



ROYAL AUSTRALIAN AIR FORCE

Podcast Transcript

Conversations on The Runway – Space Series Episode 7 – ‘Space 2.0’

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Guests: Jennifer Stephenson & Kody Cook

Michael Veitch

Now, I don't know if this happened to you, but when I was a kid, one day towards the end of my schooling, I was forced to sit down in front of Mr. Weatherall, was probably someone else in your case, and have that really difficult, really awkward conversation. You know the one I'm talking about. That's right, where I had to reveal to Mr. Weatherall, something very private, very intimate, and that was ... what I intended to do when I left school. Mr. Weatherall was, of course, the school careers officer. He didn't really know what to do with me, which put us on an even par because I didn't really know what to do with me either.

So, he opens hopefully, "Any thoughts about next year?" I um'd and ah'd and made a few idiotic suggestions just to keep the conversation going, but I think one of the more ludicrous spur of the moment suggestions I made was something like maybe a career in space, which of course made him laugh, then get angry and then give up on me once and for all and direct his attention to the far more sensible boy waiting patiently outside his office. But over the course of *Conversations on The Runway*, I've been reflecting on that long distant conversation because I've come to realize that if I were a kid today and made that same suggestion, maybe a career in space, it wouldn't sound quite so ludicrous at all.

Because going forward, careers in the space industries are stepping up to a whole new level in terms of accessibility technology, and of course opportunity, and Australia is positioning itself to be right there at the forefront of a very space age and space ready business model. Are we ready for it? On *Conversations on The Runway* this week, it's space 2.0, the wave of Australia must ride to secure a space industry future. Again, we have two brilliant guests for you. Space engineering is what makes Kody Cook get up in the morning. Kody has worked extensively in the space industry, used to work for Boeing too, does quietly, has a Masters in mechatronic engineering, has worked in all aspects of mechanical, electrical, thermal engineering, as well as robotics, and is now a product lead and lead systems engineer at the cutting edge Adelaide firm, Fleet Space Technologies.

Think Elon Musk's SpaceX, but in the City of Churches, hello Kody, how are you going?

Kody Cook

I'm very well. Thank you.

Michael Veitch

Kody's joined by Jennifer Stephenson, director of the Department of Defence Space Awareness Project Office, responsible for providing Air Force with SDA, that's Space Domain Awareness. We'll talk about just how important that is in a little while. Just an aside and something which warms this old military history buff's heart, Jennifer also headed up Australia's first World War Centenary Program, including the big commemoration for the 1918 Battle of Villers-Bretonneux in France, a noble achievement if ever there was. Jennifer [foreign language].

Jennifer Stephenson

Merci, Michael.

Michael Veitch

All right, I've shown off enough. Let's get to it, space 2.0. We know that space is no longer benign. In fact, it's exploding in terms of its reach, speed and numbers of space actors. I'll open by asking both of you, do you think Australia is capable of being one of those new space 2.0 players? Jennifer.

Jennifer Stephenson

Thanks, Michael. I absolutely think that Australia is really well positioned to be part of space 2.0 and has a really good, exciting future. I'm passionate about what Australian industry can do right now. And I think that we're building on what's happened over 50 years. We're in a different place right now today, and space industry in Australia has got so much potential.

Michael Veitch

What's happened over those past 50 years? What were we like then and what are we doing today?

Jennifer Stephenson

Well, I think, in the past, we were really led by what was happening in the US and between different Cold War fronts. Whereas today, Australia is looking for its own niche market and companies like Felicia are filling in those opportunities. I think that there's a lot more that we can do there. People are looking to Australia for our geography and for our special technologies that we can provide, and Australian industry is really got a lot of exciting things happening.

Michael Veitch

I'll throw that open to you, Kody, how you're seeing Australia's space industry going forward.

Kody Cook

We talk a lot about space 1.0 versus space 2.0, the transition from the large geostationary satellites now to having constellations of these small micro and nano-satellites. I think about how much the entry barriers are lowering for small startups to be able to put stuff in orbit. And for academic institutions and government agencies to be able to put capabilities in orbit. The cost to launch stuff is dramatically reducing. Australia has one of the biggest economies in the world, but in terms of our space-based capabilities so far, a lot of what we've supported has been a lot of the ground infrastructure. Comparatively to a lot of other nations, we haven't been launching quite as much. I think we're hitting a point now with this miniaturization of our technology, that we can start to carve out this niche that Jennifer's talking about, and that's kind of what we're trying to do at Fleet.

Michael Veitch

Kody, I'm glad you mentioned the 1.0 model (quote) "risk averse, slow to innovate and heavily regulated," that's how the Australian Strategic Policy Institute described the old model. Is that fair, do you think?

Kody Cook

Yeah. Ah, man, I hate to talk too much about my old Boeing days.

Michael Veitch

Go on.

Kody Cook

I try and look at the differences between something like the SpaceX model and the Boeing model. I experienced it firsthand where you get so wrapped up in process and systems engineering and documentation, that it, compared to a lot of these newer companies that are coming along, it's stagnant. Development cycles take years and years. Now at the rapid pace that technology's evolving, we need to be able to have shorter development cycles. We need to be able to put automation into our processes to be able to scale and to build things quicker, to be able to integrate new technologies into our products sooner. There was one project, and I worked at it for two years, and it was a minor change to an existing system, but it was two years' worth of work. Now, in the same space of time here at Fleet, we will have built five different iterations of satellite, and we'll have launched three out of five of those.

