DSS 42

Tidbinbilla's forgotten role in the Apollo Program

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July 2019

Preface

The Apollo program is considered by many to have been man's greatest technological achievement in his long history. It was a defining example of his insatiable quest in trying to understand his role in the universe. Although it was as Armstrong said as he stepped onto the Moon –

"That's one small step for man; one giant leap for mankind".

it was but the first of many ever more far-reaching steps he will need to take to satisfy his curiosity as to what is out there in the vastness of space, where it all came from and why it is there?

Much has been written about Apollo. Virtually all of it has been in the nature of scientific and technical papers. Here in Australia it has focussed on the role of Honeysuckle Creek, the 'Prime' Apollo station in Australia, and to a lesser extent, Parkes Radio Telescope.

The role of Tidbinbilla rarely gets a mention. Now, as the 50th anniversary of the first landing approaches, it is an appropriate time to correct this.

This short record is not intended to be another rigorous scientific or technical work detailing DSS 42 Tidbinbilla's day by day operational role in Apollo but rather the personal account of some of the personnel who played a part in it. It has been compiled from recollections they have managed to extract from their now fading memories, notes they made of the events they were involved in at the time and scraps of memorabilia they have saved. It is hoped that they adequately describe the skills and dedication the staff of Tidbinbilla had towards their 'jobs', and goes some way to recognising their significant contribution to the success of the Apollo program.

Acknowledgements

This account of Tidbinbilla's role in Apollo has been compiled primarily by three of the Tidbinbilla personnel John Heath, Bruce Window and Mike Dinn, who contributed in one way or another to man walking on the Moon. Several others have also contributed materiel and where appropriate, they have been acknowledged.

Brief biographical details of the main contributors are -

John Heath was one of the original SpaceTrack Pty Ltd engineering team set up under Bob Leslie in July 1963 to operate the soon to be built Deep Space Tracking Station at Tidbinbilla. His responsibilities initially were associated with the microwave systems but this was expanded in 1965 to include the transmitter system and in 1967 to include all of the RF systems. In 1967/68 he played a major role in upgrading the RF systems at Tidbinbilla for the upcoming Apollo Program.

Bruce Window had an extensive involvement from the early days of Australia's support of the USA's space programs. He commenced his space tracking career at Minitrack, Island Lagoon near Woomera in 1962 where he worked as a technician for the Weapons Research Establishment. He left WRE and joined SpaceTrack at Tidbinbilla in 1964 and in due course became an Operations Team Supervisor involved in the Apollo program.

Mike Dinn, was employed by the Department of Supply (DOS) as a Deputy Station Director and during his time with the Department he was involved in the day-to-day operational role of the DSS 42 and Honeysuckle Creek tracking stations. His responsibilities also included dealing with high level issues relating to the overall management and operation of the station that arose between Australia and the USA.

Introduction

The Apollo Program was for many, mankind's greatest technological achievement; one that captivated the entire human race as no other had done before. Man had long imagined leaving his native Earth and travelling to other worlds and Apollo was the first time he had succeeded in taking his first meaningful step to fulfilling his dream.

The Apollo Program came into being when the USA decided it would commit its extensive scientific, engineering and industrial resources to putting a man on the Moon and bringing him back safely to Earth.

The task and everything about it was remarkable from the complexity of the spacecraft, the sheer size and power of the 3-stage Saturn rocket that took it to the Moon and back again, to the extensive networks set up here on Earth to communicate with the astronauts throughout the mission.

In its launch configuration the rocket stood 110.6 metres (363 feet) tall and weighed 2,970,000 kilograms (2,920 tons). At lift-off it developed over 7,891,000 lbf (35,100 kN) of thrust.

