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# The Original Computers

## An Interview with Mary Whitehead

### Kerry Dougherty

Interviewer: Kerrie Dougherty  
Interviewee: Mary Whitehead  
Recorded: May 1991

This interview was originally recorded as part of a series of oral history interviews with people involved in Australian space activities, for use as commentaries in the book *Space Australia: the story of Australia's involvement in space* by Kerrie Dougherty and Matthew James. The selection of Miss Whitehead as a commentator for *Space Australia* was partly influenced by a personal research project I was undertaking at the time, to examine the professional lives and working conditions of women in science and engineering between the end of World War Two and the 1970s.

Mary Whitehead was a former Long Range Weapons Establishment/Weapons Research Establishment (LRWE/WRE) Experimental Officer, employed at the Establishment's Salisbury headquarters from 1949-82. Miss Whitehead was the first female professional officer employed by the LRWE and headed the first LRWE computing team. She was involved in the management and processing of trials data from the Woomera Rocket Range, nearly 300 miles north-west of Salisbury, for most of her professional career.

KD Mary, what background led to your first becoming involved with the work at Woomera?

MW When I was at school, my favourite subject was mathematics and I did an Arts Degree in Mathematics at the University in Melbourne. I was there from 1935 to 1937. There were a few women doing mathematics, but not many. I would say only two or three out of a class of about twenty, but I am a bit vague on that.

KD How did you first come to work for the Weapons Research Establishment?

MW Initially I worked for the Department of Labour and National Service in Melbourne doing some statistical work. I came in as a Librarian, though I had no formal library qualifications. There were very few professional women in the Commonwealth public service when I joined. I learned on the job. An awful lot of my work has been learning on the job, because there were new things opening up, and I had only my formal mathematical training at university and then a year on the mathematical statistics course run by the Council for Scientific and Industrial Research,<sup>1</sup> which was very sound training indeed.

The work I was doing for the Department of Labour and National Service was mainly social sciences [data]: pretty inexact materials, which I found somewhat frustrating. So when there was a recruiting drive for mathematicians at Salisbury,<sup>2</sup> which was known then as the 'Long Range Weapons Establishment', I applied for that and got the job working in the Bomb Ballistics section.<sup>3</sup>

KD Would you outline what your general duties or functions were when you first came to the Long Range Weapons Establishment?

MW I found, somewhat to my horror, that I was to be in charge of a team of Computing assistants. They were doing the computations and reading the film records and other timing records [of the various weapons trials]. Some of the formulae we were given, others we had to devise [for ourselves]. This was all for the work on the Bomb Ballistics range at Woomera, because I was working in that group. So my job was a mixture of mathematical work, setting up computing schedules and, as I said, looking after the team. There were half a dozen of these youngsters: four of them came straight from school. One had done a year or so at the university and had to drop out because of illness and the other one was doing an Engineering Degree. (I have always thought what a waste that she never finished it. She got married and decided to give it away.)

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<sup>1</sup> The CSIR was the Australian Government's research and development agency. In 1949 it would be re-organised and re-named the CSIRO (Commonwealth Scientific and Industrial Research Organisation). CSIRO staff were involved in many of the space science programmes at Woomera.

<sup>2</sup> Salisbury, South Australia, was the site of the former munitions factory that became the headquarters of the LRWE/WRE. The town was located some 25 km (15.5 miles) from Adelaide. Today it is an outer suburb of the South Australian capital.

<sup>3</sup> The LRWE was officially founded in 1947, although staff recruitment did not get underway until 1948. Miss Whitehead applied for a position at Salisbury in 1948 and commenced work in January 1949. The Bomb Ballistics Computing team, which would process the data from bombing trials, was established in January 1949: the Test Vehicles Group Computing team, which handled missile trial data, was established in October 1949. By the end of 1950, the two Computing teams had been combined into a single unit, the Mathematical Services Group.

KD In these the early days of the Computing team, the women did everything virtually by hand didn't they? Did you have any mechanical calculation aids?

MW The girls always worked in pairs to check their work, but when I first went [to Salisbury] there were 18 Friden calculators: they would be museum pieces now.<sup>4</sup> When they did multiplication, it was really done by succession of additions. You could also do square root calculations! Trained operators could really race through [calculations], but they were noisy. We had to have egg crates as sound dampers on the walls: we also had carpets in the rooms,<sup>5</sup> again because of the noise. You get about half a dozen of those going full belt, it was quite loud! We thought that we did very well when we got the Marchant calculators! Friden did bring out an electronic machine later, which was about the same size as the old mechanical ones but it could do a few extra things. I think it could take square roots automatically and it was quiet! But we didn't use that much - by that time we were getting onto the computers.

KD When did you begin to introduce electronic computing?

MW It would be well into the 1950s.<sup>6</sup> The first programmes for the kinetheodolite<sup>7</sup> cameras were being used I would say by 1957: the [Hollerith] cards could be punched up automatically. The old read out machine would do all the punching up, but it would often take two or three tries to get it through [the computer]<sup>8</sup> because the mean error free running time I think was three minutes - and the programme took fifteen! So we had a few trials before it was right, but we did get them through and that was considerably better than, say, four weeks of hand calculating.

Then, in 1960 I think it was, they got the first IBM (see Footnote 8) and that was a whole new ball game. It was terrific. It tremendously increased speed. Read-out used to be running around the clock and the IBM could do [the same amount of work] in one shift or one and half [work] shifts. Of course, once people realised they could get more information brought up, it was running on three shifts too not long after!

KD Did the electronic computer ultimately supersede the female Computers?

MW Not until the Range was running down, because there was a tremendous build up of knowledge that was required [to fully process the trials data]. People realised that they could get this and that - and they could get it very quickly - [from an experienced Computer]. 'Can you give us this information?' There was always extra work to be done and the girls would have to prepare the data. [Even when] the original readings were done on automatic machines there was other work to be done: they would probably have to do perhaps some hand punching, or the tapes from the first primary calculations would have to be edited, because there often were errors. On a lot of the work, we did have to go back and do independent checks to see that there were no errors.<sup>9</sup> In the automatic readings, the girls did have to punch in the figures appearing on the dial: they could make an error and 99% would be okay, but there would be one error and of course it would stand out like a sore toe when you saw the results! Then, they'd have to run it through again and produce the tapes with a further analysis. We had to get the primary data [right] before it went onto the secondary analysis, as those tapes were sent off to England for the researchers to study.