Michael Veitch

Couldn't have happened in the old days.

Kody Cook

I don't think so, and it is a bit of a weigh up of risk. To come back to that, the miniaturization of technology and to talk about how being able to build multiple back-to-back iterations is so easy to do when one of your platforms only costs half a million dollars compared to a multi-hundred million dollar platform. There's some very different changes there from an engineering point of view to make to change that mindset.

Michael Veitch

I think one of the things that we've learned over this series is how much the industry is molding itself to the technology. Technology is becoming sort of leaner, and cheaper and cleaner, and the industry has to adapt too. Jennifer, from where you're sitting, what does space 2.0 bring to ADF capabilities?

Jennifer Stephenson

Well, I think, just like everyone, we get to take advantage of the smaller more rapid environment that's happening. So, we don't have to start out now with a 20 year vision about what we're going to buy in a single one-off acquisition. Instead, we have to adapt as well. We have to be agile, working with industry and look at, "okay, what do we need now for the next five years? What development can we be looking at that's going to then help us decide what we're going to get in five years after that?" We're looking at much shorter timeframes for acquisitions, and that's quite a big change for Defence.

Michael Veitch

I'd like to talk about acquisitions a little bit later, and also supply chains, because they sound dull, but they're very, very important. The Australia government set up the Australian Space Agency with its brief to promote growth of the Australian space industry. Jennifer, you work in Australia Defence Acquisitions, you're the government sector. Kody, you're on the commercial space industry, both of which will be required to establish, as one commentator said, and I love this phrase, "The nexus between defence and civilian space activities." That's a great way to put it, isn't it? But just talk about that fusion between government and industry that space really needs to go forward.

Jennifer Stephenson

Yeah, yeah, absolutely. Looking at Australia, we certainly have a role to play, but we're not ever going to be like the size of the US. So, we have to work out together, what can Australia offer the world? That is only going to happen by civil-military partnerships, and that's where the Space Agency's role is amazing because they're going to bring everyone together. Although we're only small, the Space Agency is only small so far, it's really going to be the policy driver for both the civil and military sector. We're working all very closely at this stage to see, what can Australia offer the world?

Michael Veitch

Indeed. One commentator said Australia simply can't pretend to be a (quote), "a NASA down under." Another phrase I really like. Is there another country, perhaps? Is there another nation space industry that we need to be modelling ourselves on or indeed, can smaller countries like us model themselves on our industry going forward? What do you both think about that?

Kody Cook

Yeah. I like to think about, in terms of the economy, size of the country, population distribution, we're very similar to Canada. And they sort of stepped forward in terms of the space industry before we did. And you look at the work they've done in space-based robotics and Canadarm for the International Space Station, and they're starting to carve, or they have been carving themselves this niche. So, in terms of modelling ourselves after a nation, I like to think about this outside of the space industry as well, in terms of resources, education. There's a lot of things I admire about the way that Canada's handled themselves. In terms of picking what Australia's niche is, Australia's had a space industry for a long time. There's no argument there, but I don't think I could argue that we have niche yet, that's our thing. I try and step back and look at the bigger picture about what Australia can offer. We're geographically dispersed, we've got a strong resource-based economy. We have a lot of startups now who's doing space-based IoT, so maybe there's something in that of the seven to nine companies worldwide that are trying to do this. We've got two of them in South Australia. I think, at the end of the day, we're going to have to either leverage that whole mining thing or we're going to be doing IoT comms.

Michael Veitch

Well, that's one of the things that your company does. You've actually described Space Fleet, Kody, as a company. A company which has the potential to demonstrate Australia's viability as a commercial space fairing nation to the rest of the world. That's a wonderfully big call. Do you ever reminisce of what we could have done with that dusty piece of desert, a few clicks from where you are now, Kody, in Adelaide up at Woomera, if we'd actually ... I think another thing over the course of the *Conversations on the Runway* series is that we, and hating to dwell on the past and what was lost, but Woomera could have been something going forward, something quite special. But that was then and so we've actually been, as you say, in the space industry with Woomera going back much longer than Canada? Haven't we?

Kody Cook

Yeah, absolutely, we have. And it's kind of a missed opportunity to be honest, because Woomera is one of the most incredible capabilities in the world. Space is such an exciting frontier and it just got left behind. We didn't really do that much with it. Launch is a tricky one, right? Launch is fun and sexy, and everyone's trying to get involved in it. You've got Musk is pretty much changing the world. He's almost monopolizing in every launch market at the moment, small SATs and traditional alike. When it comes to putting stuff into bigger orbits than just into low earth orbit, when you really want to shoot stuff out there, you're better off being closer to the

equator and on the East coast of a nation. So, you kind of want to get as North and as East as you possibly can.

If Australia was to have a sustainable launch capability for long-term interplanetary travel, which at the end of the day is kind of where I like to think when it comes to this space stuff. I wonder if Woomera is actually located in the best spot for Australia, or if we'd have to look somewhere like Queensland.