Configuration of the Apollo Spacecraft

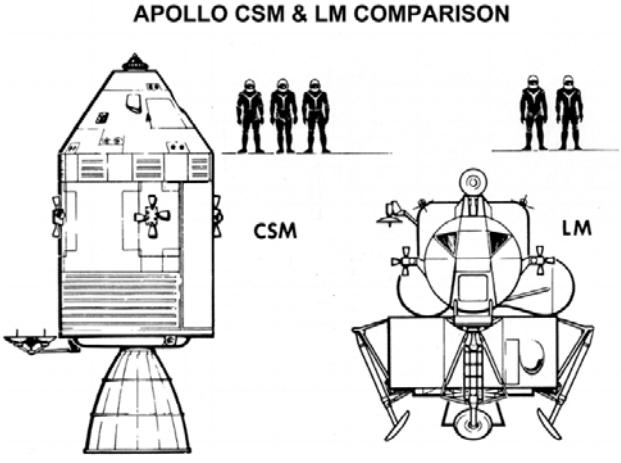
The Apollo spacecraft was in effect a combination of several components each designed to undertake specific functions that were essential to the overall mission. It comprised two main components - the Command Service Module (CSM), which took the three astronauts to the Moon and back to Earth, and the Lunar Module (LM), which was used to transfer two of the astronauts to the Moon's surface and return them to the CSM. The CSM itself also comprised two main components- the Command Module (CM), which was where the astronauts controlled the spacecraft from, and the Service Module (SM), which basically comprised the third stage rocket motor that took it to the Moon and back to Earth, and miscellaneous equipment required to support the astronauts throughout their trip. The LM too comprised two main components – the complete vehicle that landed on the Moon and the vehicle that returned the astronauts to lunar orbit to rendezvous with the CSM for their return to Earth. The CM also comprised the Re-entry Vehicle that enabled the astronauts to survive the final stage of their mission of re-entering the earth's atmosphere and landing safely in the ocean.

The general arrangement of the CSM and the LM are as shown in the diagram -

The CSM was designed to support the three astronauts for the nominal ten days the overall mission was planned to take. The smaller LM contained everything needed to support two astronauts for 4 to 6 days, which was appreciably greater than the period they would be on the Moon. It was this high level of support built into the LM that was to prove crucial to the survival of the three Apollo 13 astronauts after they experienced a major equipment failure in the CSM on the way to the Moon.

At launch, because of the physical constraints dictated by the third stage of the rocket, the several components could not be assembled in the configuration required for the lunar landing or the return to Earth and consequently it was necessary to reconfigure them once they were on the way to the Moon.

For most of the mission, the three astronauts occupied the CSM and it was only after the spacecraft had entered lunar orbit that two of them transferred to the LM for the lunar landing. Thus for the duration of the lunar landing one astronaut remained alone in the CM. As continuous simultaneous communications links with the astronauts was considered essential throughout all stages of the mission, full comms links were provided between the CSM, LM and Earth stations.



Earth-based Support of Apollo

The US decided from the outset that it would support its Lunar and Interplanetary missions with a dedicated network of three stations on the Earth so as to be able to maintain continuous contact with the spacecraft. Initially, this took the form of a network called the Deep Space Network (DSN) that was designed specifically to communicate with unmanned spacecraft at interplanetary distances. The special communications links required for manned Apollo missions led to a second dedicated network of three stations being established near the existing Deep Space Stations at Goldstone, in California; Tidbinbilla, in the ACT; and Madrid, in Spain. The new stations were integrated into the existing Manned Space Flight Network (MSFN) that had been created to support the earlier Earth-orbiting Mercury and Gemini programs. The new stations were referred to as the 'Prime' stations. Additional redundancy was built into the communications link with the Apollo spacecraft by using the existing three DSN stations. Even more redundancy was provided with the installation of a second low noise amplifier and transmitter at the DSN stations. The US generally applied this design philosophy to all aspects of its space programs and the value of adopting this approach was to be clearly demonstrated on several occasions during the Apollo program.

The three DSN stations were referred to as the 'Back-up' or 'Wing' stations. The command and control and telemetry demodulation functions of the 'Prime' station were not duplicated at the 'Wing' sites however, and this hybrid arrangement made it necessary to install a microwave link between the two stations to enable the Prime station at Honeysuckle Creek to process the data received by the Wing station.

The upgrade of DSS 42 to enable it to support Apollo resulted in some of its DSN equipment having a dual DSN and MSFN function and this made it necessary to differentiate between the various configurations and functions the station could have. The following nomenclature has been used in this booklet -

DSS 42 - refers to the antenna, including the DSN antenna-mounted microwave, receiver front-end and transmitter subsystems and the dedicated equipment in the DSN control room.

HSK-X - refers to the DSS 42 antenna including the DSN antenna mounted microwave and transmitter equipment that was used with Apollo, and the dedicated MSFN equipment in the MSFN control room.

The MSFN Wing – refers to the MSFN control room.

Tidbinbilla – refers to the overall site when operating in one or other of these configurations and includes the original DSS 42 site infrastructure comprising the administration offices, power house, stores room, workshops, canteen etc.