KD The Computing teams were based in Salisbury, but I understand that the women went out to Woomera on a regular basis?

MW Oh yes, quite a bit, particularly in the early days. There was a shortage of operators for the instruments that had to be crewed at the Range, and the chief of our group<sup>10</sup> firmly believed that the Computers should know as much as possible about the trials [whose results they were processing] so the girls went up there. They saw the aircraft make the

<sup>4</sup> The Powerhouse Museum holds Friden and other mechanical calculators in its Computing and Mathematics collection. The Marchant calculators that replaced the Fridens at Salisbury were electro-mechanical, which made them both quieter and faster to operate and could perform a wider range of operations. They, too, are now museum pieces.

<sup>5</sup> Most rooms in the LRWE headquarters had bare wooden floors at that time: carpeting was reserved only for the most senior staff. The fact that carpeting was used in the Computing office indicates how severe the noise problem was.

<sup>6</sup> Miss Whitehead's recollection is somewhat incorrect here. As early as late 1951, a range of LRWE-developed Hollerith equipment had been introduced to aid in the computing and tabulation of some trials data. A number of semi-automatic data-processing machines were acquired by the mid-1950s and by 1957 WRE had developed some instrumentation fitted with data converters linked to a custom-designed digital computer, WREDAC. Miss Whitehead's comment is referring specifically to the introduction, around 1957, of the first programmes for automatically processing the kinetheodolite data directly to Hollerith punch cards.

<sup>7</sup> Kinetheodolites are optical tracking instruments that combine a modified theodolite (the telescopic instrument used by surveyors) and a recording cine-camera. They were widely used on the Woomera Range for tracking and optically recording missile and other weapons tests.

<sup>8</sup> The computer being referred to here is WREDAC (Weapons Research Establishment Digital Automatic Computer), one of only four digital electronic computers in Australia at that time. Developed for WRE by Elliot Bros., London, it was in operation by 1956 but was superseded in 1961 by an IBM 7090 computer. By the end of the 1950s Australia, through the work of the LRWE/WRE, led the world in the automation of data processing.

<sup>9</sup> Due to the relatively high turnover of Computing staff (most left within two years to be married) errors by inexperienced junior Computers were common and every calculation had to be checked several times for accuracy. There was an estimate that 'every kinetheodolite point was calculated twice and every piece of telemetry data perhaps three times'.

<sup>10</sup> George E. Hicks, first Head of the LRWE Bomb Ballistics Group.

trials, they talked to the pilots, they talked to the people on the instruments, they operated the instruments, and so they got to know everything that happened up there. The following week they would come back to Salisbury and analyse those records. Because they had been up at Woomera, they might find there was a sudden gap somewhere: we lost the bomb, or lost the aircraft, or there had been a bit of a power failure - they knew what had happened and it meant they could interpret those records.

This was a tremendous advantage and it was also a morale builder. They were doing these figures - and because they were bright youngsters they wanted to know: what is it all about? Where does it fit in? They went up to Woomera and they operated the instruments, in often not very comfortable conditions. They might be right out at a tiny little outpost and the wind could be very cold in winter and it could be scorching hot in summer. It wasn't easy going, but it was interesting and it really grabbed their attention. For some time I went up on every Woomera trip. Then, as some of the girls got a bit more experience, I would make sure there was one of the more senior ones there, just looking after them.

With the bomb trials, we would go up to Woomera on the courier [flight].<sup>11</sup> We always went by air then. Nowadays (1991) I think [staff] go [to Woomera] by bus, but it is a sealed road now. Anyway, we would fly up in the courier. They were Bristol air freighters and the seats were generally metal. Sometimes there were heaters in the aircraft and, if not, they would provide blankets - if they thought of it! We came home fairly frozen: it was a two hour flight. In the early days [of the bombing trials] the bombers were actually based at Mallala.<sup>12</sup> The Computers would fly up for the bombing runs [on the courier] and then come back on Friday afternoons, because we wanted to get in as many trials as possible. The courier left Woomera at about midday and we couldn't get back in [from the Range in time], so we used to come back in the bomber. That would land at Woomera [to pick us up] and then we were dropped at Mallala and took a bus into Salisbury. That was a bit different, because we would be sitting in either the navigator's seat, or back in the bomb bay, or right down in the bomb aimer's position. This was right in the nose and that could be a bit hair-raising at times. Particularly on one occasion, I remember looking out to the side and I was looking up to the top of the pine trees! But they were good pilots.

I remember the very first visit. It had rained a bit and I didn't know what to do with the girls [to occupy them]. I asked if they would like to go and visit one of the [construction] camps just<sup>13</sup> a few miles out and so off we went. The roads were slippery: I had never known roads like that! There was an Army lad driving us and I take my hat off to him. There would be a bit of a bump that would send the car into a skid and you would find you were facing the other way! That was a bit hair-raising.

KD I gather that, in fact, sending women to the Range was quite controversial in the beginning?

MW Yes. The Range was run by the Services, with an Army Brigadier, Neylan,<sup>14</sup> in charge. He didn't want women on the Range! Probably most of the men couldn't see that it was necessary, but, as I said, our chief had worked with the women Computers in England and he knew these girls were all interested. He believed it was better for them to go to the Range, and he was a man of great persuasive abilities: a very clever man and a good scientific administrator. Anyway, the Brigadier was very concerned.<sup>15</sup> He didn't want the young girls (and some of these youngsters, I think, were about 18) and he thought that it was better that they should not go into the Other Ranks Mess. You see it was all arranged in the Service style - the Officers Mess, the Sergeants Mess and the Other Ranks.<sup>16</sup> So Neylan said that the girls could be honorary members of the Officers Mess: but they only had limited access. We would have our meals there, but we had to be out of the Mess by, I think it was, 9.00pm or 8.00pm.

<sup>11</sup> Woomera was 480 km (298 miles) from Salisbury. Due to the poor nature of the access roads to Woomera, and limited rail services, surface transport from Adelaide to the Range was arduous and slow, especially in the early days. Air services provided the quickest, most reliable access to the Range and there was a regular 'courier' service operated by the Royal Australian Air Force, between Salisbury and Woomera several times a week, providing transport for staff. This service operated until 1955, when it was largely replaced by a commercial charter service.