Michael Veitch

Jennifer, what do you think? Are way more suited to lower earth orbit or versus higher orbit capabilities where we are down in the bottom left-hand corner of the world?

Jennifer Stephenson

Well, I think that's why the couple of launch companies that are doing some interesting things are very interesting, because they're focusing on exactly a niche area. Equatorial launch up the top is focused more on those equatorial launches. Then of course, you've got the polar orbit, with the ones down here in SA who are doing some really interesting things. So again, it's about looking at the overall market, and as Kody says, what could we add to that, that isn't already sort of taken over by SpaceX or some of those other big players? So, I think that there are still opportunities for a bit of launch in Australia.

Michael Veitch

Well, what about those other opportunities, say deorbiting and graveyard orbits? Is Australia positioned to take up something in those areas?

Jennifer Stephenson

Yeah, quite possibly. I think there's a whole lot of things that they're looking at right now to see where there is a market. When you look at the potential size of the market over the next few years, there are huge estimations about the number of launches and then the amount of time that they will be in orbit. That's certainly a growth area. And I know that there are a number of very smart people looking at how they can get a part of that market. That's the kind of thing that we're looking at with the Space Agency. What can Australia offer down here from our particular advantage point to the rest of the world and to get just a small percentage of that market is going to be useful for companies.

Michael Veitch

One of the things that your company, Kody, is offering, I believe, is a technology that may one day, I believe challenge traditional methods of mining, utilizing low earth orbit nanosatellites. How does that work?

Kody Cook

Yeah. Oh man, this is a deep thread.

Michael Veitch

We don't go for the shallow threads here on *Conversations on The Runway*, Kody, we did warn you. Go on.

Kody Cook

No, this is good. This is good. This is super relevant as well, because we we've literally been doing RFIs for NASA and all sorts of things around this tech at the moment, so it's exciting stuff.

Michael Veitch

RFIs?

Kody Cook

Request for information.

Michael Veitch

Thank you very much.

Kody Cook

Yes. It's the preliminary stage in sort of doing quoting. It's about essentially telling an agency what your capabilities are.

Michael Veitch

Okay. Okay.

Kody Cook

The way this works, how do you use a satellite to try and mine something? That sounds a bit abstract, but at the end of the day, it all comes down to communications. For a lot of these regional areas where you're looking for something, rare metals, for example, you typically don't have very good coverage in terms of cellular or fibre, so you need some way of being able to get data back to the cloud where you can do your processing. How this looks overall architecturally is, when it comes to trying to find where these deposits are, is you can put these massive internet of things or IoT sensors out there that are using pretty similar geophones and some new technologies as well, and you put massive arrays out, you collect data for a long period of time. You're constantly sending that data back via the satellite network, and then you can do real-time processing on data as it arrives.

So, you can use machine learning over those datasets, and you can essentially find out where stuff is. This technology that we're looking to that we're actually starting to demonstrate now, the plan is to take this to the moon. We want to find out where all the water ice is on the moon and eventually on Mars, and we want to deploy these same large-scale arrays of sensors in some of these other planets.

Michael Veitch

Another thing we've learned is that, for the last 50 years or so, the moon's been a somewhat neglected lady, but her moment in the sun, literally speaking, might be coming again with this new technology and all the things we're discovering about the moon. Those mega constellations, so what we're talking about Kody is sort of like clouds of small satellites, totally different from the old ones of the '60s and '70s, the size of a B-double, but these are small things, aren't they?

Kody Cook

Yeah. This is a podcast, you might be able to see behind me, but there's this one up on the shelf there.

Michael Veitch

Here's one I prepared earlier.

Kody Cook

Yeah. Roughly the size of the loaf of bread, if it was squashed a little bit. These aren't big satellites at all, but in terms of the technology that's on board, we'd like to think of it from a capability density point of view. So, you're going to have to put a chunk of matter up into orbit to provide a capability. What's the maximum amount of capability you can get for X number of kilograms? So, we try and increase bandwidth. We try and use multiple input, multiple access schemes, we're doing experimentation around beam forming and all these vast different technologies, tying them together, miniaturizing them, and then launching them into space.

Michael Veitch

I envisage the kind of a beehive analogy where the little new nanosatellites are like swarms of bees sort of doing their jobs sort of as one kind of collective system, but that's probably not too far off the mark, is it?

Kody Cook

It both is and it isn't. They're not swarms, as in they're like clustered together in a big group. For Fleet, we get more benefit when they're evenly distributed in a large blanket. So, if you've seen any of the SpaceX videos about how their constellation looks, you really want to evenly distribute your satellites in terms of their longitude, and then inside of an orbital plane, you want to have them evenly distributed there as well. That's what provides the best latency, the maximum capacity, and essentially just the best experience for our customers.

Michael Veitch

Pardon my ignorance. What orbits we talking about? Lower earth orbit?

Kody Cook

Yeah, our satellites are at 582 kilometres. So, low-earth orbit. We've got two filings for 45 and 53 degrees. Overall, when we talk about a mega constellation, we've currently filed for 153 satellites in orbit.

Michael Veitch

Wow.

Kody Cook

As of today.

