Raising the Bar Sydney 2018

Warwick Holmes – To infinity and beyond

Welcome to the podcast series of "Raising the Bar Sydney." Raising the bar in 2018 saw 20 University of Sydney academics take their research out of the lecture theatre and into bars across Sydney, all on one night. In this podcast, you'll hear Warrick Holmes' talk, "To Infinity and beyond." Enjoy the talk.

[Applause]

Okay, ladies and gentlemen, thank you very much indeed for coming this evening to the University of Sydney's "Raising The Bar." The theme of my talk tonight is titled, and I've just forgotten what it is, "To Infinity and Beyond." That's right. Okay. So, tonight I'm going to be presenting to you some themes about space engineering and space science. And the relevance to Australia. And I'm going tp put this in the format of giving you some antidotes about space engineering and some of the history of engineering in Australia.

Before I start, I just want to check that you've all got the right drinks, because this a bar. I understand there's some interesting space cocktails here tonight. So, I tonight have a Bailey's Comet with me, you see, Bailey's Comet. There's Pink Galactic Garbo Blasters I believe courtesy of Douglas Adams. And did you know that there was a crater on the moon called beer crater, which I just feel is appropriate somehow for tonight.

So, because we're in a bar, I think the general theme I have, I'm going to ask you some questions first of all and then half an hour later you're going to ask me questions, okay. So, the questions that I'm going to ask you are in the theme of a Trivial Pursuit. So, we're at a bar, we're going to have a Trivial Pursuit night. So, the first question I want to ask the audience is how many Australian astronauts have there been? Four, I heard. Any other? Three? Okay, who are the three? Andy Thomas. Anybody else? Okay.

There have been three Australians who were astronauts. The first one was Philip Chapman. Now, you may not have heard of Philip Chapman. Philip Chapman was trained to be an Apollo 14 backup astronaut. He was born in Melbourne, and he was a graduate of the University of Sydney. Okay, that's how important he was. So, I think that's far more impressive that he was a graduate of the University of Sydney than the fact that he was an Apollo 14 backup astronaut. Unfortunately, he never flew, because none of the prime astronauts got sick. So, he never actually had a chance to fly and he actually never went into space.

The second astronaut is Paul Scully-Power. He was on STS-41-G. He's a pilot specialist and he analysed eddy currents in the oceans and space. He too, was a University of Sydney graduate. Which I find even more impressive, okay.

The third astronaut was Andy Thomas. And he went to the University of Adelaide. Anyway, so that was the first little trivia question for you. Okay, so John Glenn was the first American astronaut to go into orbit around the earth. There were two other flights before that. There was Alan Shepard and [inaudible] who did what they called ballistic flights, straight up and down. They went more than 100 kilometres, so they did officially go into space, but they didn't go into orbit.

Now, Yuri Gagarin is famous as the first Cosmo that went into space. The first American was John Glenn. What location on the planet earth was his voice first heard from space? Where? Where in Australia? Parks, Israel[laughter]. No, his voice was heard at a place called Muchea,

M-u-c-h-e-a, which is a tiny, tiny little one-horse town in Western Australia. Now, when they calculated where the trajectory of the mercury capsule coming over the Australian coast was, they decided to put a little porta-a-cabin in the middle of the Australian desert, effectively, because Muchea is effectively on the edge of the Western Australia desert.

And they put a port-a-cabin there with all these antennae and the power supply. And they even sent a specialist space medical doctor, a doctor of medicine who specialised in space medicine, to sit inside the port-a-cabin, together with an astronaut, one of the other Mercury astronauts, also went and sat in this port-a-cabin in the middle of the Australian desert because they couldn't relay the signals back to the control centre back in Cape Canaveral.

Because this was the first station after the launch and they had to find out, well is he still alive, is he okay, they actually paid an astronaut and a medical doctor sitting the port-a-cabin for when he first came over, and they said, "John, John, John, are you okay?" And he said, "Yes." [Laughter] And they packed up and went home. But that location, there's no evidence of this amazing historical event, the first American voice in space coming down to Muchae, and there's a little brass plaque in the desert, on the floor that says, 'Here the first American voice in space was heard in Australia, blah, blah, blah; 1961,' whenever it was. And there's no evidence at all that that actually happened.

