EPISODE 3 | Taking flight AND reducing emissions

with Stephen Fitzpatrick of Vertical Aerospace

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- How electric vertical takeoff and landing works
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The magic of flying

Ilham Kadri: Good morning everyone. Today. I'm very happy to be speaking to Stephen Fitzpatrick who is at the center of some of the most exciting developments in aerospace, urban air mobility, and the electrification of flight. Stephen is the founder and CEO of Vertical Aerospace, a startup that is developing electrical, vertical takeoff and landing air taxis that will revolutionize - I would say it's already revolutionizing the way we travel. He's also the founder of two other companies, OVO Energies and Kaluza, which are playing the key role in ramping up renewable energy use and electrification. At Solvay, we are delighted to partner with Vertical Aerospace to develop the entire composite structure of their amazing air taxis. So Stephen, thank you so much for joining me today.

Stephen Fitzpatrick: It's a pleasure. It's an absolute pleasure to talk to you.

Ilham Kadri: Stephen. I read a lot about you and your story is inspiring. Born in Belfast, you are called today Britain's Elon Musk. You told the world that you have been very affected by the shame of flying, and wanted to find the solution, which we all live with today. And there is no way to ask people to go back to limited mobility. We should be able to achieve the AND, the A-N-D in flight to be able to travel AND reduce emissions. And this is one of my passions and intimate beliefs. Is that true Stephen, what I told you just now? Who are your role models? What are your drivers and personal values - your recipe of success?

Stephen Fitzpatrick: So, a lot of questions, Ilham, but let me start with the flying. So I've always loved flying and you know, thinking back to the time, I always find it magical to be able to be in a completely different place. Especially growing up in Ireland, to be able to fly well, almost anywhere in Europe and be in much better weather. Holidays in Spain and France when I was a child. It seemed amazing to me that you could get on an airplane, and then in just a few hours, be in a completely different world. And so I've always loved the story of the early pioneers of flying. And when I think about all of the challenges that humanity faces, going back to Greek mythology, history is another passion of mine. So going back to Greek mythology and all the stories of man's dreams of flying and all the technologies, and all the risks, and all of the failed experiments, and all of the work that went into creating the first aircraft. And you think from the Wright brothers, just 70 years later, we've reached the moon. I thought it's just impossible that after waiting thousands of years to realize this dream, we're going to stop and voluntarily stop flying. So I thought that is not, I don't think that's in human nature. And so then if you think about all the ingenuity and all of the technology that went into creating the first aircraft, if we apply the same

determination. It's a decarbonization as we did to flight, if we make that the dream, then, of course we can do it. And so it's one of the things that I feel very passionate about, and you know, there's been within any business, there are highs and lows and good days and bad days, and I think really successful businesses, successful entrepreneurs, successful teams, they have a passion for what they're doing that makes it worthwhile even on the bad days. And so I have three young children, they all love the idea that Vertical makes airplanes and zero carbon airplanes. And this is something that motivates me a lot, that it makes my children proud, it satisfies my urge for innovation, and also to be part of a solution for something that is as romantic and as wonderful as being able to fly.

How electric vertical takeoff and landing works

Ilham Kadri: You gave us actually some recipe of success. It's determination, you know, resilience, right? And dream and leaving a legacy obviously. That's what you are saying about your children and you know, the future generation, right? So can you explain to our audience how electric vertical takeoff and landing technology works and how it will change the way we work and travel, Stephen?

Stephen Fitzpatrick: At the heart of the new technology that we're building is the wonderful advancements we've seen in electrical power, in motors, and also energy storage batteries. And so the number one thing about these aircraft, they're all electric battery powered with electric motors. And then one of the wonderful things you can do with the electric motors is you can design aircraft that you can use the same propellers to lift off the ground and then propel you forward through the air. So they're called eVTOL, electric vertical takeoff and landing. We have eight rotors, instead of one rotor that you would get on a helicopter. It helps the aircraft take off from a rooftop or from a helipad. And then we transition into forward flight and we can reach speeds of more than 200 miles an hour, with a range of about 120 miles, 170 kilometers, carrying four passengers. And so one of the very many benefits, obviously zero carbon, but also it's extremely quiet, we don't have a jet turbine, we don't have very large rotors. And so it's extremely quiet, and it's also much, much safer than traveling by helicopter. And so it's a hundred times safer than traveling by helicopter. So what we're going to end up with is a vehicle that is a zero carbon, super quiet, very, very safe, and then also extremely affordable. It's going to cost up about 20% the cost of flying by helicopter. So this is going to make vertical flight possible for just about everybody that lives in a city, anywhere around the world.