Michael Veitch

Good to know what's up there, and that's where SDA comes in. Jennifer, we've discovered space is being congested with, as Kody has been talking more and more, well, not space, debris, but there's a lot of expensive and wonderful new technology out there, but also a lot of old debris that's threatening to choke vital orbits, perhaps, and risk vital satellites, the ones that Kody's putting up there. It would seem important to know what's up there. And this is what my take on what the space domain awareness is. That's probably very thumbnail. SDA, what really actually is it?

Jennifer Stephenson

That's pretty accurate, I think, **Michael Veitch**, essentially, it's about knowing what's up there and keeping a track of what's in the way of things that we might be wanting to protect. So, it's about understanding that space is congested. So with the amount of small satellites now going up thousands a year, that is making space very congested. Put on top of that, you've got all of the debris from old satellites once they died. There's no... currently, no sort of legal regulations/agreements about what happens to old the satellites. All of this new lot of huge satellites going up, which aren't necessarily intended to be around for a long time, there's currently no regulation about what happens to them when they end their life.

Michael Veitch

It's simply a matter of creating a vast sort of 3D map of space as it ... going up a certain altitude orbit as it envelops the world, and keeping an eye on what's actually in there. Is that...

Jennifer Stephenson

Well, essentially it's a bit like that. We call it a catalogue. So, it's a catalogue about, what's up in there, going around earth? And so that we know what things are. We know whether something's a piece of debris, whether it's a satellite, who owns the satellite, or what that satellite's doing. What kind of orbit it's on, if it's staying there, if it's doing expected things or unexpected things. That's about the surveillance part of what we're doing is using a whole range of different senses, both ground-based and space-based to put this picture together about what's happening. Of course the next step is then what you might do about understanding what's happening, then what steps do you take?

Michael Veitch

I'm guessing one of the things that would keep someone such as yourself, Jennifer, who works in SDA up at night, the notion of an international incident occurring from falling debris causing damage on earth, damage to persons, damage to property, heaven forbid. Is this one of the aspects of what SDA has to take account of?

Jennifer Stephenson

That is one of the areas. I guess we're particularly, being in the military environment, more interested in intentional movement of things in space. So understanding we've got some very precious space assets that Australia is interested in understanding what happens because should something damage those, we lose GPS, all sorts of terrible scenarios could occur. So, we're interested in tracking what is happening around those very special and important assets and not so much... It's also the accidental bits and pieces falling around, but it is more about what people might be doing with nefarious intent.

Michael Veitch

Indeed. Also, we've also talked about that remarkable sort of sliding scale as our dependence on space increases, so does our space awareness vulnerability increases. The more we use it, the more we have to lose up there. I guess that's probably pretty true, isn't it?

Jennifer Stephenson

That's certainly true. We talk about space being congested and contested. Now that you've got different countries in this race to dominate the space environment, and in an environment where there isn't much regulation, so you've got a lot of people working out how they can have the best positioning in space, and that doesn't necessarily involve letting other people have good positions. So, we're tracking all of that sort of thing to understand how to best protect our assets and understand what's happening to them, and then you start getting into the area of manoeuvring and all those sorts of things to get out of the way of either debris or something else.

Michael Veitch

How much faith do you have in the very notion of space regulation, Jennifer? I mean, is it a bit of a furphy? It seems to an outsider, like how can you possibly regulate something like that, but do you remain hopeful?

Jennifer Stephenson

Look, I do remain hopeful. I think treaties about space have been around for a very long time, and it's only now that I guess they're being tested when people are ... technology improved to such a degree that we're talking about mining on the moon and such things, but we have managed to do international treaties and such things. It's the seed, which is probably one of the best parallels. I think that there is certainly a great deal of goodwill from most nations about how we can work together to come up with this. I think it's not just about who has real estate. I've been watching that Space Force TV show that came out recently, which gives you some ideas about who might want to put their flag up and own things.

But it's also about what we were talking about earlier, the debris - about what should, as good citizens of the universe, what should we be doing about technology that's only designed to last for five years? How should we be recycling or putting that in the garbage?

Michael Veitch

Kody, Jennifer mentioned that intriguing notion just now of mining on the moon. We were talking about your nanosatellites contributing to mining on earth. Is it possible that your technology could be used for that sort of thing on the moon one day, discovering what's under the surface?

Kody Cook

Absolutely. It's already on our roadmap. We've got dates and rockets that we want to launch on to send our satellites out there. So, it's just going to be happening, either which way. To go back to something that Jennifer was talking about there, that from the commercial point of view, the work that she does and her team is absolutely essential, even from a commercial point of view. I go to sleep each night, waking up in night terrors where Kessler syndrome taken effect and all my satellites have been torn to shreds. It's a reality. Oh, there's other things. There's bigger things that keep me up at night, granted - US elections and whatnot, but it comes and goes, the Kessler syndrome one.

But at the same time, we are starting to see people invest in technologies which are trying to combat these issues. My favourite wine is always from a South Australian startup here, Neumann Space, and they were talking about the idea of being able to fly around and essentially chew up satellites and then to use them as fuel to keep going, and then just sort of Pac-Man its way along, eating up space junk up, after space junk.

Michael Veitch

Now, I got in trouble early in this series for bringing all sorts of science fiction analogies into it, and now, Kody, you're doing it, so I'm going to be in trouble again, but go on because this is much better than anything I came up with, I can tell you.