<sup>12</sup> Mallala was the location of a RAAF training establishment which was assigned to support LRWE operations. It was about 50km (31 miles) north of Adelaide. Freight and courier services to Woomera operated from here until 1955, when they were moved to RAAF Edinburgh, in close proximity to Salisbury.

<sup>13</sup> Construction of the Village and Range facilities began at Woomera in 1947, but was not completed until around 1954. The construction workers were housed in a separate camp, about 3.2km (2 mi) from the perimeter of the Village itself. This camp was essentially a 'tent' city, with the workers tents actually pitched inside small, prefabricated huts.

<sup>14</sup> Brigadier E.M. (Tiny) Neylan was the Range Superintendent at Woomera from 1948-51. In overall charge of both the Range and the Village, he had been CO of the Australian Army Anti-aircraft Defence Command during World War Two. Woomera was administered by the Australian Armed Services until 1953, when its administration was transferred to civilian officials. The Range Superintendent, however, continued to be a military officer until the post was abolished in the 1980s.

<sup>15</sup> The conservative Neylan was very concerned about the 'moral safety' of the young Computers, in a situation where there were large numbers of unattached men and very few single women. Although he was eventually persuaded to allow the Computers to visit Woomera, in the early days he insisted that they wear Army dress during their working hours (hat, khaki shirt and slacks, heavy brogues and leather jerkins in cold weather) to discourage the amorous attentions of the men.

<sup>16</sup> The Mess system developed at Woomera due to the early administration of the Range by the Services. Civilian workers were assigned to one or other of the military Messes, depending upon their job status. Even after the transfer of the Range to civilian administration the Mess system continued, although a civilian Staff Mess was developed, as well as a small Mess for the growing number of single women, known as the Noorabalya Club. This system was still in operation in the 1960s, when a new, separate facility, the ELDO Mess, was established specifically for ELDO Project staff and their guests.

Our own quarters was one of those Army huts with a row of rooms, and I think there were two rooms at the end always [kept] for the girls going up there, because there was generally only about four that went up at a time. The Army nurses were at the other end<sup>17</sup> and there was one room that was set aside as a sitting room. The question of showers and toilets was a problem as there was no female ablution block. We could have our showers, I think it was between 4.00 and 5.00 in the evening, and after that the showers had to be free for the men. So we were all coming in from the Range pretty filthy dirty, but I know we had to be very slick about getting in and out!

Neylan wanted us to make sure we would go by the military rules. Well, I had four years in the Army and experience never goes amiss!<sup>18</sup> I knew the Army ways, and the things that upset them. We did everything we could to go according to the book and things smoothed over. The men were very good at looking after us in all sorts of ways and I think this is something which is perhaps different nowadays. One of my male colleagues went up there and said, 'Oh, I hate going to Woomera. For one thing, the language. How on earth do you put up with it?' and I could honestly say that I had never heard any bad language. They were very good, I thought, in that way and we found it interesting. We were well looked after. It was rather basic living, but we were all young and strong.

KD You were never at Woomera for more than a week at a time, or a couple of weeks at a time?

MW No I wasn't. I wasn't living there. Later on there were quite a lot of girls that were living up there. They had permanent staff on the Range who operated the tracking instruments, as well as all sorts of clerical staff. That was some years later and they set up a separate women's quarters.<sup>19</sup> Again, the long huts, but they had the bathrooms and toilets within the huts there. We didn't have to go out across the mud.

KD What were your working hours at that time, both at Salisbury and on the Range?

MW At Salisbury, I think it was something like 6 minutes to 9 to 6 minutes to 5, something like that, with a half hour break for lunch. At Woomera, during the bombing trials, we generally had to be out at the Range at 8.00am as a rule and we would have our lunch at one of the more central posts out there. We would probably get back to the Village somewhere about 4 o'clock. It was about an hour's drive from the Range to the Village and the roads weren't sealed in those days!

There was no night work in the early days, but there were night trials later, especially when the *Black Knight* and *Blue Steel* came along. However, there were these cameras<sup>20</sup> that had to be calibrated by taking photographs of the stars and that was done, generally speaking, in the summer months because the star patterns were better. But if something happened to one of the cameras, for instance if the air conditioning had been left off, well this might have caused distortions. These were huge, specially built cameras, so they would have to be re-calibrated and that meant going out probably, if it happened in the winter months, somewhere between 12 and 4 o'clock in the morning. It was pretty cold! It would take two girls six weeks to calibrate some of those cameras. Once we got onto the computers it took probably ten days to do all the readings. You couldn't get away from that, but then [the data went] into the computer: that made a big difference!

KD Do you recall any incidents of 'close calls' for Computing staff working out on the Range?

MW Well, we know with missiles that at times they didn't always go the way they should. Once, one sort of dribbled off the end of the launcher and then flopped to the ground and went spinning around and they didn't know what had happened. But there was another time, one went off and then veered off over to the right and the girl on the kinetheodolite, she was following and it was getting bigger and bigger! She went to dive into the trench that was built there as a safety and she found that it was full of the observers! There were a few cases like that. Again, the very first time we saw a bomb in the trials, the bomber came along one particular line. The big [tracking] cameras were right on the line and right behind them there was a tower for the observers to follow the bomb down with binoculars. I think there was a camera there, too. Somehow there was a hang-up and the bomb dropped about 50 yards away. They were watching it and realised it was coming really close. When they knew there was a hang up [from the radio communications] they went down that tower very quickly!

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<sup>17</sup> In 1949, the single female population of Woomera consisted of four Army nurses, ten typists and telephonists and thirty waitresses (working in the Messes and the construction camp). Army nurses worked in the military hospital at Woomera until the administration was civilianized in 1953.

<sup>18</sup> Mary Whitehead worked as a clerical assistant in the Australian Army Medical Service from 1941-45.

<sup>19</sup> Permanent women's quarters with their own ablution facilities were first established in the Woomera Village in 1952.

<sup>20</sup> The ground speed cameras used in the Bomb Ballistics trials. These cameras were used in pairs to measure the bomb release point and aircraft ground speed by triangulation. They were calibrated for lens distortion and other anomalies by means of astronomical images photographed by the cameras. The star plates produced were then analyzed in detail, with the precise location of each star measured and compared to known astrometric data.