Ilham Kadri: Yeah, this is fabulous. We are in the business of composites Stephen but we are also in the business of batteries as you may know, and electrification of cars, and we'll talk about this. But coming back to air taxis, when will it just

become a normal for me, you know, to take an air taxi between Brussels and your place, right? So London or Paris or New York and Boston.

Stephen Fitzpatrick: So the range is 120 miles, that's the battery only range. And we're going to certify that vehicle between 2024 and 2025, so in the next three or four years. And you will see that pick up pretty quickly I think. In major cities, you will see these aircraft. Once they're certified, you will see these aircraft flying around. In terms of production, we'll start relatively small. But in a few years time, we will reach quite a high production rate. We've already got pre-orders for nearly 1500 aircraft, for airlines all over the world. But your question about flying from Brussels to London or Paris to London, or Paris to Brussels, that will probably take a range extender that could be a combustion engine or a hydrogen fuel cell and that will give us a range of more like 500 miles. So that's when you're going to start to see L.A., San Francisco, Washington, New York, London, Paris, or Berlin, Frankfurt. All of these flights that we would normally fly by conventional aircraft, we're going to be able to take air taxis.

Are air taxis affordable?

Ilham Kadri: Yeah, this is fabulous. So how affordable will it be compared to traditional transportation?

Stephen Fitzpatrick: It's a great question. The costs that we're projecting, even when we launch, are about a dollar per passenger mile. So that is about the same as taking a taxi on your own. So it's really, really competitive and it's incredibly economic. The reasons are, the energy source, the electricity much, much cheaper than petrol or gasoline, kerosene. But also because it's an electric drive train, very few moving parts, and therefore very little maintenance and operating cost. And so just like electric vehicles where we think, you know, we've already built an electric vehicle today that can do a million miles. You know, we're going to see these aircraft fly with great economy. And so this is as I said, going to be affordable for just about everybody. And what that will equate to, for example, in local terms here, that would be a trip from Heathrow Airport to Canary Wharf in about 12 minutes and costing about 50 pounds. And so that's like, you know, maybe an hour and a half in bad traffic in the morning. So a massive time saving and actually cheaper than taking a taxi.

Ilham Kadri: I cannot wait. And how many passengers, Stephen? Can I bring my family with me or a group of friends?

Stephen Fitzpatrick: You can take your small family with you. I would say it can take four passengers. If you're a pilot, then you can take an extra person

obviously, and you can fly the plane. But now to begin with, we will have four passengers, it's piloted.

Lesson learned from EV batteries and Formula 1

Ilham Kadri: So this is fabulous, this is a bold dream, this is disruptive, this is reinventing a space from a passionate gentlemen, but also a businessman, right? And I know I heard that you are a huge fan of Formula 1 and even invested in a team at one point. I hope it's right. So what are the lessons, I mean, not from a race car only. But also from Tesla, you know, reinventing the auto and the clean mobility, which frankly, my business is just booming today. We cannot supply all the PVDF material for EV batteries. Nobody believed in it 20 years ago, and even now in COVID-19, in a crisis situation, EV is just taking over in the automobile. So what are the lessons and are they lessons you are taking, you know, hands on in your business today?