Kody Cook

Yeah. Well, they're essentially building these ion thrusters, and I'm no expert by any means, that they can chew up a bunch of different materials, and if there's some way of processing them, they can be reused as propellant, essentially.

Michael Veitch

Wow. Sort of the ultimate sort of destroying monster that can fuel itself as it destroys.

Kody Cook

Exactly, but the beauty here is its eating trash, right? It's showing up the things that are threatening our platforms. It's a saving grace. In terms of satellites, right, if you have a satellite and you need to get rid of it at the end of its life, you've got two options. If you happen to have propulsion on board, that's great. You either shoot up to a graveyard orbit or you shoot down the atmosphere and burn up. If you don't have propulsion on board, and our current iteration doesn't, we have to just belly flop. We just put the solar panels sort of into the wind and then just, we deal, but as quickly as we can, but it's a passive process. So, if we do have thousands and thousands of satellites going up there, even if they've got propulsion on board and something fails and they can't talk to it, or it can't work, it becomes pretty stressful.

Michael Veitch

Just as an, not really an aside, but just for a layman, what percentage, I'll ask both of you this, what percentage of what we have put up in space has come back? I gather it's small.

Jennifer Stephenson

Yeah. Look, I don't know a figure on that one, but as Kody's identified, certainly in a lot of the early days and even now, propulsion, to get rid of it at the end of his life cycle, is not really part of the concept.

Michael Veitch

We had just this conversation with the Dr Space Junk, I'm sure you know her, Alice Gorman, who said that, yes, it was a kind of a lack of thinking. It's alright putting something up and having it stay there, but what if something else wants to come up and that gets in the way, and how you're going to get the first bit down? Well, bad luck, you can't. And we don't even have space shuttles going up there or your Pac-Mans going and cleaning things up anymore. It will get to a point, won't it? Maybe not in our lifetime where it just almost becomes dangerous for new technology to be deployed in space without taking into account the inherent dangers of old technology up there.

Kody Cook

It could be something in our lifetime, if the junctures, albeit rare, intentional or unintentional, are devastating. There's been, I think, two events in history that are responsible for some ... Jennifer, I'll let you talk about this. You've got to know more about the incidents that have caused the majority of space debris. Can you...

Jennifer Stephenson

Well, that's true. There are really two main events where a satellite ran into another one. I don't have the figures, but that caused something like 10 to 20,000 pieces of space junk from one collision. That was from a place of old junk, an old one that wasn't being used, gets run into and then that's the Kessler effect we've been talking about. It creates this enormous amount of other pieces of material, and they can be one centimetre upwards. I mean, there's that famous story where a flake of paint ran into the window of the International Space Station, went through what a couple of layers of glass and stopped. They had quite a few layers but that could've had disastrous results.

Michael Veitch

When was this event, Jennifer?

Jennifer Stephenson

The Space Station one?

Michael Veitch

Yeah. No, well, no, the satellites crashing into each other?

Jennifer Stephenson

The first one was quite a few years ago. Now, Kody, I'm not sure if you remember.

Kody Cook

That's 2007 or 2009, there was one around there. I think there was one late '90s.

Michael Veitch

Who were the space actors involved in that?

Jennifer Stephenson

I think that ... Oh, I can't remember the details actually, but I don't think ... there was nothing nefarious about it. It was one of those accidental.

Kody Cook

I've got here - Google to the rescue. We've got the 2009 incident was between one of the commercial Iridium satellites and a Russian military satellite. It was accidental. They collided at 11.7 kilometres a second and created something like 30% of the space debris that's currently out there.

Michael Veitch

Wow. All the paperwork, all the legal ramifications.

Kody Cook

Commercial, you know. Geopolitical. It's interesting, space policy is one of those things which is starting to get very interesting. But something I wanted to jump on from what Jennifer was saying, in the space design world, commercially, we try and keep in mind that anything smaller than about one centimetre squared, we try and build to be ruggedized enough to take the impact of, and then anything that's bigger than 10 centimetres squared is something that we can detect. We know it's out there. But there's this range in the middle. There's a sort of like evil Goldilocks Zone between a centimetre squared and 10 centimetres squared, where we can't build anything to be thick enough to survive the impact, but we also can't detect it, so this is like dangerous, dangerous gap there.

Michael Veitch

And we've all seen the movie Gravity, of course. Well, this is why we need something like SDA, Jennifer. Defence, of course has big ambitions when it comes to space, the strategic defence update cites a dazzling array of needs requiring such things as sovereign independent communications abilities to enhance space situational awareness, tracking sensors, etc. You work in defence acquisitions, which to an outsider may not sound very interesting, but it actually is vital because you establish the relationships between defence and industry. How are those two bodies supporting each other in their respective ambitions?

Jennifer Stephenson

It's a really interesting time to be in my job, and it's really exciting because we're just at the start of this journey with Defence and Space 2.0, and Australian industry is just at a really interesting point. So, we're converging and we're sharing a lot of both ways to get things done and just general information about what the opportunities are. I feel really lucky to be doing this role at this exact time in history, but what we're trying to do is respond in a really innovative way.