So, Australia has had some strange historical, space-related thing happen in terms of engineering and science. You may have heard recently about rocket labs in New Zealand, whose built this rocket in New Zealand that they've now put a 17-metre rubber cord with the electron into space. And they've sort of made Australia look a bit silly, because you know, we don't have any rockets which can go into space.

Well, that's so not true, because in Woomera between 1964, and 1972, ten 32-metre high rockets, 3 metres in diameter, weighing more than 100 tonnes with 137 tonnes of thrust were launched out of Woomera into space. Now, this is what they called the Europa rockets. And they were developed out of the precursors of what we call the Arians now. Arian 1, 2, 3, 4, and 5. And these are now the biggest rockets, one of the biggest rockets in the world, which the Europeans use from French Guiana. For launching very, very large GS Soyuz satellites.

But the precursor and all that technology was developed in Australia. And there were 10 of them. Ten 137-tonne thrust rockets. These are monsters. And I'm almost certain most of you here will never have even realised that. They're about six times larger than the Electron Rocket, which is now the focus of so much attention in New Zealand and Australia. This Electron Rocket, which is much, much more than what we did 54 years ago. And almost nobody knows about it.

Now, another Trivial Pursuit question who here is a local? Who here lives in Surry Hills, or knows Oxford Street, a few hands. Okay, who thinks they know Oxford Street really well. Come on, I mean it's not related question, you know. Up in the back there. Okay, so do you know where the Mitre 10 store is? And you know Paddington Town Hall. Okay, what building is between Mitre 10 and Paddington Town Hall? It's only 1.4 kilometres away.

Oh, who said that? You get a higher distinction than the university metal. You must be with the University of Sydney. You must be. How do you know that? How do you know that building? It was a start up hub, oh dear. Okay. Well, okay, well it is indeed the Telstra Building. I don't know if you know it. It's 363 Oxford Street. This was probably the most important building for four hours in the entire history of the civilised world. Now, what an outrageous statement. Why can I say that? This building was previously called Paddington PMG, Post Master General.

We're all familiar with the; well I hope we're familiar with "The Dish" Movie, which publicised Australia's role with the Parkes Radio Telescope picking up the video signals of Neil Armstrong

and Buzz Aldrin walking on the surface of the moon. That was one of about eight different critical signals which were being received from different ground stations in Australia all were channelled through the Paddington PMG building. So, not only the video from Parkes, but the heart rate monitoring, the respiration, the blood pressure of Neil Armstrong of Buzz Aldrin, the biomed sensors went to fire in another station in Honeysuckle Creek.

In Narrabri, they had a thing called a Helios set, which is measuring and looking for coronal message actions. If there was a huge explosion from the sun, or radiation burst, they had to jump back inside the lunar module to not be killed from the radiation. The voice signals, the telemetry and the tele-commanding to the lunar module and the command surface module in orbit around the moon were via Oro Valley and Carnarvon. There was a station in Morea which was used for relaying the signals from the PMG back to the states. So, the actual control centre for the entire Apollo 11 mission, was in Houston of course, but all the signals to and from the spacecraft via these eight different ground stations, were all controlled, the channel switching, the monitoring, the configuration, the redundancy, the robust connexions were all done at 363 Oxford Street, Paddington PMG.

That building was a single point failure for the entire Apollo 11 mission. If something went wrong, if they had a power failure, or if a truck crashed into it or something, we would have had no communication to any of the astronauts. No video, no audio, no heart monitoring. No science. There was a thing called the Alsip [phonic] which is a science package. And all the ground stations in Australia and the United States would have heard nothing. And that was the role that Australia had, not just the Parkes Radio Telescope, which has been immortalised in "The Dish" Movie. We had a far bigger role with the communications, the telecommand telemetry. Many, many different signals. Far more important than just the video. The video was of course interest to all the public. And this is the huge publicity coup for NASA. But the engineering and the real-life saving data for that entire mission was all controlled, and switched and channelled, just 1.4 kilometres up the road from here. And Australia's got many examples of this incredible things which are happening, relating to space engineering in this historical context, which nobody knows about.

