

Interview of John Saxon by Hamish Lindsay

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Transcript

Questions from Hamish Lindsay in italics.

On the 7th of April 1994, this is an interview with John Saxon, who has followed a distinguished career in space tracking and related fields and is currently Operational Supervisor at the Tidbinbilla Tracking Station.

May we begin with how you entered the industry, John?

Okay. Yes, well, a very brief thumbnail sketch of how I came to enter the industry.

First let me say that I was born in the UK, a small village in Middlesex, now part of Greater London called Pinner. I went through part of the war there and then went through the English public school system – which I could not stand – and finally ended up in the 50s doing an apprenticeship in electronics and computers at Marconi Instruments in St. Albans, outside London.

After that I was doing a variety of jobs and eventually ended up down in Australia on a project in Adelaide which was a defence project and I did a lot of flying in V bombers – Vulcans, Victors, Valiants – and we were essentially checking out some of the world's first inertial navigation systems. So I visited Australia quite a number of times. Eventually returned to England when the contract was finished, married an Australian girl over in England and so was, by this time, quite desperate to return to Australia.

I'd always been interested in the possibilities of space and the things to do with the space business and when I found that they were setting up tracking stations in

Australia to support various missions I immediately was inspired to write off to whoever I thought might be interested in my services.

I did obtain a position from England with the Tidbinbilla Tracking Station which was then involved on the Surveyor project and deep space missions. However, just before I migrated to that position, I was offered a position at the Honeysuckle station on the Apollo project and manned space flight was something that was particularly of interest, so I was very keen to do that instead, and very kindly the people at Tidbinbilla released me to join the Honeysuckle station.

And so I started there on the 1st of September 1966 and one of the things that used to happen in those days was that we, people in various positions, went on training courses to the Goddard Space Flight Center outside Washington in Maryland, and so, as it was sort of on my way to Australia, they allowed me to start off with a four week training course at Goddard in preparation for the Apollo program and I went through a thing called the M&O Supervisors course, Maintenance and Operations Supervisors, and this was a general orientation on all the systems on the station and about the missions and projects that we were going to get involved with.

So I spent four weeks there in the company of one Kenneth Simpson Lee, otherwise known as the Silver Fox. He was, he and I were classed as Assistant Operations Supervisors, Assistant M&O Supervisors in the Goddard or Houston terminology and we both went to the training course there.

A little anecdote on that. The very first day we got there, this Australian and pseudo-Australian – we had never seen a microwave oven – and we went down to the basement very hungry, ready to, we didn't know that American restaurants served breakfast or anything, so we traipsed down to where everybody else was going to get their cups of coffee and Ken saw this aluminium foil wrapped hamburger and he thought this would make some breakfast in this new style microwave oven which we'd never heard of but sounded like a good deal. Stuck the hamburger in the oven and promptly fused every light and electrical circuit in the whole training centre and

everybody was queuing up for their coffee so the Australians' name was mud for quite a while. Took us a while to recover from that one.

So after my four weeks training in the States I actually returned to UK and migrated to Australia. They put me up at some magnificent Captain Cook Motel down in Narrabundah and the first day I was picked up by I think the Chief Engineer at the time, Wes Moon, who was a character in himself, we might talk about him a little bit later if I can avoid being libellous, and drove me out to the station and that was an experience really, just to go to the station the first time.

Was the station completed, the building and antenna up?

The antenna was fully complete but not completely established, things like the masers, the low noise amplifiers were not installed at that point and there was still work being done but basically it was complete and fairly ready to go.

I was lucky I didn't have to do all the initial work there, a lot of the equipment was installed and on the floor and we still hadn't got any furniture though, we were still sitting on packing cases, literally, there were desks made out of old packing cases, lots of packing cases there for all the equipment so there was a good carpenter there, a good rough carpenter called Paddy Shea who managed to make work benches and desks and everything else out of these packing cases. So the station was in the process of being commissioned at the time that I arrived.

Just one word about the journey out there was a little bit of a surprise to me, I anticipated at least a paved road, in fact at that time the paving stopped at the Monaro Highway – long before Tharwa and it was dirt all the way, for the majority of the trip out to the station and the road to the station was a temporary road, it was not the final bitumen road that we had up the hill, it was a temporary one on the other side of the valley, very rough, very windy and very boggy, if it rained. I remember that if there was any thought of rain there was competition to get a particular couple called the Kirbys who worked in the documentation section who were fairly large,

there was a lot of competition to get those two in the back seat of your car so that you had a good chance of making it up the hill with both of them bouncing up and down together. We had an engineer called Jim Kirkpatrick who ran the powerhouse and who still works here at Tidbinbilla who used to get bogged at fairly regular intervals on that road but I don't ever recollect actually getting bogged myself because I always managed to get the Kirbys in the car first with a bit of luck.

So anyhow we got to the station and I guess I can talk a bit more about that road one day but there was a rather funny anecdote with that road – well there's a lot of funny anecdotes regarding that road – but the bitumen gradually got extended and there was a huge push to get the bitumen extended past Lanyon in the late 60s when Lyndon Johnson came out because he was going to have a barbecue at Lanyon and they just missed out by about 200 metres of finishing the bitumen all the way to Lanyon and it rained and it rained and it rained and it was a total bog for that last 200 metres and apparently Johnson got out there and came out to meet all the assembled foreign affairs officials and things all in their blue suits out for the barbecue and Johnson came out in his checked shirt and 10 gallon hat and remarked that he thought it was a barbecue but it was quite an interesting exercise just getting along the road that day because it was CIA and everybody all the way down there.

There were helicopters in the sky.

Yeah all of that, yeah you remember it.

Oh there was lots of other incidents on that road, lots of crashes and nothing amazingly nobody was ever seriously hurt on that road which was quite amazing. I went off the side of Mount Taylor twice with other people driving I might say. Mount Tennant not Mount Taylor.

Okay so we're into the tracking station. When we first started there was the opening ceremony with Harold Holt and quite a few people from NASA headquarters. I know that you're more aware of all the names than I am, Hamish.

Yes there was Dr. Seamans and there was Chris Kraft from Houston and Edmond Buckley.

Edmond Buckley, what was he? Oh no Buckley, yes.

Data acquisition.

That's right Buckley had a hand in selecting the sites and all the contract negotiations with the Australian government and all the rest of it on behalf of NASA headquarters.

So anyhow Harold Holt came out to open it. I was told to be at my operating position which was the main control console for the site – and one of my jobs was to look after some of the communications in and out of the site with external agencies and I was given the nod that Harold Holt might want to talk to somebody in America and we would demonstrate the NASA communications network to him by that means.

