critical operations or organizations really need to apply human factors. Human factors can get confused with user experience.

Adam Kress:

Yeah, I was thinking that as well. What's the difference?

Thea Feyereisen:

It's not just making things pretty. It's making things work well. So for example, some of these electric cars are so focused on making things pretty, they forget about making things work well, even in critical situation. For example, you don't have electric power and your car is on fire because you hit a tree and your battery exploded. How do you open your door? Well, guess what? In some of the models, it is a hidden manual button underneath the carpet that you don't even know about, and you need a screwdriver to open it up. It looks real pretty. But if your car's on fire and you can't open the door, that's a problem.

So it's important that we're humans. We appreciate beautiful things, but we also appreciate useful things. And so what I really like to work on is that intersection of what we call form and function. Make it look good, make it pleasing, but also support both normal and emergency situations.

Adam Kress:

Yeah, yeah, that's a great point. How does someone get into human factors if people out there think this sounds super neat? I guess, I don't know if you're a younger person or a college student or maybe more into your career. How do you get into the study of it?

Thea Feyereisen:

Yeah. Well, human factors for me was a perfect... It is kind of this intersection between engineering and psychology. And so I love that intersection of the human mind and the human body as well as engineering. Remember, I'm a big Star Wars fan.

Thea Feyereisen:

But I think another characteristic that is really important is the high empathy. You have to care about the pilot. I see an accident, oh, that stupid pilot. Why did they do that? Well, they're human. Humans make mistakes. I make mistakes. You make mistakes. Pilots make mistakes. My only checkride that I ever failed was for my multi-engine instructor checkride. And the examiner failed an engine. And in that moment of stress, I turned off the working engine. I shut down the wrong engine. That was stupid, right? But that's what happens when you just react.

Thea Feyereisen:

And so we see a recent accident, pilots hit a bird. They had one good engine, one bad engine, they shut down the good.... It happens. So how can we design something to reduce that error, to support decision making, to make things safe? So I think empathy is a really important characteristic to have for human factors engineer. I love it. It's a great fit. I love engineers. I love pilots. I say I speak pilot, I speak engineer, and it's been a great career for me.

Adam Kress:

Yeah, that's awesome. Well, Thea, I want to thank you for joining me on the podcast today. It was great to have you. We have just one last question that we ask everyone who joins us on Aerospace Unplugged. And that is when you unplug, you're not thinking about human factors, you're not thinking about aviation, what do you like to do to have fun?

Thea Feyereisen:

Well, I like to hang out with my daughter, Lulu. Shout out to Lulu. She is a senior at UW Madison. And if she lets me hang out with her, we enjoy time outside together, whether hiking or playing tennis or having some gelato. Yeah. So I love being a mother and enjoy spending time with her.

Adam Kress:

That's great. Well, thank you again, Thea, and like always, thank you to our listeners out there as well. If you want to learn more about aviation safety in general, I encourage you to seek out Honeywell's white paper that I mentioned earlier on the podcast. You can find that on the Honeywell Aerospace website and we have a link to that in the description of this podcast. Thanks again for listening, and we'll catch you all again on the next episode of Aerospace Unplugged.