So, we've looked around and seen some of the great tips and tricks that the US have been applying more recently about innovation and having innovation centres. So that's why we're part of the Lot 14 Innovation Hub here in Adelaide. We want to be really having our ear to the ground to understand what industry is doing.

We're working really closely with the SmartSat CRC, who, their role is to work also with industry and create those partnerships that we need. So, looking, as we were discussing earlier, what's the niche opportunity for Australia? We're, working with SmartSat, they're taking sort of the needs of defence and civil departments to look at and say, "Well okay, how can we translate that into things that industry's currently doing or help them steer them in a direction that's going to suit the needs of defence". So, it's a really great opportunity for us to add those partnerships, and as we said before, working in a more reactive sort of timeframe, not looking 20 years ahead, but looking at the five-year horizon.

Michael Veitch

Is there something inherently different between Defence's relationship with Industry in terms of space? I mean, is it the same as having to go out and buy a Jeep or buy a Tank or have one made? Does space have particular characteristics when it comes to what you have to do, how you have to interface with industry, Jennifer?

Jennifer Stephenson

Yeah, I think it does. It forces us to approach things differently. We don't have all the answers. So, if you want a Jeep, you can decide what you want on that Jeep in a way. Whereas with space, all of the possibilities are just actually in the process of being devised. As Kody's saying, they've got these great ideas, some of those haven't been tested yet. So, how do we work in partner with industry to decide together what are the interesting opportunities, get those tested, get some innovation funding in to see if that's something that will be useful, and then develop that into a commercial product.

Michael Veitch

So, Kody, perhaps a much more organic or symbiotic relationship than what we've seen in the past, what do you think?

Kody Cook

I look forward to this. At the moment, Fleet hasn't put too much emphasis or focus into defence. At the moment, we're a VC backed company. We look at the commercials, and our founders don't have the same defence background that I do. But one day we are potentially looking to share our capabilities with Australian Defence. There's another leg to this chair that I think has been missed a little bit as well, and that's the involvement of academic institutions, the universities and the research element here as well. We have a phenomenal amount, way more research going on in Australia in the space domain, than I had any awareness all before I worked in Fleet. We partner with universities for a lot of different projects. This mining stuff, we've got university partnerships there. FPGA scrubbing. So being able to make sure, FPGA's, if you weren't aware, susceptible to space radiation.

Michael Veitch

I'll back you up there, Kody. FPGAs, just explain.

Kody Cook

Field-programmable gate array. It's a special type of computer.

Michael Veitch

It's exactly what I thought it was.

Kody Cook

You kind of got three different kinds of computers. The one you find on your desk, which is like your general personal computer, you've got the little microchips that you've got in your microwave, your microcontrollers, and then you've kind of got your FPGAs, which are ... think of it as programmable hardware that you program for a very specific application. So, people talk about software defined radios in space. So, you want to change your frequencies, or you want to change your radiation propagation pattern. You use a software to find radio to do this, which requires an FPGA. Now, these FPGAs, just the sheer materials that are used, they're prone to what are called 'single event upsets', which is where you get radiation from something like the sun, which hits the computer itself, and then all of a sudden, your zeros start turning into ones, and your ones turn into twos, and all this crazy stuff starts happening, and it breaks.

Computers are awful in space. You have to be able to, when these things happen and your computer breaks in space, you've got to make sure you've designed it in a way that you can recover from that. And there are universities in Australia that are specializing on that, on scrubbing FPGAs. There's so much stuff going on in academia in the space domain that I don't think a lot of people are even aware of.

Michael Veitch

Well, we're discovering a kind of a tripartite relationship, aren't we? Between academia, industry, and government. That's certainly a model I have not heard of to this extent going forward.

Jennifer Stephenson

Yeah, that's right. I think that's one of the opportunities, Michael, is that there is this opportunity right now to work with industry and universities, and we're certainly aware of, just about I think every university across Australia has a kind of space field at the moment. There's some sort of niche that they're looking into. A lot of the forefront universities have already partnered with industry to come up with some of their technologies.

Michael Veitch

To supply chains, which is also not the sexiest sounding notion, but I know that they are important, and particularly a country like Australia that is so heavily reliant on overseas supplies for space material. Could we one day become independent in the terms of what we're trying to do if we're limited to not necessarily blasting off from Woomera anymore, but actually making the stuff that goes up there? Do you look forward to those days, guys, when we can do it all in house, so to speak?

Kody Cook

Absolutely. Supply chain, right now, I was talking about the things that kept me up at night. Supply chain is my big one, right in this day and age.

Michael Veitch

Especially this year.

Kody Cook

Especially with COVID, oh my goodness, don't get me started. It's been wild really. I was talking earlier about startups have to do multiple iterations of satellites in a short amount of time, and we have to work quickly. We go sort of two years between, roughly two years, between going for funding rounds with venture capitalists, all of our investors. So, we need to prove a certain capability in a certain amount of time and the choke point in our entire process, our biggest single risk isn't actually the technology, it's the supply chain that we're dependent upon and launch vehicles. If a launch vehicle is delayed too much, it can be game over.