There were no casualties out on the trials that I know of. There was a casualty in one of the shops<sup>21</sup> where they were preparing missiles and evidently housekeeping not quite as good as it should have been. The missile that was being mounted on an aircraft fired up. There was one man injured and another one, I think, was killed. That happened when I was over in England and of course we heard about it over there. I think it even made the papers. As far as I know that was the only [fatality]. They had a Safety Officer there who was an Army colonel, who had left the army and gone straight onto permanency as the Safety Officer.<sup>22</sup> The contractors used to perform about him being so strict, but I think probably he saved many lives. He made sure there was good practice and there was good discipline in keeping those practices in the workshops, so there were very, very few accidents.

KD Neylan was obviously concerned about having a small number of young women in what was pretty much an all-male environment. Were there any real problems in the early days? Did you find the girls actually required chaperones?

MW I tended to [act the chaperone] a bit, but that was in the first year. It wasn't to say somebody couldn't go off to the film shows that they did have there. They would generally say, 'So and so wants to take me off to the film'. I knew they couldn't go far because there was the question of transport and I had a pretty fair idea of where they all were. I don't think I ever said to anyone, 'Don't you go out with that person' or anything, but they were very circumspect because I had been told, 'You have to behave very well when you go up there'.

It could have been quite a situation but, looking back, I think in many ways a lot of men treated the girls as their young sisters. Perhaps I was being utterly naive, I don't think so. I think that, later on, there were occasionally problems but nothing very dangerous. I think it was more that I found that there would be a bit of gossip going at times because [some girl] wore a very tight sweater, etc., which would particularly shake the girl. This, I regret to say, was from some of the Army [nursing] sisters. I think that probably the trouble was that Army sisters have generally always been in a pretty privileged position in any Service set ups and here were some other women there who were not under their control to do as they were told.

KD What were your relations with the Army nurses like, generally?

MW I think they felt that we should do exactly what they told us and that was something I took a strong stand on. It did cause some trouble, and perhaps I should have been more tactful, but I did what I could. Sometimes there had been a night trial on the missile range, or the trials had been cancelled and anyway, the girls would come in, and as soon as they went into the room, if the senior Sister was about, she would say, 'You must not make any noise whatsoever. You may only speak in whispers. There are night Sisters who are trying to sleep'. I had heard this from the girls a few times, though I hadn't been [there]. But one time when I was up there, I heard this happen again. The girls hadn't been noisy: I had been in the room next to them. I am afraid I said my piece and evidently I annoyed the lady very much - and the next thing I knew there was to be a conference to try and sort things out between [the nurses and the Computers] which made me even more irate!

As I said, it sorted out. It was a case of I think I got the point over, but we were all in the same situation. They had some odd hours, some of ours had some odd hours. I was able to speak with feeling, I remember, because [on one occasion] when I had a head cold I would go out onto the Range and come back and flop into bed and try to sleep it off. There was plenty of noise from the Sisters' sitting room, but I was used to camp life and I thought, 'Well, that is the way it is'. I thought they would also be used to it and they should put up with it!

KD Did you mix much with the wives of the Range staff?

MW We didn't see a great deal of them, unless occasionally we would happen to know some of them, and we would go over to their houses. Or it might be that the man of the house might have been working with some of the girls and his wife would say, 'Well bring them over here for a night away from the Mess'. This we thoroughly enjoyed. I don't remember any scratchiness there: now I am talking personally. In fact, most of them seemed to be very nice women. It was a different life [for them] and they mightn't have had all of the excitement that the people working on the Range itself got. Of course later on there were quite a few young married couples would go up there and the man was on the Range somewhere and the girl could probably get a job [on the Range or in the Village] in clerical work, administrative or in the canteens.

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<sup>21</sup> This incident occurred on April 19, 1956. A Blue Jay missile, mounted on a Sabre aircraft in Hanger 3 in the Woomera Technical Area, suddenly ignited and launched while the aircraft's launching circuits were being checked. Two De Havilland team members standing by the missile when it launched were the most serious casualties: one was killed, the other badly injured. Other people in the vicinity were severely burned.

<sup>22</sup> Miss Whitehead is referring to the Range Safety Officer, Ed Goodwin, an English-born Australian, who had formerly been an RAF Squadron Leader, not an Army Colonel, as she described him. Goodwin had had a long career in explosives and dangerous materials handling even before coming to Woomera.

KD Apart from the nurses and the Computers, what sort of jobs were there for women in the establishment at Woomera?

MW Well in the construction camp, there had been women in the canteens: they were there earlier than we were. Later there was a school teacher, clerical staff: there was a girl who was an assistant in the Meteorological Office. She was a Computer too, actually one that had been a Computer at Salisbury. She married an engineer who was transferred to Woomera and they welcomed her with open arms as a trained Computer! There were quite a few kinetheodolite operators. When the hospital was no longer an Army one, there were quite a few nurses and I suppose what would now be called domestics and nursing aids. There were a few women who served in the messes.

KD Did you find, in your early days at Salisbury, that you were a fairly rare breed, as a female mathematician?

MW Yes. When I went to Salisbury, in January, 1949, I was the only woman on the professional staff in any direction. Later that year, about October I think, there were three other women, also mathematicians, who came to join the computing teams.<sup>23</sup> There was one from Western Australia, two from New South Wales. Later some Queenslanders came.

KD You don't recall there being any women in the engineering field or any of the professions?

MW There were no [women] engineers [at Woomera]. There were no women scientists apart from the Computing officers. It was only in the later years, I think it would have been the 1970s, that there were women in the engineering section. At Salisbury, there was a woman in the missile division. Her basic training was chemistry. She started as a Computer and went through and got her degree. There was another one that went through and got her degree in mathematics. She is still working out there (1991) as a research scientist and is doing a lot of the simulation work I think. The third one that went through, she did bacteriology and so parted company with weapons. She went to England and Germany. She was working in Bonn for quite a while and then married a chap in the Swiss Diplomatic Corp so the ex-Computers get around.

KD As the senior woman on the Computing team, did you find yourself in the position of having to 'stand up' for your junior Computers, or look out for their interests?

MW One of the early occasions where being the senior woman had to come in was during the coal strike [of 1949]. There were great restrictions on electricity and we were not allowed to use radiators, even in the depths of winter. Because of the conventions of dress, women were not allowed to wear slacks to work, but in this case I went to the Chief Administrative Officer and pointed out that it was extremely uncomfortable and cold. I obtained permission for the girls to wear slacks to work. He was a trained administrator and everybody said he was a very hard man. I found that if you put up a [strong] case to him, I don't think I ever got a knock back.