Stephen Fitzpatrick: So I think there are lots of lessons either from the EV space. There are lots of lessons from Formula 1 in fact. But probably the most important thing is a quote, I can't remember exactly who I should attribute this to, but I think it's: we overestimate what we can achieve in two years and underestimate what we can achieve in 10. And I think when I think about aerospace - and this is a lesson I learned in OVO, pick a big, big market and then find a way to start, you know, so you've got to think big and then you've got to start small. And so for us, this is we look at aerospace and we see the electrification of the propulsion, massive advances in energy storage, development of new synthetic aviation fuels or hydrogen bank rules, advanced materials, supercomputing, all of these technologies are converging and are going to completely transform aerospace in a way that electrification has transformed the automotive sector. Everybody thinking that you know it's 20, 30 years away. But I think what a lot of experts miss is that new technologies, you know, they develop at almost an exponential rate. And we talk a lot about the software that most forecasts the future are wrong and they're all wrong. But the common theme is we project kind of a linear progression. As human beings we kind of understand the linear progression. But actually most technologies develop in an exponential progression and then undershoot the development. And it's very hard to tell the difference to begin with when you see technology developing, because the changes are so small. But then if you get this inflection point, like we've had with the EVs where the range is that long enough now for electric vehicles, that they are a perfectly acceptable choice for most consumers. And before you know it, everybody wants one, and it happened pretty quickly. So it's going to take some time with aerospace. It's a very risk averse sector, it's an incredibly safe way to travel. Part of the work we're doing with Solvay is you know, using very advanced materials

that they've got a very high tensile strength or heat retardant capabilities and so on. And we need to demonstrate exactly that they meet the safety requirements and it takes time, but these new materials are there.And so once we go through that certification process and so on, we're going to see this transformation in aerospace. And for me, I think it's going to happen much faster than most of the experts predict.

Future of emissions-free flight

Ilham Kadri: Wow. And I echoed this, Stephen, by the way, you talked about the composite material which lighten you know the mobile, the objects, the aircraft. But in electric vehicles I mean, 50% of the cost of an automobile just a few years ago, 50% of the cost was the battery, now it's 25% and our teams are working on making the battery smaller, higher density, safer solid, actually rather than liquid. Do you believe that your case and making a proof point, and starting your business will actually impact the future of electrification of flight and do you think we'll see long-haul electric powered flights. I know Airbus talks about hydrogen-powered flights or aircraft by 2030, we are working on hydrogen membranes as well. Where do you see, you know this scaling up or going to long-haul electric powered flights?

Stephen Fitzpatrick: So one of the reasons we started with eVTOL is that it's the best application of electric technology in aerospace. You cannot do it - eVTOL is very difficult to do with a combustion engine. We have helicopters, that's really it. Whereas with an electric powered train, you can design completely new geometries, new airframes. And so this is where we start. But the reality is, you know, we have seen the 20th century dominated by a very small number of aerospace giants. I believe that the giants of the 21st century will be different companies. And that it’s companies that develop capabilities in electric flights that will build larger and larger airplanes and develop more expertise building bigger planes. And of course, Airbus, Boeing, Textron, Leonardo, these are wonderful companies. But I think the skills you need to win in the era of electric propulsion are very, very different than the ones you need in the 20th century. So we are very optimistic that you know, companies like Vertical will be the champions of the 21st.

Ilham Kadri: And indeed, I mean, look at Tesla. Nobody would have bet years ago that Tesla will revolutionize the world of automobile and the car industry. We talked about it before we started the podcast that we have a good relationship with our mutual friend, Bertrand Piccard, who was the first to fly around the world - and you see the picture out there - in the solar powered plane. So I was wondering, what are your thoughts on solar power and obviously green

hydrogen and sustainable aviation fuels, and other methods of emission-free flights.

Stephen Fitzpatrick: The reality is it's going to be very, very difficult to turn the wonderful design, the wonderful engineering behind solar impulse into something a bit more scalable for mass transit. But what I can see is, and I'm learning a lot more about if you can turn, you know, abundant solar power on the ground into sustainable aviation fuel, there are lots of science, lots of chemistry and technology we already have today. Then, you know, you can create a zero carbon aerospace economy very, very easily. And I have no doubt whether it's going to be based on hydrogen, ammonia, some kind of synthetic kerosene, we're going to see these combinations of electric propulsion and some form of chemical energy storage over the next 10, 20 years. I think the applicant for most applications, obviously we know long-haul transoceanic flights just cannot be done with today's battery technology. And it's almost impossible to imagine the kind of energy density that we would need to make that a reality. But I don't think we need to. And I see some great work going on with energy companies, with chemical companies, aerospace companies. And this is what I really believe that we see this acceleration of investment and development for zero carbon technologies that comes when you get the intersection of all of these technologies. And it's not in one field that the breakthrough comes, it's when two, three fields are interested, really exciting things happen. And so this is what I think we expect to see. And I don't know whether it's mostly hydrogen and kerosene. I think there's going to be a lot of different technologies for different applications, but for sure, the future of aviation in the next 20 years is going to look nothing like what it did 20 years ago.