Kody Cook

If your supply chain gets blocked, because these things are all outside of our sphere of control. It's a massive, massive risk to the business, and I think a lot of businesses. Now, as what we're trying to do about it, at Fleet, we try and bring as much of our manufacturing and the components that we use to, essentially our headquarters. We try and do as much manufacturing as we can in-house, then if we can't do it in house, we'll try and do it in Adelaide. If we can't do it in Adelaide, we do it in South Australia. If South Australia can't do it, we'll do it in Australia. And if we have to, then we'll go out to the rest of the world.

Michael Veitch

Oh no, you can't, because there are some internal borders closed within Australia - bugger - we have to go somewhere else. It's what's been happening this year.

Kody Cook

When COVID hit, when the planes stopped flying between Adelaide and Canberra, we had to get to Canberra to do our essentially environmental testing campaign. It's pretty much what you shake it, you cook it, you freeze it, you suck the air out of it, you bombard it with radiation. You just abuse your satellite to make sure it's going to survive. When we had that test campaign going, the flights were all stopping at that point, we couldn't get across. So, we literally had to hire a car, pack our satellites into the back of an SUV and drive across to make it.

Michael Veitch

I love it.

Kody Cook

Multi-day road trip with satellites.

Michael Veitch

That's a very Australian way of doing it. I do like that. Is our acquisition, is our defence space acquisition model, different from other countries? Do we have our own way of doing things?

Jennifer Stephenson

Well, look, I think we're just at the very early stages of our space acquisition. Only recently that space became a domain in the defence field, so that's been a really good change in the terms of profile for space, and that's given us quite a raise in understanding around defence about what space contributes. But we certainly are trying to do things differently, as we alluded to before. We really want to make the most of this innovative environment. The technology is increasing so rapidly and changing, so the companies that we talk to, they said that, certainly over the last year, their technology's changing and improving so much more quickly than they had even expected themselves. So, a things improve, we have to be able to have our finger on the pulse, if you like, because it's not just Australia that needs this, all other countries are watching and tracking this improvement as well. So, we've got to keep up. That's our impetus in, it's in a way, I think the space environment forces us to be doing things a little bit differently. And that is why we are so keen to be involved with the space industry, through all the forums and through all the innovation centres, and all of those sorts of things. Because otherwise, we're going to be making decisions independent of what industry can provide, and that's certainly not going to get us our aims.

Michael Veitch

Kody, you mentioned before Fleets, internet of things, which is a wonderful ... I don't know, it sort of verges on some wonderful kind of space philosophy, if you like. Tell us about the nomenclature, how did you come up with that name?

Kody Cook

Okay. I honestly was not the person who came up with internet of things, and funny enough, it has absolutely to do with space. Internet of things is actually a concept of putting a computer in every device that we interact with. So, smart glasses, smart phones, smart watches, smart cars, smart houses, smart cities, inside of hospitals.

Jennifer Stephenson

Smart fridge.

Kody Cook

Smart fridge, so everything's a smart something now, and this is ... IOT or internet of things has become this sort of term that captures all of these smart devices. The idea is that, if you're collecting data from all of these different, previously dumb devices, all of a sudden we start to learn more about how we do life and how we do work. So, you can collect huge amounts of data, we can run analysis over it, and we can find things that we previously didn't know about. We can optimize businesses or an interesting use case to think about is what we call 'industrial IOT'. This is sort of, think of it as devices on pipelines, or it might be putting sensors on our power grid to be able to figure out when we have outages, or it might be, for example, array of sensors that are used to find what's going on in the subsurface of the earth.

There's all these different remote applications that, if we had something out there that was collecting data, we would be able to make far more valuable insights from a business point of view. And then you take it to the next level and you can also put actuators out in the fields. So, if you have smart devices being deployed everywhere, all of a sudden, a pipe bursts out in a remote area and water spewing out everywhere, the IOT network detects what's happened and has the ability to send a message automatically to go and turn that pipe off so that you don't lose the water. Where the satellites come into the IOT picture is that there's just not enough connectivity in the world. There's so many areas that don't have an internet connection.

Jennifer Stephenson

I think **Michael Veitch**, it's estimated to be something like 50 billion IoT devices this year, and it's growing exponentially. There's just so many of these devices.

Michael Veitch

It seems to me, space is one of those domains where humankind consents that we are going to be using it so much, but we're not even on the cusp of discovering exactly what we'll be able to do up there.

Kody Cook

Yeah. Oh man, I love this idea. If we don't get out there, if we don't start building technologies, and this is why I like what SpaceX is doing, both with Starship and Starlink, is that they're getting out there, they're doing stuff now. We won't find these new applications, these new use cases, these new industries that are enabled by space, unless we're dabbling in the area. You look at what we can do in a microgravity environment, in terms of the manufacturing. We can make stronger materials because of the absence of gravity, just in the way that the crystal structures form when you're, say quenching a material. But we just don't know. We don't know what we don't know at this point in time. We're not putting enough stuff out there to know what we're missing out on.

Michael Veitch

It's such SpaceX, Northrup Grumman, they're doing some extraordinary things in terms of on-orbit servicing. What does that involve?