The point I'm trying to make is that we do space engineering incredibly well when we're given the chance. So, if we're allowed to join with NASA or the European Space Agency to support their missions, we do an absolutely first-class job in terms of the engineering. But we're very humble and you don't hear about it, which I think is a shame because we have the opportunity to hopefully do that in our own context with the Australia Space Agency, but a lot of people don't support it, they don't understand it, they think it's a joint, there's this giggle factor, or what are we doing space for. You know, that's something which the Americans and Russians do. But when we've been given the chance, we do it incredibly well in our own context.

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>> Now, one final example I have for you, this is one of the best stories. Save it until last. I'm going to tell you a juicy Russian or Soviet spy scandal story. Isn't that good? Yes, thank you. Actually, I encourage heckling. You're all being very well-behaved. I teach University of Sydney students who are animals, okay. So, I'm used to being savagely acoustically abused. So, I'm feeling very unnoticeable. I don't know what's going on. Okay.

So, everybody knows Sputnik, okay, it was the first object launched into space in 1957 by the Soviet Union. W hat was the second spacecraft that was launched. Come on, smarty [laughter]. I'm sure you know. Okay, well it was Sputnik 2. Now, Sputnik 2, duh, okay Sputnik 2 had a very interesting pilot, it was Laika the dog. And like the dog was the first living thing that actually got put into space and the Russians became to see, well, what's the physiological effect of space on an animal. Okay, what was also very important was Sputnik 2 carried a radiation monitor. Because they were curious to know was there any radiation in space.

Now, because of the inclination of the orbit and the shape of the orbit, the altitude, when the space craft Sputnik 2 was going over Russia, it actually was at an altitude which fell between what we now know are these two radiation belts, we call the Van Allen radiation belts. There's an inner belt and an outer belt. And there's actually a gap between the two where the radiation dips down, then it comes back up again, okay. So, over the Russian stations, they were looking at the telemetry from Sputnik 2, looking at probe life of the dog, how happy he was, which he wasn't. And was there any radiation? No, there wasn't.

Okay, when the spacecraft was flying over Australia, Professor Harry Messel from University of Sydney, who's a professor of physics. You might know him because he actually wrote a series of textbooks many years ago. You know? Oh, they were good textbooks weren't they? Yes. You're a happy customer. Okay. He was in charge of the radio physics division at the University of Sydney, and he said okay, when Sputnik 2 comes over, we're going to try to pick up the radio signals, and decode the telemetry and see if we can get some science data for the Russians to help them recover some data from their mission. Because obviously, Russia is on the other side of the world. So, he received this data, they picked it up they successfully got the transmission, they knew the [inaudible] so they could actually track the orbit with these antennae, they've got Miyagi antennae, and they picked up the data and put on the tape recorder. And there's this weird modulation, these weird sounds.

They didn't know what the call of the demodulation codes were to actually extract the data, but they had the raw information. So, they rang up the Soviet Embassy and they said, look hello, I'm Professor Harry Messel. I've got some really interesting data from Sputnik 2. They said if you give us the demodulation codes we can process that and give you the data. And the Russians said, nit. No. They said we are not going to give you that, this is our proprietary information. Even though it was science data, which is meant to be shared. This is in the year of the Cold War of course, and the Russians just weren't; or the Soviet Union I should say were not happy to share that data.

Biggest mistake they ever made because they actually measured these radiation belts before the Americans did. But because they didn't release the data, three months later, Explorer 1 got launched and the Americans measured the Van Allen radiation belts, because Van Allan was the scientist who was responsible for the Geiger counter on Explorer 1. But three months earlier, the Russians actually had that data recorded by Harry Messel, but they never saw it because he didn't release it, and they didn't give him the codes. But those Van Allen belts should be called the Vanerum belts. Because Vanerum was the Russian scientist who actually put the Geiger counter on Sputnik 2. Okay?