Making a sustainable and profitable business

Ilham Kadri: So I know that you are passionate about climate action, and you put that passion into action with the companies that you founded, Stephen. In addition to Vertical Aerospace, You also founded OVO, we see it in the title here. Energy is one of the UKs biggest domestic energy suppliers, which provide a hundred percent renewable energy. What kind of business leadership do you think we need to make our businesses both sustainable and profitable? Which you are doing, right? So this is not for non-profits, right? So how you can make a business sustainable and profitable, and create technologies we need to ensure that more sustainable future?

Stephen Fitzpatrick: Yeah. So first and foremost, I think I have to be patient. So there's a lot of opportunity in a zero carbon world, but you know, you cannot expect it's going to be a quick win. That's the first thing.

Ilham Kadri: Yeah.

Stephen Fitzpatrick: Second of all, what I said earlier, thinking big, having a big vision, that's going to keep you motivated. But then also starting small and finding some way to finding some niche or finding some opportunity where you can develop skills, capability, credibility, raise capital, find a useful, valuable application of what you're doing. The third one and probably most important to be sustainable and profitable, let's say you have to be really rigorous, you have to pay really close attention to detail, you have to follow science and technology. You cannot just have a great idea and hope that the PR and the storytelling, and the hype will see you through. Because in the end, you know, there's so many stories about great ideas that turned out not to be great businesses. And it's mostly because the technology wasn't ready or the technology was too expensive, or the technology didn't work, or so many different things. So I think really trying to understand not just what the big dream is, but also how the thing is going to work. Do the numbers add up to the physics, to the chemistry, whatever it's going to be. That's the most important thing. Because you know, the numbers don't lie. Even if you know, you want more than anything else for it to be true. If it's going to be sustainable economically, then you know, the numbers have to add up.

Ilham Kadri: Yeah, interesting. But I guess Stephen, you must have had the lows, you talked about that, failures, or sobering moments, or nobody would really believe in that idea. How much of determination to get there, right? And you know, this is not worth the battle and I need to go to someone, something else.

Stephen Fitzpatrick: So I think it goes back to the third point before that there's the flip side of the problem that you can have a great idea but the technology doesn't work. And that's when you really believe the technology works.

Ilham Kadri: Yeah.

Stephen Fitzpatrick: Then you know what's going to happen next. Like, so there are so many experts, their views are very entrenched from their own context, their own experience, their own expertise. And yet they don't maybe know what's possible. So this is where, you know, whether it was for OVO Energy or for Vertical, we did the numbers, we did a lot of calculations, we tried to work on where we thought battery energy density was going to go, where we thought advanced material science was going to go, what we thought regulations might

do, it wouldn't change. And we weren't look, this is going to happen, this is absolutely possible. And we can make a vehicle that is so much better than a helicopter. Even if we displace the helicopter, that's a $50 billion a year market. And so when you understand that we developed a psychology in OVO Energy and it was how we decided we wanted to run the company. And very basically we said, if technology makes it possible and it's better for the consumer, then that's the future. Sooner or later, that's what's going to happen. And so even if it's a threat to your own business, and for some of the time we were thinking, okay, we've built up this great business, but actually there's this new technology that means the thing that we've invested in is no longer the best. And then you need to utilize your own business because if you don't do it, a competitor will.

Power of partnerships

Ilham Kadri: No, it's a great wisdom. The power of partnerships, right? I mean, you cannot do it alone. And I know I heard you saying before how important partnerships have been to the success of Vertical Aerospace? Can you tell us more about that?

Stephen Fitzpatrick: You know, I really believe in aerospace, in particular. But you know, in business, generally, I think so many times, we convince ourselves that we are the best company, the best team, the best person to do all of it. That you know, we know better. And I think in technology that's particularly true. And if you're developing something like an electric aircraft, the temptation is to say, we need to design every part ourselves. It needs to be perfectly designed for our application. There can be no room for compromise.

Ilham Kadri: No.