Anyhow the time came and in wandered Harold Holt and said, "I'd like to talk to my old mate Hubert Humphrey, the Vice President". I said, "Yes sir. Put on this headset –immediately" – stuck a headset on his head and told him how to press-to-talk button and got on to the Goddard Voice Control which was the centre of the NASA communications network just outside Washington and said, "I'd like the White House".

They said, "Yes sir". White House came on in nought seconds flat and I said. "I have the Prime Minister of Australia talking through the NASA communications network, opening this American station here in Australia and he'd like to speak to Hubert Humphrey" and they said, "Oh he's in a car somewhere but no problem" – click click

click – and there was Hubert Humphrey. I was pretty impressed by this I must admit the speed at which it all happened.

In March 1967.

That's right yes.

17th of March 1967.

Was that the date? I know there was a lot of preparation for that opening of the station and we were told though that operations came first and nothing should interfere with the opening of the operations and even though the station was going to be officially opened in March we would do some tracking operations and work the station up into a viable entity prior to the official opening – and I very much remember being called and asked if we could track Lunar Orbiter which was an early spacecraft in orbit around the moon – from the Deep Space Network and it was a very good source for us to use as a simulated manned spacecraft so that we could get some experience of pointing at the moon and doing all the right things.

And I accepted some tracks of Lunar Orbiter prior to the opening and then was jumped on from a great height as to how could I possibly get involved in these operational things when we had all this problem opening the station.

So anyhow we did track Lunar Orbiter, it was rather amusing. Do you remember Ian Anderson up in the cone?

Yes.

Oh yes, well there was the inevitable teething problems of getting a new station online and one of them was that the very first spacecraft we tracked, they sent us predicts, we were what they call an 85 foot site, a 26 meter diameter antenna and they also had 9 meters?

30 feet.

30 foot diameter network of stations around the world, Carnarvon was one of them and needless to say they sent us predicts to point the antenna as if we were a 30 foot site in the northern hemisphere and there we were an 85 foot site in the southern hemisphere and the predicts were totally wrong.

So we decided we'd go ahead and try and track this thing anyhow and we thought the best way to do this was to look at the moon with human eyes. We didn't have – later on in life, there's another story about that, we had a TV camera looking along the axis of the antenna and you could actually see visibly on a TV monitor what the antenna was looking at and so it was quite handy you could actually make adjustments and point the antenna actually at an object such as the moon quite easily. But on this occasion we didn't have the TV set up so we sent a guy called Ian Anderson up the antenna with a pair of binoculars. And he was, I don't know, sitting somewhere in the cone looking for the moon with his binoculars and saying, "Up a bit, down a bit," and he was very Scottish and he said, "It's so close it hurts". You could say that much better than me.

So there we were trying to track the moon first and then the Lunar Orbiter around the moon with this antenna with a guy up there with a pair of binoculars telling us to go up a bit, down a bit. So that was the very first operation we did and I believe we eventually managed to lock onto the Lunar Orbiter despite the fact that the predicts were all wrong and so we felt we had achieved something under difficult circumstances.

Later on of course all these teething troubles were overcome and we got into the real reason for our being which was to support the Apollo missions and particularly the lunar phases of the Apollo missions as they only had three of these large antennas around the world. One outside Canberra, one outside Madrid and one outside Barstow in the Mojave Desert, California.

So let's pause just for a second.

Okay we were talking about the very early days of Honeysuckle, and I guess the next period was working up towards the support of the Apollo missions and there were various ways of doing this. Obviously we had to run a lot of technical tests on the equipment and make sure that was working – and then we had our first taste of tracking a live simulated Apollo spacecraft in the form of a Super Constellation aircraft which they sent out to the site with all the equipment that made it look like an Apollo spacecraft – as far as the electronics were concerned – and they sent a full team of people to the station to simulate the astronauts in the spacecraft, to look over our shoulders as we did our job and to generally give us a real work over.

Up until that point in time we had been fairly “laid back”, I suppose, is the phrase, casually getting ourselves up the curve, reading documents, looking at things in theory. Now here was a chance to apparently support what seemed to be like an Apollo spacecraft and things changed very rapidly from then onwards.

We had the leader of this group who came out of Goddard Space Flight Center who looked after the network, the tracking network for Apollo, was a guy called George Harris. George is one of the greatest characters of the NASA world over the years. I know a little bit about his history after he left the Goddard Space Flight Center and I can go into that later but George was an interesting character because he shook us up quite badly.

What happened was we ran through a couple of simulations, they were fairly good disasters, everybody thought it was quite amusing. Then after a couple of these aircraft tracks, pretending to be the Apollo spacecraft and all the people on the ground looking over our shoulders, George called the entire station together to talk to them.

I vividly remember this, he got the entire crew, technical, non-technical crew, down into the canteen, the cafeteria, in the basement. We had a Director at the time called Bryan Lowe who was an interesting character, more into research and development than administrating a station.

I remember seeing him sitting cross-legged on the top of the ice cream machine, one of those top opening freezers we had there. Bryan was sitting on top of there and George Harris addressed the crew. The first thing he said was, "You guys are a bunch of shit". Pardon my french on this tape but that's exactly what he said. We certainly sat up and took notice after that. He told us it was not a joke, this was really serious, we were supposed to be a closely knit team, snap, snap, snap, everything to go like clockwork on the voice loops. To be capable of doing this thing we had to react to failures and problems and carry on tracking as if nothing had happened.

Subsequent to that we had a lot of these simulations, we developed ourselves a very good, probably the best in the network method of simulating the Apollo spacecraft. We carried on our own in-house simulations and I'll talk a bit about those later on, but the ones with the aircraft sim teams were really quite phenomenal. Nothing was sacred. The mission timeline was followed as much as possible you could do with an aircraft. But this aircraft, because we were simulating lunar phases as well as earth orbit phases, wanted to be in view for quite a while. It used to circle around the station, or quite often in the distance, if they wanted low elevation work. This aircraft had a large light on it so you could actually see whether you were pointing at it with the antenna through this TV camera I described before. We used to get a huge number of telephone calls about strange lights in the sky, UFOs and all that sort of thing as a result of this aircraft. Anyhow, these simulations were quite incredible.

Of course we started off as standard missions without too many contingencies or problems, but later on the problems came just fast and furious.

The sort of things that used to happen: We had a guy simulate a heart attack in the middle of the telemetry area and fall down and we had to make sure that he was

carted away on a stretcher with all the right oxygen and all the things that would happen with a heart attack, but carry on tracking and the mission timeline and everything else. This guy did such a good demonstration of having a heart attack – this was Laurie Turner, one of the supervisors there eventually – he did such a good acting job with his heart attack that I think it was Bill Perrin or Ed von Renouard. One of the two was really distressed about this episode, went out and was sick outside. This also had to be taken care of with the contingencies.