Tidbinbilla’s involvement in Apollo

Tidbinbilla’s involvement in the Apollo Program began in 1966. At that time, the station had been operational as part of the USA’s Deep Space Network (DSN) for approximately eighteen months. In that period, it had tracked the Mariner IV Mission to Mars and had just commenced tracking what was to be the very successful Surveyor Program.

This program comprised seven missions starting with Surveyor 1 that was launched on 30 May 66 and ending with Surveyor 7 launched on 7 Jan 68. This was a very busy time for DSS 42 with the interval between successive Surveyor launches being on average every two and a half months. The Surveyor and the earlier Ranger (Aug 61 – Mar 65) and Lunar Orbiter (Aug 66 – Aug 67) programs were unmanned spacecraft that surveyed the Moon in preparation for the manned landings.

The impact of Apollo on Tidbinbilla

From the beginning of Australia's support of the US Space programs, it had been agreed that the overall management control of the Tracking Stations and the manning of them would be essentially by Australian personnel. This control was exercised through the Department of Supply (DOS). In the case of Tidbinbilla, this was initially through a Station Director and a Deputy Station Director associated with its DSN operations, with an additional Deputy Station Director being assigned to it when the Apollo Wing was constructed. The first occupant of this new MSFN position was Don Gray. Don had previously been the RF Engineer at a similar tracking station, DSS 41 located at Island Lagoon, Woomera. Prior to Don's appointment, Mike Dinn had been involved in the early planning phases of the Wing with Bill Wood and Bill Pfeiffer of College Park GSFC in the USA.

This management arrangement gave the DOS and the Station Directors considerable influence over the Contractor in respect of such issues as the filling of key operations, engineering and management staff positions; this was particularly so in the case with Bob Leslie, as John Heath recalls later.

Because NASA intended to continue with its multiple interplanetary programs throughout the four year period the Apollo program would take, it was necessary for the station to be able to switch between its DSN and MSFN roles frequently and quickly.

To do this manually would have required many man-hours of disconnecting and re-connecting the RF and antenna cables between the antenna and the respective control room with the very real risk of damaging some of the cable connectors. To avoid this, the changeover of the two sets of cables was done using two boxes of relays – the larger, more complicated RF one becoming known as the Scaff Box and the antenna one as the Richter Box after their JPL designers.

Dave Arman recalls the following points of interest regarding the adaptation of the antenna/servo systems for MSFN operations –

The change-over of the antenna control between the DSN and MSFN roles was accomplished by the Richter box named after the Servo Design Engineer at JPL. This tended to be not too reliable so much so that we ended up constructing a passive box with the changeover being made by manual plug connections in case it failed, but we never had to use it in anger.

The layout of the DSN antenna axis controls was Declination on the left-hand-side of the control panel & Hour Angle on the right-hand-side. MSFN controls were the opposite. As the same people operated the antenna in both DSN and MSFN roles it was considered this might cause confusion, especially during periods of high activity such as initial acquisition after a launch.
To overcome this risk, the MSFN controls were reversed.

The communications links between the Earth stations and the spacecraft required for the Apollo manned missions were significantly more extensive than those used for typical deep space unmanned missions. The most significant differences arose from the need to monitor the astronauts' well-being, the status of their life support systems and the ability to communicate with any or all of them at any time during the mission. This required high capacity multiple links to enable real-time simultaneous transmission of audio, telemetry and TV data.

The overall modifications to the DSN stations to enable them to support Apollo were extensive and in addition to the modifications to the Communications Centre to house the additional communications equipment and the equipment required to interconnect the Prime (HSK) and Wing (HSK-X) sites by microwave link, it included major upgrades to the antenna-mounted microwave and transmitter subsystems and a new building to accommodate the new antenna and RF control equipment.

Initial MSFN plans to have only one access door to the MSFN control room, and that the installation work would be done by Collins personnel were not agreed by the DOS, who wanted two doors for safety reasons, and the installation work to be carried out by the existing SpaceTrack staff. Both issues were implemented in accordance with the DOS policy.

Because a major portion of the MSFN upgrade was in the microwave, transmitter and receiver sections, John Heath, who was to have returned to the Company he worked for in the UK in 1966, was requested to delay his departure to oversee this work. This was agreed by all parties and he extended his time at Tidbinbilla accordingly.

Tidbinbilla's Technical Staff

Tidbinbilla had been manned and operated by SpaceTrack Pty Limited from its very beginning and the DOS decided that the MSFN Wing would also be staffed by SpaceTrack personnel (not by Honeysuckle Staff as GSFC had initially proposed).