Another case was when the [men's and] girls' hostel accommodation was getting tight and they were going to toss the girls out [to make more room for the men]. I protested about that. I said the girls had less pay than the men and they would have the extra expense of travelling: why not toss the men out? That didn't go down so well, but they did find accommodation for the girls. I found myself getting into these sorts of situations, where I had to be the spokeswoman for the other women in the Establishment. Sometimes it worked and sometimes it didn't. A notable failure was when, some years later, I tried to get a crèche out there for the married women workers. This was back in the late 1960s. We did a survey on the Establishment and there were about twenty women that would have been very glad to have those crèche facilities, but no way.

KD As a Computing team leader, how did you find that your pay scales compared with those of the men who would have been on an equivalent grade?

MW There was a standard difference between the basic male award and the basic female award.<sup>24</sup> Although my pay was good, as a professional I was always paid less than the equivalent of a man in the same job.

<sup>23</sup> Miss Whitehead's memory is again slightly at fault here. The three Experimental Officers who joined LRWE in October 1949 to run the Computing team for the Test Vehicles Group consisted of two women and one man.

<sup>24</sup> The standard difference between male and female wages in Australia was that a woman would be paid at two-thirds of the male rate for the same work. Consequently, the female Experimental Officers were being paid two-thirds of the salary that their male counterparts received.

KD I understand that, in fact, a special award category had to be created for the female Computers?

MW Yes, there was a great need for it, because Salisbury was a long way out of town in those days.<sup>25</sup> We could go by train but, because it was so hard to get cars - even if you could afford one - they had to do something to attract the girls to do that hour's travel each way every day. They created this special award<sup>26</sup> and the result was [that] we could get these people, particularly after there was an advertisement for them. We got girls of very good character, too. They were of an extremely high standard because the pay was so good. It was way ahead of girls working in banks, which was probably the most respectable of the clerical jobs for women.

KD Did you find that any of the girls coming into the computing positions had any intentions of making it a career, as distinct from a holding pattern until they were married?

MW Yes, there were some. In the early days, they knew that if they did a university subject, Maths I and [then] Maths II, they could get a higher rate of pay. Quite a few did do that, but I think most of them married before they went further. There were some in later years that did go through to get their degrees.

KD Of course, at that time it was still considered the normal thing for a woman to get married. Did many of them find husbands among the Woomera or Salisbury staff?

MW Oh, a lot - yes there were a lot of marriages. There were some girls who were living out [at Salisbury]. There was a horrific shortage of accommodation everywhere and they had a hostel there for the men, in one building. Then the girls needing accommodation were also accommodated out there and I think all those girls married either men at the hostel or others around the place! We generally thought that if we kept a girl for two years we were lucky - and in those days, of course, they lost their permanency as soon as they were married.<sup>27</sup>

KD Well, the assumption was, I guess, that as soon as you got married you were going to get pregnant?

MW Yes, it was like that. We were able to keep them on temporarily, until the girls did in fact start having a family. There was no maternity leave: none at all. If you got pregnant, you left. They were only temporary employees by that time. We had to make a case for every girl to keep her. If a single girl could replace [a married one], we had to give her priority. The contractors<sup>28</sup> out there, and there were a number of them, relied on being able to recruit for themselves the Computers who married.

KD I see. The contractors waited until WRE threw them out, as it were, and then snapped them up?

MW Yes, because there was this shortage [of trained computing staff]. Otherwise the professionals were doing their own computing, but if they could get a lass who was trained in computing work and [already] in the system, she was invaluable to them. [And] if the girls from Salisbury wanted to travel, if they wanted a job, say, at De Havilland, or Bristol Aviation, they'd grab them in England very quickly. When I went over [to the UK] myself I could have had a choice of half a dozen jobs, because I knew the Salisbury set up. It gave us an open door. There were three girls that went before I did and they walked into jobs straight away without any trouble. Evidently the reports that went back to England [from the contractors in Australia] were that they were of good standard, so there was no trouble whatsoever [in finding work].

KD Did that sort of same open door apply in the United States?

MW No, that was a different matter because you would have to get work permits and all sorts of things. I don't know of any girls going over to get jobs [there]. But I know that some of the men were offered jobs when they went over

<sup>25</sup> Although suburban sprawl has now connected Adelaide with Salisbury, in 1949 it was a small rural township, an hour's ride by train from the capital. As long-distance commuting was virtually unheard of then, a special traveling allowance was included in the Computing award to entice young women into the work by covering the cost of the commute.

<sup>26</sup> Establishing a pay scale for the Computers had been an initial problem, as the Commonwealth Public Service would not accept the LRWE recommendation to pay them at the Laboratory Assistant's rate. A Public Service Inspector was eventually appointed to enquire into the pay scale question and, in his report, actually suggested an even higher pay scale! This did not suit LRWE and a compromise was eventually reached, establishing a special pay scale that was essentially equivalent to the that originally requested, but with the added bonus of the travel allowance included.

<sup>27</sup> Commonwealth Public Service regulations until the 1960s required women to be dismissed upon marriage. Although a married woman might be hired/re-hired on a casual or temporary basis, there was no provision for maternity leave and a pregnant woman was immediately dismissed.

<sup>28</sup> The British and Australian firms involved in the operations at Woomera maintained offices and facilities at Salisbury and/or Woomera. They also required Computers to analyze their own trials and other research data. As private companies they were not bound by Public Service hiring rules and were happy to employ married ex-WRE Computers, since it meant that they could obtain skilled Computing staff without the expense of training them! They also offered a better rate of pay than the Public Service for equivalent positions.



there, and one or two did take them. A man that was in charge of all of the launching of missiles at Canaveral was an Australian who had gone over there on an exchange and got an offer too good to refuse!

KD How did you find working in what was primarily a male professional environment?

MW On the whole it was very good. It would often be a bit of an initial surprise [to the men], but I think it was helped by the fact that, in the very early days, there was quite a large proportion of British scientists [who] came out to set up the general missile range. They had been used to having women working in the Computing field in England during the wartime. Because of that, I think that they gave us a better run, and the Australian men seemed to follow along. The Services found it a bit hard to take at times, but again, once they got to know what we were about, we were taken on our merits, I think.