We did all sorts of other things. Sometimes I was on the side running the simulation and giving other people a hard time. Sometimes I was the one on the receiving end. I know that either way you were a ball of sweat all the way through the whole exercise.

We used to set off fire alarms. We used to send people down to the stores to get parts and time how long it took to get the part out of the store.

I vividly remember when I was on the simulation team side of this, pulling a module out of the microwave link over to Tidbinbilla here, and I'll talk a little bit more about how Tidbinbilla was involved with Apollo later, pulling a module out of that microwave link while the guy who looked after the microwave link was down having his tea during the simulation. Of course we dragged him out from his tea, there was alarm bells rang, and it took him a while to find that this module was just slightly pulled out of his rack. When he found out he was a Central European, this guy, he was absolutely livid. He thought this was the stupidest, most Mickey Mouse thing that he could have imagined. He backed me up against the wall and was going to thump me once. I talked him out of that and explained to him that we were really looking to try and work out every possibility and react in the best possible way. Unfortunately I had to share the car with this guy on the way going home. I got it all the way home and all the way back to work again about how stupid it was to run these sort of contingencies.

But I felt myself that nothing was sacred, everything should be tried that could possibly happen, and I believe they were the reason that Apollo was so successful, particularly at Honeysuckle. If we hadn't had those simulations it would have been murder to run the real missions. As it was, the real missions were an anti-climax almost after our simulations. We really made them extremely realistic, except for the fact that when we had Australian simulating astronauts, they didn't sound like Americans. I used to write the scripts and things for them to say and you get this Australian accent saying, I don't know, I can't do it, but somebody with a broad Australian accent speaking about mission timeline events as if they were walking on the surface of the moon just did not gel at all.

But we had equipment to simulate the astronauts' heartbeats, the backpacks that they wore, the lunar rover that was on the later missions, the lunar module, the command module, the service module, the sub-satellites that they put out. We could simulate all of that, even down to being able to send commands from on-site as if they were coming from Houston and uplinked to the spacecraft. So when we had the sim aircraft, we used to have a system where we could command the camera in the aircraft as if it was the camera on the lunar rover.

No other site had this. We developed it ourselves. A guy called Bryan Sullivan wrote the software to simulate the Houston commanding of the lunar rover camera, which, in this case was up in the aircraft. So we could pan and zoom the camera around and really catch the crew up in the aircraft at awkward moments and upset them no end that we could actually spy on them up there. They couldn't see what we were doing on the ground.

I guess I got a little ahead of myself with the simulations in that we didn't really develop the on-site, our own simulation system until we had a few visits from the aircraft.

So the aircraft simulations came first, and then later on there was a lot of foresight by people like Mike Dinn and Tom Reid. They realised that in order to maintain this edge

that we developed from time to time with the simulation aircraft, we should have our own system and run it. So there was really two different kinds. There was the aircraft type, which was more or less scripted and organised by the people from the Goddard Space Flight Center and Houston.

And then there was our own type, which were completely scripted and organised by ourselves. They got quite large in the end. When we got quite clever about it, we used to involve the outside world in our simulations, places like Sydney Video, which was going to take the Apollo television when we got it, and other places like that. We actually managed to tie up most of the communications around the east coast of Australia when we had a simulation internally, or internal to Australia. Often, I think it was Channel 7, they couldn't get their news at the right time in the evening because we had all the television feeds and things in the east coast tied up on our simulations and they had to delay the news, which was quite incredible. I could never imagine such a thing happening these days. We wouldn't be so short of bandwidth, of course, these days.

So we did maintain this team atmosphere and preparation for Apollo missions a lot more than I would have imagined when I first joined the place by running our own simulations. We even hired aircraft ourselves from Masling Aircraft. I'm not sure if they're still going. We hired some aircraft and I actually flew in one for a while on one of the simulations to look after the equipment in the aircraft. That was quite interesting because they were unpressurised and we wanted to fly quite high. We had to keep the rates relative to the station, the angular rates relative to the station, quite low. So we flew high and we were sucking oxygen through straws and things. It was quite an amusing little episode. It was nice to be on the aircraft end rather than the station end for a change. So these simulations became quite excessive in some ways.

One of the things that always appeals to me about a station is when there's plenty of graffiti around. I measure the morale of a station by the amount of graffiti and the best graffiti is when things are the tightest and working the best.

I have in my possession a poster announcing a new set of simulations called Dim Sims. This was a reference to Michael Dinn who was the Deputy Director and worked with me very much in operations and was very instrumental in organising these simulations. I got the hard work, he did the organisation. I used to write the scripts and all these sort of things. I have a poster announcing a set of Dim Sims. It was done like an old time vaudeville poster with words and music by Gilkens and Sullivan which were two of the computer people. I hope you get to talk to some of them. Len, your favourite Liverpool comic which was a reference to Len Litherland who I'm sure you'll be talking to who still works at Tidbinbilla. And numerous others. I wish I'd brought the poster with me and I could describe it. But it was an excellent piece of graffiti and we have many more examples tucked away of poems that were written, songs that were sung, posters that were published and it was a good time.

So then, the reason that we were able to do all these simulations, and we felt it necessary to do the simulations, was that we had been working up to Apollo 4, I think it was which was going to be the first, you would know about this number better than me Hamish, but this was going to be the first manned orbital mission around the earth to check out the Apollo capsule.

Unmanned.

No, manned. We were working towards the first manned one. And of course as history shows they had during the Countdown Demonstration Test at the Cape. That was Apollo 1.

Okay. They had the disastrous fire and Grissom, Chaffee and White were burnt up and the whole Apollo program went back 18 months right there as the spacecraft was redesigned to avoid this fire problem.

Could I ask you, Carnarvon were involved in that and they thought that that fire was part of the simulation.

I didn't know that.

What happened at Honeysuckle?

Well, I didn't know that. We were involved in that CDDT as well. Probably not so much as Carnarvon in fact because Carnarvon's prime duty for Apollo was to track the launch and the early orbit phase. We really came into our own at Honeysuckle when it got outside earth orbit and started to get into deep space as it was seen in those days and towards the moon. So Carnarvon were probably more involved in the Countdown Demonstration Test than we were. I can't remember actually being on the console for that one. I remember being on the console for every Apollo mission. But not that one.

Anyhow, there was a substantial delay in the program and so we had to maintain our capabilities by running simulations.