Kody Cook

If it's the one that I'm thinking of, essentially a satellite is limited in its life by roughly two things - define when a satellite dies - if it hasn't been bombarded by radiation to the point where it doesn't work anymore. The solar panels get too old and they stop working in an effective sort of way. Just the radiation makes a solar panel less effective over time; or you run out of propellant and you can't do any station-keeping. So, the satellite, you literally start getting thrown somewhere where you can't operate anymore. Now, from what I understood, if you run out of propellant, I think this Northrop Grumman platform is one that sort of comes on, it piggybacks onto your satellite, and then you get a bunch of extra propellant, and you can put new solar panels on.

You're just sort of racking up like Lego blocks and increasing the lifespan of your satellite. Now, I could be wrong, but if that's what it's talking about in terms of the on-orbit servicing, yeah, I do know that as something that's particularly interesting.

Michael Veitch

You have fun days at work, don't you, Kody? I can just sense. I can just sense that...

Kody Cook

It's wild. It is wild, honestly. I love IoT and I love space. I love robotics. My background speaks exactly about the things that I'm passionate about. Some days we'll be sitting there and we'll be literally assembling a satellite payload. It's a little bit surreal that we're doing this in Australia in a clean room, and then the next day we're out, I'll be climbing trees in South Australia, deploying like temperature senses while someone underneath the tree is trying to program the device that I'm working with. It's just wild. The amount of different things that we'll do in a week is incredible.

Michael Veitch

Jennifer. I'm not sure if your days in the office are quite as exciting as Kody's, but I'm going to wrap up soon, but I want to ask both of you, starting with you, what's the most exciting thing that really gets you going forward in terms of space, Australia, our industry, our partnerships that we've discovered, that we're forging, not just with defence and industry, but academia and defence in industry, what's the most exciting thing in that realm that really gets you going?

Jennifer Stephenson

Well, I think Kody has given me a great lead in there because what's so exciting about my job is I get to speak to people like Kody all the time.

Michael Veitch

I can see why.

Jennifer Stephenson

We've got a lot of passionate people in this industry right now, and everyone is talking about their great concept. Something they'd love to work on, what are the opportunities? So, it's a really exciting time to be working in space. I think for me, being in government, the interesting thing is that it's really getting a lot of government support. Australian government, at this time, is investing a lot of money across different parts of not just defence, but the industry. It's seen as a way to stimulate the economy through this difficult COVID time, but even before the Space Agency had been set up, as a recognition that Australia's got a role to play in space.

Something that we didn't have, say 50 years ago, is that huge government support of the industry. We've got a lot of really clever people in Australia, and we don't want to lose them going overseas, taking their great skills to other countries. We want to keep it right here. So, the Government's really focused on that right now, so it's a good time. There's a lot of innovation

funding available to these clever and passionate people, and I just feel really lucky to be working with these kind of people all the time. If we can help shape some of that towards outcomes for defence, then it's a win-win for everyone.

Michael Veitch

Kody, I want to end with a quote from you that you've given that you don't know I'm going to quote, but the most exciting thing that you feel going forward.

Kody Cook

For me, I'll start with probably the most de-motivating thing that I felt so far in my career.

Michael Veitch

Go on, bring us down then.

Kody Cook

Yeah, but it ends with a ... it's a happy story. I remember back in my Boeing days, there was a team of 20 to 30 year olds who were just trying to bring space projects into Boeing. We were just a nuisance to management. We were like a self-assorted group of people who would just ... we had weekly meetings, and we would constantly be looking at opportunities from the US that we could bring in and just interest the Boeing Australia leadership team. I understand in the early days of the satellites that there were a lot of false dreams there, just the satellite communications market fell out in the early 2000's - and there were a lot of scars, and we worked and we worked and we worked, without too much success, to be honest.

In that same week, I was giving a presentation to a bunch of university students. And I was working in Autonomous Systems at the time, but they were asking questions. They wanted to know about space. They weren't overly concerned in the other stuff that we had to talk about. They just wanted to talk about what ... "by the time I graduate, is there going to be opportunities in space for me?" Here I was fighting for this stuff and not really seeing a path of it actually coming into fruition. That's changed for me now. I've moved and I've started to work in this space company, and I see the people that I get to work with, and I see that industry is actually starting to take space seriously, that the government is taking space seriously, that we're getting eyes on the research.

And for me, this is the uplifting thing. This is the little eight year old in me that looked up in space and looked in my lack of American citizenship. And it's happening now, we're doing it. Australians have a shot of being able to work on space stuff. And I think it's only going to get stronger from here.

Michael Veitch

Well, I feel very encouraged. It's a shame I can't go back in time to being that 15 year old again, as I alluded to at the beginning of the program, who wanted to work in space, but there was no encouragement. I'm glad those days have changed. Thank you so much for joining us on *Conversations on The Runway* today. Kody Cook from Space Fleet Technologies, and Jennifer Stephenson, the Director of our Defence Department Space Acquisition Projects Office, and also director of Space Domain Awareness. Kody, I'm going to leave with a little quote from you. From Kody Cook, everyone (quote), "There's a reason I call space the final frontier. There are no more islands to discover, oceans to explore or oases to unveil, at least not on our planet. Human beings are explorers and the finite lifespan of our solar system means that we need to discover new worlds." Kody, beautiful words. Thank you so much guys for joining us today. Have a great day.

Kody Cook

Thank you.

Jennifer Stephenson

Thank you.