So, what's the moral of the story? Don't mess with the University of Sydney [laughter]. Okay. So, anyway, the final story I've got to tell you is another story which again is just an interesting space fact. The Tidbinbilla tracking antennae down in Canberra, you might know it, there's a big 70-metre antenna, which is part of the deep space network for the NASA. Every single day they are listening to the Voyager 1 and the Voyager 2 space probes. Which are currently the furthest space craft out in space that have ever been launched. They were launched back in 1977. And they currently, how far away are they? It's a 40-year-old mission, 1977, it's 40 years old. Twenty-one billion kilometres away. These are the first two space craft. Or, sorry the third and fourth space craft which have left our solar system. They're going so fast that they've escaped what they call the gravitational attraction of the sun. And they have an escape velocity to actually leave our solar system and go into interstellar space in our Milky Way.

They are 21-billion-kilometre, travelling 63,000 kilometres an hour and they're 141 times, or they've got 141 AU, 141 times the distance between the earth and the sun. They're so far away from the sun that they're actually outside what they call the heavier pause, which is the

influence of the sun's radiation, the solar pressure from the sun. So, they've actually gone so far that the background pressure of the stars of our galaxy are actually pushing in with more pressure than the pressure of our sun. And this is an extremely unusual phenomenon. Because it's actually what they call the bow shock of where the influence of or sun, in terms of its solar wind, is no longer the predominant force which the space craft is seeing.

It is so far out that the other starts in the local group of our sun actually have more significance and we're measuring the solar wind for the first time of starts outside our solar system. This happens in Canberra every day. Just recently, they had to send a telecommand for the first time in 37 years to switch one of the thrusters on. It's a spinning space craft and over 37 years, the precision vector of this space craft just moves slightly away from the sun. Which is where it's pointing all the time. Because the orbit of the earth is completely with inside the beam of its transmitting antenna. So, it doesn't have to follow the earth anymore, which it used to do when we first launched it. It's so far away that just beams of the sun and the earth is going to be inside the radiation pattern of its antenna.

Now, so long as it points to the sun , now over time as the electronics has been ageing and the spin of the space craft has been slowly processing, they had to fire some thrusters to bring it back in again, 1 or 2 degrees to keep it pointing at the sun for another 37 years. This telecommand was sent from Tidbinbilla and it's the furthest telecommand ever send into deep space, and it took what's the number, I've forgotten it now, 20 hours. Twenty hours at the speed of light to reach the spacecraft. So, this light shining in my eyes now, the speed of light, you know how fast 186,000 miles per second, or 400,000 kilometres per second. Is the fastest thing known to physics.

This space craft is so far away it takes 20 hours for the speed of light carrying the radio signal to tell it to switch the thrusters, to get to the space craft. It takes 20 hours for the telemetry to come back to say, yes, I have switched. It's a 40-hour two-way light time to talk to the space craft that is so far away, in the furthest extent of our solar system. So, this happens in Canberra every day. And almost nobody knows about it.

Okay. So, what I've tried to do tonight is to give you examples of Russian spy intrigue stories where Harry Messel didn't give the data to the bad Russians, or sorry Soviets I should say. We've got this building up the road here on Oxford Street, which was the epicentre of the most important communication event in the history of technology and you could argue humankind. Landing on the moon. Not just the video pictures, but all the telecommunication, the bio sensors, the voice, the data, the science, everything. We've got rockets being launched from Woomera which are 6, 8 times larger than the rocket in New Zealand, and we did it 50 years ago and there were 10 of them. And they all worked perfectly. So, the theme of tonight is when we're given the chance to do space engineering, we do it really, really , really, really well. And my message to you tonight, I hope is that when you hear of Australia having a space agency, and there's this funny giggle factor. And the fact that they're only getting $26 million in four years, which is all that the federal government has given to the space agency. I would like to think that we should have a lot more money and we can do our own amazing space engineering. Because at the moment, all the examples I've given you have been cases where we're supporting other space agencies; NASA, European Space Agency, etcetera. Okay.

[Applause]