And we also supported some unmanned missions, particularly the first launches of the Saturn V rockets, which were eventually going to take them to the moon. And some of the other hardware which had to be space qualified. So we got experience of doing earth orbit and high apogee flights with some of the unmanned.

And then we came to Apollo 7, which was the first manned one we actually supported. The first time that the Apollo capsule had been used with astronauts in earth orbit. That was an interesting mission because if I remember rightly the commander was sick. He got flu or something after they took off and he was pretty miserable. This was Wally Schirra. And Cunningham was on there too. I remember Cunningham came down to the station later and I'll tell you about that.

But anyhow, it was a fairly tense mission all around. And it was the famous "report that man to flight control" episode, which is probably well reported elsewhere. But basically the Commander of the Apollo was pretty upset about some things that were

going on in Houston and who was in control of the mission. And I have a Snoopy cartoon actually, sitting on the roof of his kennel, pointing saying, "Report that man to flight control!". Of course he's got his goggles on and everything. It was quite well known at the time.

So we supported Apollo 7 first. That was successful from our viewpoint but, as we only had really short passes in earth orbit, we didn't really come into what we were designed to do, which was to support the further out phases of the mission.

And the next mission, and I'm not going to go through each Apollo mission in turn, I'll just hit the highlights. We tend to remember the highlights and not the lowlights. But the highlights of the Apollo series as a whole were in this order to me.

I guess Apollo 8 was undoubtedly the greatest mission that we had. It was something that I don't believe would ever be attempted these days. Here they were with a brand new rocket, the most powerful that anybody had ever developed. We didn't really know what the Russians had at the time. A brand new spacecraft, the highest orbit that anybody had achieved was 850 miles, if I remember rightly, in one of the Gemini missions. And off they went to the moon. It was quite incredible. We followed a timeline as if it was an Apollo lunar landing almost. The crew were marvellous.

There was the very famous episode where Frank Borman read some of the first chapters of Genesis on Christmas Day from lunar orbit.

Actually they each took their turn.

They each took their turn, didn't they? Okay. Well, my memory is letting me down. I'm not a religious person, but I found that pretty impressive, I must say.

That was a case where it was the only Apollo mission where we didn't have a LEM to track, and so the Wing, Tidbinbilla, and ourselves were both able to track the one spacecraft, whereas in following missions we had to split.

We didn't have a LM in Apollo 8.

That's the difference. That's correct. So we had umpteen pieces of equipment all on the same spacecraft which caused an interesting incident. I certainly tended to look at the Apollo missions in the light of what was our role in them. We were incredibly lucky at Honeysuckle in that we had, out of all the Apollo missions, the prime role so often at so many critical and new and interesting times that I can't begin to explain how many times that happened.

Obviously Apollo 11 and Armstrong setting in the moon was the main one, and we'll talk about that later.

In Apollo 8 we were the prime station in view when they first disappeared behind the moon, and we were the first station in view and the prime station in view when they first appeared from behind the moon. Whether or not they were in lunar orbit was quite an interesting question to most people at the time.

We were also the prime station on the return to Earth burn. So they were really critical times.

We were also the prime station when they actually re-entered the Earth's atmosphere from lunar distance at incredibly high speeds which no human had ever flown at anything like these speeds before, something in the order of...

25,000 miles an hour.

25,000, yes, 34,000 kilometres an hour.

And there's a funny story about that too with the Wing, Tidbinbilla, antenna. So on this first orbit around the moon, the first time that man had ever gone to the moon, we were the prime station in view. And I was the person who would have to speak to

these people in lunar orbit if for some reason we lost communications with Houston, the mission control centre.

Normally I should explain we relayed their voice through our station and others and we also relayed their commands. But I felt I was very privileged that I was in a position where I would speak to them if we lost communication with Houston and also I would send commands to the spacecraft if there was no command link with Houston. So I was very lucky there.

I guess I didn't really realise the responsibilities of that task in full until some of the publicity started coming back.

But on this instance we were the first station to see the spacecraft come out from behind the moon and it was very critical that the time of the exit from behind the moon was known so that flight controllers would very quickly realise whether they were in proper orbit around the moon or in fact they were shooting off into space never to be seen again.

And because we had so much equipment we were not tracking the Lunar Module. We only had the Command Module to worry about.

We configured all the equipment for the Lunar Module, that was normally used to support that. It was all configured on the Command Module. And there was, I don't want to get too technical here, but there was two possible modes of voice communication that they might have come out from behind the moon in one or the other of these modes. There was one planned mode and there was one unplanned mode that might have been a contingency mode. Now unfortunately it was decided, and I didn't do this decision, when the guy hears it if he listens he'll know who it was, but he decided that we should cover the backup mode just as carefully as the prime mode. We didn't put all our eggs in the prime mode basket, nor we should have done, but we should also support the backup mode.

Unfortunately there were so many ways to configure this that we ended up locking up all the telemetry and sending the telemetry back when the spacecraft came up from behind the moon, but there was a degree of confusion about where the voice was actually coming from.

And I vividly remember listening to the public relations loop from Houston saying, “We have contact, we have contact, we have data but no voice”, and here’s me pushing buttons frantically trying to find where the hell they’d put this voice. And the guy at the other end, Kevin Gallegos on the SDDS, the subcarrier demodulation equipment, was pushing buttons as well and no doubt Houston was pushing buttons. And I had my fingers poised ready to talk to those astronauts and say, “Fear not, we do have communication with Houston, but somehow we can’t get you through”. And I was very close to being the first guy to speak to somebody in lunar orbit, but I persisted and I did the right thing and we sorted it out in the end and I never got to talk to him at that point, which was in a way, after the event, a bit of a disappointment.

So I’ve got a *Time* magazine that recounts all of that data and no voice, but anyhow Apollo 8 was really an incredible mission.

And the other thing that happened in Apollo 8, and I’ll get to why I’m talking about this later, was that Mike Dinn, who was the Deputy Director at Honeysuckle, and I tended to work with Mike on the console. He was on one side doing the overall control of the station and the decision making regarding configurations and these sort of things, and I was on the other side where I was the interface with the outside world regarding mission events, things like air ground, voice command, and that type of thing.

And Mike and I worked together, mostly on one crew and I think, well it varied a lot on different missions, but Tom Reid and my opposite number Ken Lee used to work, on the early missions at least, on the other crew which was the preparation for the passes and the in-between pass times.

Anyhow, we got a rhythm going, Mike and I, and we used to be able to cover both tasks from time to time when one of us wanted to leave the console or do anything.