KD So you found you were generally treated with the same professional courtesy that one man would give another in the same field?

MW Yes, I would agree with that: they were very good in that respect. The only problem was with the system of sending graduates in science, maths and engineering to Britain to get experience in defence science. I heard of various people applying and I knew my qualifications were as good, so I applied. But what I didn't know was that the Chief Defence Scientist had made the rule: 'No Women', so I was wiped completely!<sup>29</sup> The men who went on those scientific training exchanges got a tremendous boost to their careers by getting that training. A woman who had topped the Physics School at the University of Sydney was also treated in the same way.

KD So you found that opportunities for advancement within your career were not being offered to you?

MW Not to women, in those days: that was the general feeling. It was pretty annoying and there was also the question of the pay. A few years later, when I had gone up one grade, it was still very hard to get science graduates. I found that they would bring in [male] raw graduates at the top of the base grade and then I would have to turn around and train them - yet they were getting more than I got, because of this differential between male and female workers! That was so frustrating that I joined the Professional Officers Association.<sup>30</sup> That was a bit of a surprise, too, for them to have women there. I think there were probably a couple of hundred men, mainly Post Master General's Department engineers, and there were five of us women from Salisbury that joined. We were very much out-numbered!

KD Did you find that the Association did anything to assist the women in their careers, or were you again just disregarded?

MW I don't know that it did really. Certainly I put up the question of equal pay and they all agreed that we should have equal pay and they would bring it up at their conferences. But I think it was rather like all the political parties: it was all on their platform, but none of them ever did anything about it. Some years later, I made a comment that, if they were not going to do anything, I would resign, and I did. However, I did rejoin later when there was a big push on to get professionals a decent recognition of their qualifications, and I did stay with them. By that time, in the 1960s, the climate was beginning to change.

KD Did your routine change much when the LRWE became the WRE?

MW I still went up to Woomera, though not so much, although I might go up for a week at a time, over several weeks, working on different trials. But my work was mainly in Salisbury. Then I went to England on a working holiday - that was 1955-56.

KD Did you use this as an opportunity to further your own professional experience/training?

MW Yes. There had been a proposition that there should be an exchange of British and Australian scientific personnel, which would include a couple of women. The woman from England, who had done similar work [to myself] and was a really brilliant mathematician,<sup>31</sup> was to come out here and I was to go to her place of similar work in England.

<sup>29</sup> This 'rule' does not appear to have been an officially stated policy, but an unofficial decision 'by a very highly placed officer', believed to be (certainly by Miss Whitehead) Dr. William A.S Butement, Director of Scientific Research, UK Ministry of Supply (1940-46), the first Chief Superintendent of LRWE and then (from 1949-1966) Chief Scientist of the Australian Defence Scientific Service of the Department of Supply. Whoever was responsible for the decision, it remained the standard practice with regard to travel and exchange opportunities for female WRE staff until the end of the 1950s.

<sup>30</sup> The Professional Officers Association was the trade union for professional staff in the Public Service (usually technical personnel) who were not covered by other trade unions or the various Public Sector unions for clerical staff. The branch that Miss Whitehead joined had a large membership from the Post Master General's Department (PMG), which was the Australian postal, telegraph and telecommunications agency.

<sup>31</sup> The woman being referred to is Win Lloyd, an experienced RAE data analyst who developed 'Lloyd's Law', a formula that allowed

It was all arranged and she was on her way to Australia and then I was told, six weeks before I thought I would be going, that the Australian Government wouldn't send a woman! So, six months later I decided to take my long service leave and go to England. In early '55 I had been doing more planning of trials and had established contacts at the Royal Aircraft Establishment, which of course commissioned a lot of the trials. So when I went to England I got work with the RAE.

It meant a big difference to me financially, because I worked as a temporary employee of the British Government at about two-thirds the salary that I would have got in Australia. I also did not have the support that the people who went over on these traineeships received: they got all sorts of living allowances. It was, as I said, very different financially there, but it was worthwhile. It was a good experience and living in England I was able to do quite a lot of touring around.

KD What did you do after you returned to Australia?

MW When I came back I was working pretty well all the time at Salisbury. I was working on some instrumentation assessments and then, about 1957, there was a problem with trying to get a production line of work going through the read-out computer. So I was taken off my other mathematical work and set to this task. I was on it until about 1959 and had got to the stage where the production line was working alright and I was doing some [computer] programming. Then I was called back to work on the *Black Knight* trials.

KD Did you go to the Range and see these launches?

MW Yes, I insisted on it. I would make a point of going up to each trial even though the planning and computing work was done at Salisbury. If you are there when it happens, often the human eye will pick up something that the instruments won't. For instance: on a normal *Black Knight* launch, the rocket would go up and disappear from view and about 15 minutes later it would start coming in again. We knew approximately where to look in the sky to look for it. On one occasion, at just about the right time and in the right place, but in a completely wrong direction, a meteor went across. It threw everyone. And then an American observer said, 'It's a Goddam meteor', which broke everybody up! But the point was, if I had got those plates back with the star images and two streaks, I would have thought: which way are we going? What is this? Because somebody might have told you what happened, or they might not.

So being on the spot was important to get the feel of the information. Often the missiles broke up a bit as they came in, so it was necessary to try and remember all those things and to relate them to the images that you saw on the camera plates. It was important; it was also very interesting.

KD What did you think about being involved with that programme: did you find it a very exciting project?

MW I think I was fortunate to be involved in such interesting work. I was always learning. It wasn't just the mathematics and doing all the formulae, we had to liaise with the meteorological people to get the temperatures, pressures and hence the density of the air, and hence the refraction - because the refraction of light through the air was quite important in these trials. It was the accuracy we were after. We had to liaise with the surveyors. They were on the spot to do very highly accurate surveys, because I learnt there was an error of some minutes of arc in the datum from Sydney from which all the surveys across Australia had been taken. This was enough to make a mess of our [trajectory] calculations. There were still some biases and I didn't find out what [was causing them] until I went to America where I found that they had had some similar problems.<sup>32</sup>

KD When did you travel to the United States? Was this official travel, under the auspices of the WRE?