Stephen Fitzpatrick: And the reality is, you know, especially to build something as complex as an electric airplane, the idea that we are the best company to develop every single part of the aircraft, whether you know, we are going to build better electric motors than Rolls Royce, we're going to build better software than Honeywell, we're going to build and design a better battery enclosure than you know, we could do with Solvay. Of course, theoretically, it's possible. The question is, you know, wouldn't it be better to pick a couple of areas and be the world's best in those areas and then work with the world's best on everything else. And for us, that's, you know, it's good discipline. You asked about being financially sustainable as well as you know, ecologically sustainable. And part of it is picking your focus and being really rigorous on them. I'm not trying to spread yourself so thin that you're trying to do everything. And for us, it's a real discipline and it's really worked for us. We have partnered with some of the

world's best airlines, some of the world's best engineering firms, and we are focused on designing the best airplane, and working with all of those partners to bring it to reality.

Ilham Kadri: So don't reinvent the wheel and create an ecosystem around you, right? Which is also helping you to go faster, further right? And de-risk the project probably Stephen as well, right?

Stephen Fitzpatrick: Lower risk to the project and then where the ecosystem is super important. And you know, if you have some of the world's leading engineering firms and one of the largest airlines all invested in the success of the project, then you're so much more likely to succeed than if you're trying to compete with everybody. And if we think about the opportunity to electrify flight, it is such a huge opportunity. There is more than enough to go around. And so for us, we want everybody to partner with us. In an ideal world. I don't want to compete with anybody. We all work together on the project.

Ilham Kadri: Yeah. So we are getting closer to the end of this conversation. I know the first flight of the air taxi is scheduled to happen very soon. I wonder what will this first flight mean to you, Stephen?

Stephen Fitzpatrick: Obviously, I'll be very proud, a little apprehensive, but I know the team know what they're doing. We'll do a range test, speed tests, everything. And then that's when we know we have an aircraft, a real aircraft. But that will be a really proud moment for me and the rest of the team.

Secret to success

Ilham Kadri: Last question, Stephen. I'm keen, you know, your audiences, not only Solvay employees, but the youth, partners, what would you say is the secrets of that type of success and the journey, right, leading you to the destination? If you have to give them one or few wisdom for these people, what would you tell them?

Stephen Fitzpatrick: So one of the most important things for me is to have an ambition that motivates you so much, that you've got enough passion for, that even on the worst days, you're going to say, you know, I'm not giving up. I really, really want to succeed on this. And this is where, you know, it's a bit of a cliche but you have to find a project, passion, or career that you're going to love. And not that's gonna, you know, you're going to laugh every day, every day is going to be great because there is no job in the world like that. But that you love doing that you find, you can't imagine doing anything else. And then you say, okay. And even on the worst day, I still want to do it. And I pick myself up and I keep

going because the secret of success is definitely, you know, every time you have a terrible day, you say fine, you know what? Tomorrow is going to be better and you keep going.

Ilham Kadri: Yeah. So thank you, Stephen, for this fascinating conversation. You are such a great example of not only an entrepreneur, but much more visionary, a leader who wants to leave a legacy and who is really inspiring me and us in really achieving the power of the AND. Very inspiring. Thank you very much, Stephen for your time.

Stephen Fitzpatrick: Ilham, it's been a pleasure. I hope to see you soon. Take care.

ABOUT THE GUEST

Stephen Fitzpatrick is at the center of some of the most exciting developments in aerospace, urban air mobility, and the electrification of flight. He is founder and CEO of Vertical Aerospace, a startup that is developing electric vertical takeoff and landing air taxis that will revolutionize the way we travel.

ABOUT THE HOST

Ilham Kadri is a purpose-driven business leader, scientist, optimist and world citizen who is passionate about making businesses sustainable AND profitable, science-based AND human, daring AND caring. Full bio

ABOUT THE PODCAST

AND is the future is a podcast hosted by Solvay CEO Ilham Kadri that brings together great minds to address the opportunities and challenges of making businesses both sustainable AND profitable. The podcast will gather thought leaders across the globe to discuss how businesses can profitably reach carbon neutrality and sustainability goals, ensure that innovation is at the service of humanity and its progress, protect biodiversity, transform the value chain, unleash peoples' full potential through diversity, equity and inclusion, and much more! Find more on solvay.com.