And I, on the way out to the moon on Apollo 8, I went down and I had my meal downstairs and Mike was covering my position as well as his own, and lo and behold, Mike, I'll get him to explain this one, I don't know how it happened, but anyhow Mike got to talk to the astronauts on the way to the moon. And I was jealous as all hell. I really thought it was my job to talk to the astronauts and Mike shouldn't have done it. Ha ha! But anyhow, he did it and he'll tell you why he did it and what happened and all the rest of it.

So, after that event, we went through numerous Apollo missions and never got a chance to talk to the astronauts. And the reason for that was that the systems were really quite reliable, the communications were very reliable. When things did go wrong with the communications back to the control centre in Houston, the outages were very short. We had well-established procedures to regain lines and all the rest of it.

And I didn't actually get a chance to speak to the astronauts myself until Apollo 16 when there was an earthquake in Los Angeles and we lost all the lines for a considerable period to Houston.

And during Apollo 16, John Young and Charlie Duke were on the surface of the moon and we lost all the lines to Houston and I was madly trying to re-establish lines in conjunction with other people on the side of course. When the astronauts called down and called Houston of course, then I had to respond.

And that was quite a big moment, I suppose, because I'd been waiting through all those Apollo missions. So, we had a chat for about five minutes. I guess I'm the only person in the Southern Hemisphere that ever got to speak to anybody actually on the lunar surface.

And the conversation was about beer. I don't know which it was, John Young or Charlie Duke said, "Boy, I could really use a Swan Lager right now," because they'd been to Carnarvon and Hamish will tell you all about that and they knew all about Western Australian beer. And we had a sort of embarrassed talk, or I had a slightly embarrassed talk with them about lager and beer and how they were invited for a beer any time they got back to Australia and like that. And trying desperately while talking to them to re-establish circuits on other voice lines.

Coupled with the fact that on Apollo 16 they had a problem with the high gain antenna and the signal level was very weak and the voice quality was extremely poor. I could hardly read what they were saying. And so it was a difficult conversation, but nevertheless a goody as far as I was concerned because I was beginning to think that we were going to get to the end of the Apollo series and I never would have talked to anybody.

So, we had this conversation which, it must have been a slow news day or something in America, but anyhow it was picked up by the American media and they published a few things about astronauts talking to Australia and talking about Swan Lager. And Swan of course got hold of this and thought this was marvellous publicity for them. So they sent the astronauts a whole set of crates of beer as a publicity thing and when we got to hear about this we rang up Swan and said that, "Well look, we're having a splashdown party too, it was partly us."

And so we ended up with 48 crates of beer from Swan and they really came to the party which was nice. Unfortunately there were so many people by this time involved in the Apollo program they thought the only democratic – and this is Australia all over, you have to be democratic about these things – the only democratic way to deal with these 48 crates of beer was to give everybody a bottle of beer. So everybody had a bottle of beer, we never really did have a good splashdown party for that one. We were drawing near the end of the Apollo series by then.

But I raised that because by this time Mike Dinn, who had stolen my thunder on Apollo 8 as I saw it, was off in America on the deep space side of the house working over there. So I was delighted with myself having broken not only his distance record but also time record talking to astronauts. So I sent him a message saying, "Hi Mike, how does five minutes to the lunar surface grab you?" and words like that.

And then of course the graffiti started after that and there was all sorts of poems written about me fixing the system so that I got to talk to the astronauts and stuff like this. It was heady times I guess.

So we'll just close for a moment on after Apollo 8 and then we'll pick up the other highlights and lowlights.

Okay, we'll try and keep these missions a little bit in sequence – but the next mission after Apollo 8 was – let me just say the highlights of the Apollo missions. I guess you could say Apollo 8 was probably the biggest highlight for most people.

Apollo 11 was not a real highlight to me. It was exciting, it was interesting, it was fantastic. We never thought we were making history. I didn't, at the time. It was like a simulation that went correctly. To me it was a slight anti-climax if anything, Apollo 11. I was excited and interested. I have my original log that I wrote at the time, one of the few things I kept from the whole series. I wrote a few things in red ink like "touchdown!", exclamation mark and particularly – what I should have written when Armstrong stepped on the moon was "Commander on the surface". I was so excited I wrote "Commander on the moon!" It doesn't sound too technical with lots of exclamation marks and the time to the second when he stepped onto the moon because we had a big office sweepstake going on exactly the time that he was going to walk and it was important to get that time right. I knew that the technical side of things would take care of the exact timing but I wanted to make sure we got a good reading on it for the office sweepstake.

So we did a variety of missions straight after Apollo 8, just ducking back.

Apollo 9 was an extremely dangerous mission, I thought. It was a test of the lunar landing module in Earth orbit and they flew and rendezvoused with the Command Module and the Lunar Module.

The Lunar Module was so thin, the metal was so thin you could put a spacesuit boot through the side of it with the greatest of ease. It was no way that that spacecraft could have re-entered the Earth's atmosphere and the astronauts survived.

They flew quite a few miles apart, they didn't even station keep, and finally rendezvoused – they did extra vehicular excursions, EVAs as we call them. It was an exciting mission but again it was in Earth orbit so our view periods were quite short and you had to take your excitement in small doses.

Then we got to Apollo 10 which was the first mission to orbit around the moon and go down almost to the point of landing on the moon.

Tom Stafford was the commander I remember. He came out to the site afterwards with some interesting talks for us.

And that was a very interesting mission and the first time we really started to get the whole system working as it was designed to work which was one station or group of equipment looking at the Lunar Module and one looking at the Command Module and Service Module. The whole thing was beginning to pull together to where the final landing was going to be on Apollo 11.

Then, as I say, we had Apollo 11. It was a very exciting mission for us. I felt a certain degree of unrealness about the whole thing.

I think one does when momentous things are happening. I know I fell 48,000 feet out of the sky once in a V-bomber and you begin to think that this isn't really happening.

When things are really tense you get this feeling of being remote in some ways, an onlooker.

But anyhow I was on the console there and the timeline got changed quite a lot on Apollo 11.

Originally Goldstone were due to support. Armstrong was due to come out during the overlap between Goldstone and Honeysuckle. We both had a mutual view period for about an hour or so and they thought it would be a very good idea to have both stations up during that time. Obviously a critical period in the mission. You have as much ground support as you can muster.

In fact they decided they were not going to sleep before going out to the lunar surface and they would exit early and we had every chance that we would not be in view when Armstrong was stepping out on the moon.

In point of fact it took them rather longer than we expected to check out all the voice communications and the suit integrity and all this sort of thing. It turned out that we were both in view when Armstrong eventually started going down the ladder.