MW This was about 1960. It was an official trip to the Smithsonian Astrophysical Observatory because we needed to get a bigger star catalogue than the one we had [available].<sup>33</sup> I also had to go to Aberdeen Proving Ground, outside Washington. There was a man there that had really devised the mathematics for using these cameras with the astronomical background.<sup>34</sup> He used them as markers, just as surveyors used markers, and he set up the mathematics of

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the reconstruction of the complete trajectory of a bomb with great accuracy.

<sup>32</sup> Miss Whitehead has reversed the sequence of events here. In the 1950s it was discovered that there was a minute, but persistent, bias in missile trajectories that were calculated based on observations taken from two Range posts distant from one another. This puzzle was solved during her visit to the US when it was revealed that they had discovered the cause of this type of bias. The discrepancy was the result of tiny gravitational field fluctuations caused by the buried roots of ancient mountain ranges, which were of very dense rock. A special survey was therefore carried out after her return with this information, in order to establish the gravitational variations across the Woomera Range and incorporate this data into trajectory calculations to eliminate the bias.

<sup>33</sup> This was required for use in the calibration of the WRE-designed and built KF3 ballistic cameras that were used for trajectory determination during the Black Knight programme. These cameras were star calibrated each time they were used, ensuring high precision data.

<sup>34</sup> This may have been in connection the operation of the Wild BC4 cameras that were used in conjunction with the KF3 cameras during the Black Knight trials and provided even higher measurement precision.

that. I had to see him and another chap, who I think trained under him, down at Patrick Air Force Base in Florida.<sup>35</sup> I also went out to White Sands Missile Base.<sup>36</sup> I didn't see any missile tests there, but I was talking to a man that had done quite a study in the refraction of light through the atmosphere: it was a somewhat similar climate to Woomera. I also went to the university which did the data processing for them. I got a lot of useful information from there and that was an exchange really.

KD While you were in the US, did you have the common problem of not being recognised as an Australian?

MW Oh yes! An Australian was rare; an Australian woman was very rare, and they didn't know what to make of me at times - but they generally assumed that I was a Brit. There wasn't enough difference between the Australian and British [accents] for them to recognise, unless I was talking for a bit. A story of the time I was in Florida: one of the Air Force men that was my official escort there said, in the usual chat while we were driving around, that he belonged to a choral group. He said their leader introduced them to *Waltzing Matilda*, but he didn't know what the words meant. And I looked at him and I was stunned! He said, 'Would you go through the first line'. So I started, 'Once a jolly swagman' and he said, 'What's a swagman?'<sup>37</sup>... 'Camped by a billabong', 'What's a billabong?' and it went on from there! 'What's a coolibah tree?' 'A jumbuck?' And so on! So I consulted for him. It was just an interesting example, I suppose, of some of the Australian vocabulary that they don't know about. When I was up in Boston there was a man there who had been at Salisbury, and was over at the Smithsonian. He had taken me out to have dinner with some friends of his. At one stage they said, 'You know this is infuriating. You and John can understand us, but we can't understand you and John when you are talking together'!

KD When you were in Florida, did you meet any of the astronauts?

MW Yes, I met one while I was there. What happened was, I had been working with this team [at Patrick AFB] during the day and they said, 'Come out and have a meal'. They invited along one of the astronauts as well - I think it was Gus Grissom.<sup>38</sup> It was very interesting.

KD How did you find the professional relationship between Australians and Americans working on the Range and when you went to the States?

MW They couldn't have been kinder. Again, I think I was the first woman to have gone [to the US] from Australia and they were very good to me. I had the security clearance and everything else had been pre-arranged. Apparently the American Embassy was quite pleased: they said that the whole thing had all been planned beforehand and they didn't even get last minute requests and so on. That was perhaps more luck than anything else, but it was an interesting experience.

KD How did you find the co-operation of the Americans as compared with the British?

MW The Americans were very good. The only time [my presence] was queried was when I made my visit to Patrick Air Force Base and when I was being taken around there I was always escorted by one of the Air Force [officers]. When I was working for the Brits in the Royal Aircraft Establishment, there was only one time [I had] a problem. There was some data that was not at Farnborough: it was in one of the offices in the City and I was sent up to take a look at it. When I [arrived] the chap heard my Australian accent and he said, 'I can't show this to an Australian'! The Australians

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<sup>35</sup> Patrick AFB was the home of the USAF Missile Wing which operated the Long Range Proving Ground (later Eastern Test Range) at Cape Canaveral. This missile and rocket launch facility was the launch site for the first manned US space missions, prior to the construction of Kennedy Space Centre. Miss Whitehead may have been visiting Hal Morris, who was the Data Processing Engineering Manager at Patrick. He had previously visited Australia in 1957 and been impressed by the advanced level of data processing at WRE.

<sup>36</sup> White Sands Missile Range was the US Army's missile testing facility in New Mexico. It had been the original testing ground for captured V-2 missiles after World War Two, under the supervision of Wernher von Braun and his team of German rocket engineers. It was environmentally and climatically similar to Woomera and employed many of the same type of tracking instruments.

<sup>37</sup> *Waltzing Matilda* is a popular Australian folk song, often considered the country's unofficial 'national anthem'. The first verse begins 'Once a jolly swagman/camped by a billabong/under the shade/ of a coolibah tree...' The second verse begins with the line 'Down came a jumbuck/to drink at that billabong...'. The uniquely Australian terms that confused the American officer are here defined: swagman-a tramp or hobo who carries his possessions on his back, wrapped in his swag, or bedroll; billabong-a waterhole near a creek or river, often only containing water after a flood; coolibah tree-a species of eucalypt (gum tree) common in flood-prone inland areas; jumbuck-a sheep.

<sup>38</sup> Captain Virgil I 'Gus' Grissom was the second American in space, as pilot of the Mercury MR-4 mission on July 21, 1961. Commander of the first manned Gemini mission (GT-3) he later died in the Apollo 1 launch pad fire in January 1967.

were in very bad repute with the Security people<sup>39</sup> and this old chap evidently had the idea that Australians were no good at all. He finally rang back to Farnborough was told [that it was alright for him to give me the information]!

KD When you returned to Australia after your US trip you continued working on the Black Knight?