The sequence gets a little complicated from there on because Goldstone had a 64 metre diameter antenna, a 210 foot dish, as well as their 26 metre, 100 foot dish, 85 foot dish sorry, on the Lunar Module. In theory the larger antenna should have improved the signals considerably over our small antenna at Honeysuckle.

In fact there was a problem with the signal to Houston from Goldstone. There was some inversion of the signal I know and various other things happened.

Finally Armstrong deployed the camera, this was after the camera was deployed on the leg of the lunar module. Finally at that time Houston decided to take the picture from Honeysuckle and Armstrong stepped out on the moon and said his famous words about one small step for man and all of that came from Honeysuckle.

So we were, at the time it was part of our job, we didn't really think too much of it but it's a source of great pride now that Australia was the people who were intimately involved in that first transmission of Armstrong's steps on the moon.

John, can you remember if we were two way at the time? Was Goldstone or ourselves two way?

I believe Goldstone was two way on the Lunar Module probably. We could well have been two way on the Command Module which was still in orbit around the moon and when we talk about two way we mean we were transmitting and receiving from the same spacecraft.

We also had Parkes, the radio telescope at Parkes was in support of Apollo 11, they thought it was a very good idea to use the 64 metre diameter antenna there.

There was a difference though that Parkes had a 30 degree elevation limit, they could not come down closer than 30 degrees above the horizon which made their passes looking at the moon considerably shorter than ours when we could come down to one or two degrees elevation actually.

The sequence went that they took Honeysuckle's television of Armstrong stepping out on the moon, about five minutes or so later – according to my log – Parkes had AOS, acquisition of signal as we called it, and their television signal was better than ours and Houston started taking the signal from Parkes about five or six minutes after Armstrong actually stepped on the moon.

So let's put that one to rest right now, there's always been some arguments between CSIRO and ourselves about who covered it but I have all this logged and I have the voice tape so there's no question.

We finally have a letter from John Bolton who was the director of Parkes at the time that agreed that all the evidence points that Honeysuckle was the first to get that signal.

John, can you remember your thoughts at the time that Armstrong stepped on the moon?

As I say, we definitely didn't, I definitely did not, really comprehend that we were making history. I felt somewhat remote from what was going on even though we were working flat out and doing all the things that we'd practiced so often in simulations. My feeling at the time was, "By golly this is actually working. It's not like a simulation, with a bit of luck nothing is going to go wrong and things are actually going right".

I mean, they didn't go right. The checks of the portable life support systems on their spacesuits for instance before they stepped out on the moon were totally in a totally different sequence from that which we were expecting. Every time they changed modes on those spacesuits we had to make major reconfigurations on the ground and we were really, really busy trying to keep up with the astronauts doing their own thing and, with that in mind, it was pretty hard to sit back and think about any history making things.

Who was controlling the telemetry when they were changing their modes?

Well, it was really a team effort. We at the operations control console were supposed to keep tabs of the sequence and try to conduct, orchestrate all these people who were working on different equipments to do the right things.

The busiest man, without a question, was the man at the front end, as we called it, in the Subcarrier Demodulation equipment because all these modes affected how he routed the signals through the station. He had to literally second guess what the astronauts were doing because they were not following the sequence. He was sort of

yelling out all the different things that he was seeing. We were then directing the telemetry people, the people who were actually processing the life support data, the things like the astronauts' heartbeats and all of that, to change their modes and trying to report to Houston what was happening at the same time, telling them what we were doing, keeping a log of all the events.

It was all extremely busy. It was a real team effort.

A lot more manual operation than we have these days, of course, where everything is remotely controlled from a central point, or we attempt to do that.

It was a very busy time and there really wasn't time to sit back and think about the implications of all of this. Of course, we had been building up towards this. To us, this was the start of a new set of missions which were going to go on for a considerable time. We knew about follow-ups that were going to happen, or we thought were going to happen. This was, to us, a successful start and an interesting and exciting time. I never got a chance to sit back and say, "Hey, this is incredible, what's happening here?". I guess my thoughts were primarily on the work at the time.

Apollo 11, we had the best parts of that sequence, too. We were the prime station at the important events.

This happened throughout just about every Apollo mission. We were delighted with that.

Especially Apollo 15.

Yes, I'll get to Apollo 15 because I think myself that was the other highlight. Really, Apollo 8 and 15 were the real highlights.

Apollo 13, you could say, was a low light, but it was also a highlight. Let me explain that. Apollo 12 was a reasonably standard mission. We were beginning to get into

the rhythm of how to cope with lunar operations. Apollo 12 was a very good mission. That's the one they went and visited the Surveyor site and actually found another man-made artefact on the moon, which was interesting and exciting. They brought back parts of that.

Apollo 13, though, of course, for those who follow the series, was the one where there was a fan problem in one of the fuel tanks in the service module, which caused an explosion, which blew the side out of the service module, and the crew had to use the lunar module as a lifeboat.

We were tracking at the time, if I remember rightly.

Again, I would have to go back to the records because what happened with that one, as far as I was concerned, I came on shift for the majority of the pass that occurred immediately after the explosion.

The explosion had happened, and I have a feeling it happened when Goldstone was in view. When I walked through the door, all hell was breaking loose on the ground. The reason for that was that the Lunar Module was on the same frequency, the same channel, as the Saturn IVB third stage rocket.

The SIVB was intended to be crashed into the lunar surface so that the scientists could look at seismic results from that crash. They were looking at that with the seismic equipment that had been left on the moon by Apollo 11 and 12. They put a transponder, a transmitter, on the SIVB, which was the same frequency as the Lunar Module. There was no possibility in the normal mission flight plan that the lunar module would have to be turned on at the same time as the SIVB was turned on.

Unfortunately, they had to turn it on to have communications through the Lunar Module lifeboat, so we were using it. Both vehicles, the SIVB and the Lunar Module, were within our antenna beam width and both on the same frequency.

So, all hell was breaking loose. How do we work out how to track both vehicles and support communications with the astronauts in this very difficult time while they are both rotating on the same frequency?

I believe it was Mike Dinn, in fact I'm sure it was Mike Dinn, that on the fly developed a procedure of first of all using one transmitter and receiver pair to track the SIVB and pull the frequency away from the frequency of the lunar module. Then after that had been done, we were able to track the lunar module, communicate two-way with the Lunar Module and support data and voice and everything else that was needed to work through this difficult time.

I'm sure Mike will describe this in much better detail than I can, but luckily that technique was already being discussed as I came through the door.

Of course, the remainder of that mission is history now, but it was a very tense episode indeed. There was no guarantee that many times during the mission that the astronauts could be returned safely to Earth. It was quite an interesting, as well as exciting, time for us on Apollo 13.