MW Yes, I worked on the *Black Knight* project and later the *Blue Streak*. It was interesting because, with so many people involved, they all had to be very highly organised with the information they required. A lot [of the trials data] went through an automatic processing - like the trajectory, which was calculated by radar. But they needed much more accurate trajectory data both on the ascent and then on the re-entry and that is where the cameras came in. By this time, of course, we had the computer programme written. The girls still had to do all the reading and make measurements on the plate but the programmes had been set up. The reading machines were Zeiss comparators<sup>40</sup>, which could be [accurate] to a millionth of a metre. I didn't do the actual programming of it but I did the mathematics. They had to tie in the atmospheric details as well as the survey details. We had to make all the fine corrections, if there were any distortions of optical systems and so on. They all had to be fed into the computations.

KD What was your involvement with the Blue Streak/Europa project?

MW The zig-zag pattern on the *Blue Streak* - that was at my request, because we were required to know whether the missile rolled as it went off [the launcher]. There were, I think, three or four cameras - they were called launcher high speed cameras - around [the launch site], so with that pattern, if the rocket rolled you could measure it really easily, depending on where that diagonal was relevant to the top and bottom stripes.

I had seen the black and white checks that were [used] on other missiles, I think that might have been in America, and this was the same sort of thing. But making a continuous line like that, you could measure to a degree whether or not it had rolled: as far as I know, I don't think they did.

KD Did you ever have much contact with the NASA people in the early days, with the set up of the Minitrack system or later with the other tracking station?<sup>41</sup>

MW No, I didn't have much to do with that. I might [go to] see the stations, just as a looksee - to see what they were like - but unless their records were coming through [the Computing section], it was not my business. Generally at WRE if you needed to know something, okay you could go see and talk to people; otherwise you were not encouraged to do it. There were people in the building next door to where I was [and] I didn't even know they existed! Things were on the need to know basis and if they were on different work, you didn't need to know - and that was it.

KD Then generalised mixing wasn't really encouraged?

MW Well, there was nothing to stop you talking to people, but you didn't discuss your work unless it was something of mutual interest: that is what it amounted to. Perhaps there might have been more [broad-ranging discussion of work] among the men.

KD Did you ever find security precautions oppressive or offensive at any time?

MW No, I don't think so. We had to have our passes, to show our pass to get in [to Salisbury or Woomera]. About 1960, they decided that we must always wear our passes: people thought, 'That is a bit of a pill' and I think a lot went through the washing machine at home! We were told that the pass would be a plastic clip which would clip onto your clothing. Well that is fine for the men, since it clipped onto the top [shirt] pocket. But for the girls....Well, the part holding the pass was plastic, but the part that clipped onto your clothing was metal and could pull threads [in the cloth]. I said [to the security people], 'That won't suit the girls. And they don't always have a top pocket'. Came the day that we had to [start wearing the passes] and I went off up to the top Security chap. I was wearing a dress, sort of polo neck thing, no belt. Another lass was with me, similarly dressed. I said, 'Where do we put our clips?' I asked for chains [to

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<sup>39</sup> Due to its previously lax approach to security (which was to change significantly between 1949 and 1952), as well as other factors, Australia had a bad security reputation with both the UK and the US for many years. In 1948-49 the US embargoed Australia from receiving any classified intelligence information and forbade Britain from passing on US intelligence information to Australia as a 'third party'. The taint from this embargo obviously lingered on for some time in the UK.

<sup>40</sup> Comparators allow for two image plates to be set side by side and examined together, in order to compare the two images and identify any differences between them. In the Black Knight trials, the camera record plates of the Black Knight re-entry would be compared with the calibration star-field image taken after the trial in order to determine the exact trajectory of the rocket.

<sup>41</sup> The US Navy established the global Minitrack network in order to track the Vanguard satellite, launched in 1958, and a Minitrack station was installed at Range G at Woomera in 1957. With the establishment of NASA this satellite tracking network was transferred to its control. Later, in 1961, NASA established its first non-US Deep Space Tracking Station, for lunar and planetary probes, at Island Lagoon, about 27 km (17mi) south of the Woomera Village.

hang the passes from] and he said, '[If you want chains] there is nothing to stop you buying them and putting them on'. So we got them!

KD Did you have any involvement with the WRESAT project at all?<sup>42</sup>

MW Oh yes. I did work on that. I did the data processing to get the trajectory, to validate that it went where it was supposed to. There was also a lot of telemetry processing.<sup>43</sup> I was overseeing that, but there was another lass, a professional [in that field] that did the detailed work on the telemetry. That took a few months to do, as well, as I remember.

KD What programmes did you work on in the later part of your working life at WRE?

MW The last *Blue Streak* [*Europa*] launch was my finish with the [trials] data processing. I did a survey of instrumentation accuracy, which personally I thought was a waste of time. I was on that for a couple of years. My last six or seven years I was doing work in the library. They had just started to really get going with [library] information data bases and they set up a link to the data bases in California - Dialogue was the [main] one. There are several others now (1991). I was working on that, doing searches for people in the Establishment, and when later other library staff became trained on that, I did some programming to really simulate Dialogue programmes so they could be run on the computer at Salisbury. The idea that the people could learn [to use Dialogue] on the Salisbury computer, without taking up OTC costs.<sup>44</sup> The last programme I did was sort of a housekeeping programme for the library, so that they would know what data bases were being accessed and by which division in the Establishment. I actually retired in November, 1982.

KD Mary, one last question. Working on projects at a place like Woomera, did you ever have any interest or desire yourself to go into space?

MW Oh yes, there was the interest. It would be wonderful! But I think I was a bit old by the [time spaceflights began]. I thought that it would be physically beyond me because I would have been well into my 40s by then and I don't think I would have been able to take the physical stress to get into the physical condition!

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<sup>42</sup> WRESAT was Australia's first satellite, developed by the WRE and the University of Adelaide and launched from Woomera using a spare US Sparta/Redstone rocket on November 29, 1967.

<sup>43</sup> This small scientific satellite carried fourteen separate instruments (which were a continuation of sounding rocket work done by Adelaide University) and also sent back telemetry on 15 different 'housekeeping' functions. Telemetry was received at NASA STADAN (Satellite Tracking and Data Acquisition Network) stations around the world and returned to Australia for processing. The satellite functioned until January 10, 1968.

<sup>44</sup> OTC, the Overseas Telecommunications Commission, was the Australian Government agency that maintained Australia's international cable and satellite communications links. Miss Whitehead is referring here to the cost of using a cable link to access the database in the US.