We were the last site as we generally were to track the re-entry phase of that mission where they entered the Earth's atmosphere. There was quite a tense time when they had to vacate the Lunar Module and just get back into the crippled Command Module for a very short period to re-enter the Earth's atmosphere. We were tracking both modules, the Lunar Module and the Command Service Module.

I know there was a lot of interest in where the Lunar Module re-entered exactly and where it burnt up. We were required to take very careful records of antenna angles and things like this when we lost contact with the lunar module. In fact, it entered the atmosphere and went into the sea in between Australia and New Zealand. There was a great deal of interest in where that might be, primarily because the Lunar Module had a package to be installed on the Moon which had radioactive isotope power supplies and there was a concern that had it entered over land there might

have been a radioactive contamination problem. In fact, it's probably in part of the deepest part of the ocean between Australia and New Zealand and they believe that the integrity of the shells of these power supplies will be maintained until the half-life or more is over of the radioactive material. So it's not believed that there will be any real problem with that. But there was a lot of interest in where the lunar module re-entered on Apollo 13.

Apollo 14 was interesting. It was the last of the simple missions. We almost completely rebuilt the station in between Apollo 14 and Apollo 15.

The difference between the Apollo 14 and 15 was almost like a new project.

If I remember rightly, people were screaming there was too much overtime.

Well, they probably were, because one of the ways that we worked at Honeysuckle was that there was a lot of overtime actually during the Apollo missions and everybody realised that would be necessary to cover around the clock or whatever was required. But, in between, missions people liked to think they could relax a little bit, even though by that time we were supporting all the packages on the moon and various other spacecraft, deep spacecraft almost by this time, maybe a little bit later.

So there was no continuous shift work at Honeysuckle at that time and something like rebuilding the entire station in between Apollo 14 and 15 required a lot of overtime obviously. So the wives and families of our little group were extremely, they were the real heroes of the Apollo, putting up with all our horrible hours and anxieties and all the rest of it.

So we came to Apollo 15 which was a really a changed mission. There was a whole bunch of new communications with scientific experiments in the service module bays.

There was a Particle and Field sub-satellite which the astronauts ejected from the service module into orbit around the moon. Got some stories about that too. There was a lunar rover for the first time which they drove around on the surface of the moon.

The communications were becoming horrendous. There were so many links involved, the backpacks of the astronauts, the relay from the Lunar Rover, the relay from the lunar module, the Command Module in orbit around the moon, the Particle and Feld sub-satellites. It all got quite difficult and we had severe doubts before Apollo 15 that it was all going to work the way it should.

This was the first mission that really got into the science, I believe. It's commonly believed that Apollo was a pure publicity gimmick and a part of the Cold War space race between America and Russia. In fact there was a lot of science done on Apollo, even Apollo 11 collected some rocks and things, but it really I suppose was the one which was part of the Cold War and the space race.

By the time they got to Apollo 15 they were getting into the real science. There was a huge amount of work to be done, a great deal of additional complication.

Obviously the technicalities of these things will be covered in other documents elsewhere but, from our point of view, we had almost completely rebuilt the station. We were not too sure that we would be able to support all this complexity, that the new equipment would work and we went into Apollo 15 with some qualms to say the least of it.

Again, Apollo 15 we had the large share of that mission. We had just about all the EVAs, all the walks on the surface of the moon, all the bringing up of the first rover, downlink to the ground, all the critical parts of that mission we were prime for.

It was all supported 100%.

And that was what I was getting to. We did go into that mission with a great deal of trepidation and it was quite amazing. Everything went by the book, it was just click, click, click, click, it was perfect.

I think our only major problem was Apollo 8 when we lost the feed cone.

We had various equipment problems throughout the entire Apollo series. We lost the feed cone in Apollo 8, we lost a major computer, a 642B during Apollo 13, another story about that. We once lost a transmitter during a critical period.

This is the sort of flavour of how it went. On this occasion we lost a transmitter and had to explain to Houston in writing what had gone wrong. In fact it was a moth, a large bogong moth which got into the air flow system which ensured that the transmitter was properly cooled. And when it sensed that because of the moth in the sensor that it wasn't being cooled it shut the whole thing down.

So we thought we knew Houston pretty well by this time and we thought we'd be a little less formal than normal. We said that the problem being caused by a greasy Italian moth.

Now I don't know why we said that but anyhow we did. We got a message back within a nought seconds flat that says, I can't quite remember the exact words of the message back but it said something like, "You mess with my moths and I'll mess with your face" and signed "the brethren" or something like this from Houston. We thought that was quite amusing at the time. We got on very well with Houston actually.

There was one particular flight controller who looked after the communications to the spacecraft from a network point of view who was called INCO. I just can't remember the exact acronym something about communications anyhow. And this guy was quite renowned, one of the people that we used to know pretty well, a guy called Ed Fendell. Ed Fendell was Jewish and known around Houston as "Super Jew". He had quite a write up in one of the *Life* magazines at the time because he was quite

incredible. He used to be able to command the Lunar Rover camera from the ground to look at everything that was happening from his console but thinking ahead by the delay between the Earth and the Moon. A couple of seconds, he used to have to do everything a couple of seconds in advance of when it was really needed.

The best thing that he ever did like that was to point the camera which was left on the Moon on the Lunar Rover at the Lunar Ascent Module, the part of the Lunar Module that went off from the surface. He followed the ascent of that Lunar Module when the astronauts fired the motor – from the camera on the surface. There's a fairly famous sequence showing it blasting off from the surface of the Moon. But he was doing all of that two seconds in advance of when it really happened or was going to happen. It was quite incredible that all of that sort of stuff was done manually. I take to think of trying to do it with computers these days. It would be quite difficult.

We used to be able to see all the commands as they went through my console. I had a printer right there which said the names of the commands and we could see Ed commanding the camera quite often. He'd go zoom in, zoom in, zoom in, iris open, iris closed, pan left, tilt up. Just a continuous stream of commands moving this camera around on the surface of the Moon. He had a better console than I had for doing that sort of thing. I would have dearly loved to have done a bit of that myself.

In point of fact, I did get to do some commanding of the Apollo from my console at various times, several occasions in fact. It was usually Ed that was on the other end telling me what he wanted done. And we used to argue with him about exactly when to change the antennas and to change the bit rates of the data coming down from the spacecraft. We used to tell him he was leaving it too late or he wasn't doing it early enough. We had pretty good visibility of what was happening. We used to argue with him in a good natured manner but nevertheless when the job was done, I used to bug him about when the astronauts were going to wake up and all this sort of thing. He used to come back and say, "Well, if you had your way, you'd know exactly

when they went to the toilet and when they had a shower and all the rest of it.” I said, “Right, that’s true.”

It was important to know when events like that were, not necessarily going to the toilet bit, but at least when they were going to wake up and that sort of thing because we’d see differences in the respiration and EKG and things, their heartbeats, and would be a little concerned if they were not physically getting up or whatever.

So we had a good relationship with Houston, their network controllers, their flight controllers for the spacecraft systems, particularly the communication controllers.

And anyhow, we got to Apollo 15 and that I think was probably the highlight of the series as far as technical support was concerned. It was all new and different. We were supporting all the various downlinks and uplinks that I mentioned. We had the station here at Tidbinbilla supplying us with support on some of these links. And it was all quite complicated. And it went very well.

It was very nice getting to know the astronauts. Dave Scott came down to the site after about Apollo 16. He was the Commander on Apollo 15. And it had been a fabulous mission and we were able to talk to them on – not just a publicity level – but also a technical level. It was very interesting to see it from their point of view as well as ours.

We had a connection there with Endeavour, remember? We gave him a photograph of the station because of a leak.

I don’t think that was Apollo 15. Dave Scott. Was it? I thought it was Apollo 17.

No, it was called Endeavour. It was my picture of the front of the thing that was taken.

There was a lot of coincidences about the name Endeavour and they still continued.

But Milton Turner gave him a... Yes. And that was Apollo 15.

Was it? Okay, well, it was pretty much on the anniversary of Cook's springing a leak in the Cook River up in Queensland that Endeavour actually sprung a water leak problem.

And funnily enough I was being interviewed about that a year or so back by a woman who was doing an article on the Endeavour replica that was being built in Fremantle. And she said I believe there was some... the name Endeavour had been used in space and there have been various coincidences. I explained to her about that one. Also we'd had the Endeavour Australian telescope in one of the shuttle missions and would you believe the shuttle Endeavour was flying at the time this woman interviewed me and would you believe they were springing a leak in the equipment up in the shuttle which we were supporting at the time. I mean, you know, you can't go much further with coincidences than that.

So anyhow, Apollo 15 I guess was the scientific highlight and also a technical highlight of our operations. We had a large share of that mission all through Apollo 16 and 17. Of course we had expected to support 20 Apollo missions, but the budget realities set in after the American public realised that it was going to be more of the same, they shut down the missions Apollo 18 through 20 and we only supported... 17 was the last one.

One of our people here, Laurie Turner, was on the console during Apollo 17 and he talked to the astronauts there on their way back from the moon I think. That was about the third and only occasion that anybody...

Oh, not quite. There was an occasion when there was an inadvertent transmission made to the astronauts. We had, as I mentioned, the capability to press a button and talk to the astronauts any time we wanted to but obviously we didn't. It was normally only used for contingency.

But we did have a Deputy Director on once who was extremely Scottish and he pressed the wrong button. He thought he was talking to Parkes but actually he was talking to the astronauts and he said something very quickly in a very Scottish accent and by that time I jumped on him, took his hands off the button, pressed the right button for him and told him what he'd done. By this point the astronauts came down and said, "What did you say, Houston?" Houston said, "We didn't say anything." And we said, "Nothing."

To the best of my knowledge that was the fourth and last, the only other occasion that anybody from the station went up to an Apollo spacecraft.

Anyhow, so then we had the Apollo 16 and 17 missions which were fantastic, great, incredible, interesting. We were supporting some of the older ALSEP packages that were left on the Moon simultaneously with these other lunar operations. Particle and Field Sub-satellite was an interesting one in that we supported them for a year or two after they finished the Apollo program. It was interesting because they had more or less completed their prime task to measure the particles and fields around the Moon by the time they were running down the manning over at Houston and they were sort of let us play with them.

Not exactly play with them, we were actually conducting the operations from the site on those Particle and Field Sub-satellites. We got to do all the commands and things to them to control their operations as they went behind the Moon and came out again, dumped their tape recorders and things.

I had a very embarrassing time with that in that I commanded a complete pass around the front of the Moon on one of these sub-satellites and nothing happened. It did not react at all to my commands. I was getting quite concerned about that and after it went behind the Moon again, I suddenly realised that I had been commanding the wrong one. There were two in the orbit and I just had to push one different button and I had the other button pushed and I was commanding the wrong one. It was

doing all sorts of things, we were not looking at it. That was a considerable embarrassment, one of the few things I really screwed up on over the Apollo program.

Okay, John, to wind up now, what did Australia gain from the Apollo missions or the missions in general up to that time?

Okay, I think both parties gained. We worked as a team with NASA. It was an inter-government agreement that we acted as a team with them. We played a very, very significant role in the whole of the Apollo program for them. They could not have done it without us, I like to think.

But in return, there was a huge learning technology transfer to Australia. We had a huge number of people go through those tracking stations over the years who were using cutting edge technology equipment at the time which never would have been seen around Australia if it hadn't been for these projects. Those people took that knowledge that they had gained and went off into other industries and applied it elsewhere.

So Australia gained in technology transfer. Also, of course, all of this was paid for by the American taxpayer. All the money that was spent on our salaries and all the money that was spent in Australia was direct import of American taxpayers' money into the Australian economy. So Australia gained financially as well.

In return, and the people from the Australian Space Office will be able to tell you about this, we put a certain amount of Australian money back into the program to, what they call "the Australian contribution", which is still around and still being spent from time to time, into assisting NASA one way or another, maybe improving roads in the area or improving their publicity, their image and this sort of thing. I might say just about all the roads in this area of the Tidbinbilla Ranges were, I think, pretty much paid for or subsidised one way or another by NASA. So the local farmers and

everybody else benefited from improved communications, transport and everything else.

So there was a lot of benefits for Australia, I feel. Apart from the sharing of the scientific knowledge, of course, there were scientists here in Australia involved in the project and I'm sure you're going to talk to them. As far as I'm aware, I can't prove this, all the lessons learned from Apollo and the scientific knowledge gained was shared with scientists around the world. I don't think there was any real secrecy about any part of Apollo.

Did we contribute anything to the Apollo program, that you know of?

You mean scientifically?

In any form. Operationally we did.

Operationally we did. I mean, we, as a team, worked with them to improve their operational techniques. Some of their, we continuously made input about better ways of doing things, both technically and operationally. I was involved in a number of teams which were formed to produce follow-on equipment. We helped with the development of equipment for Apollo and for future missions.

There was a lot of benefits on both sides, in my opinion.

Thank you very much, John. Thank you very much indeed.