This photo of the DOS and the SpaceTrack Engineering Staff was taken in 1967 or 1968. All bar Guy Sherman were to become involved in some way in Apollo.

They are from the left – John Heath – Senior RF Engineer; Jim Wells – Senior Instrumentation Engineer; Keith Brockelsby - Chief Engineer; Bert Forsythe - Deputy Station Director; Bob Cudmore - Company Manager; Jeff Newnham - Analogue Systems Engineer; Don Gray - Station Director; Allan Bailey - Antenna/Servo Engineer; Clive Jones - Facilities Engineer; Eric Donnelly - Support Services Manager and Guy Sherman - Station Admin Officer.

This is a more complete group photo of the Engineering/Technical Staff.

From the left – Roy Stewart – Digital Systems Engineer; Jim Wells – Senior Instrumentation Engineer; Pat O'Connor – Frequency and Timing Technician; Nigel Barkham – Receiver Engineer; Clive Jones – Facilities Engineer; Allan Bailey – Antenna/Servo Engineer; Jeff Newnham – Analogue Systems Engineer; Don Gray – Station Director; Harry Vonthetoff – Senior Comms Technician; Bob Cudmore – Company Manager; Peter Barcock – Instrumentation Engineer; Geoff Rose – Senior Microwave Technician; Keith Brockelsby – Chief Engineer and John Heath – Senior RF Engineer

Operations Section Staff

DSS 42's first tracking commitment had been Mariner IV in early 1965. This comprised several ad hoc shifts controlled by the Station Director Bob Leslie, assisted by Paddy Johnstone. Shortly afterwards, the station was formally committed to supporting the Mariner IV Mission on a full-time basis, and three Operations Teams were formed with Paddy Johnstone, John Weatherly and Bruce Window as the Operations Supervisors. The Surveyor series of missions required tracking coverage to be expanded to twenty-four hours per day, and a fourth team was created with Dave Arman the Operations Supervisor. By the end of the Surveyor program, the following staff changes had occurred; - John Weatherly had resigned and 'Paddy' Johnstone had transferred to JPL, and Tony Keiller and Ron Hargreaves had replaced them.

The MSFN specific operational control position at the Wing was known as the USB Supervisor. Two shifts were required to cover MSFN operations, and the Ops Supervisors for these were Bruce Window and Tony Keiller. The vacancies this caused in DSN operations were filled with two SpaceTrack technical staff Henry Brown and Peter Topley.

The six Operations Supervisors that covered the DSN and MSFN missions during the Apollo period are shown in this photo -

This Operations Section. From the left – Bruce Window, Henry Brown, Tony Keiller, Don Gray – Station Director, Bob Cudmore – Company Manager, Ron Hargreaves, Neil McVicar and Peter Topley.

With the ending of the MSFN commitments after Apollo 17 and DSS 43 becoming operational, Bruce Window and Tony Keiller were absorbed back into the Tidbinbilla DSN Ops group to be part of the teams for DSS 42 and DSS 43."

Preparing for Apollo

In mid 1966, three members of the DSS 42 engineering team – Bob Cudmore (the Instrumentation Engineer at that time), John Heath (the RF Engineer) and Tony Saville (the Comms Supervisor), went to JPL to be briefed on the scope of the MSFN upgrade. At about that time, two others - Mike Dinn (Deputy Station Director) and Jack Rothwell (the Antenna Engineer) also went to JPL to be briefed on those aspects of the upgrade that they would be responsible for.

The equipment layout in the new wing was as shown in the following photo.

When it came time for John Heath to return to the UK in mid 1967, the exciting prospect of Apollo and the new DSS 43 antenna proved too great and he decided to remain at Tidbinbilla.

The station upgrade proceeded smoothly throughout 1967 and the early part of 1968 with few installation problems. One that did occur was recalled by Peter Stewart, one of the RF Technicians –

I spent some time on the RF front end and cryogenics with Pete Gracie and Les Gronow and developed a high level of fitness climbing the antenna.

The Wing equipment layout.

One thing I haven't forgotten from working in that area was Les and I installing new spiroline (an expensive, large, low-loss and not very flexible coaxial cable) in one of the antenna cable trays on a night shift and over-tightening the gland nuts and ruining it.

John Heath and Geoff Rose were none too happy with us the next morning!

Peter also commented on the team spirit that existed at Tidbinbilla in that period -

My time at 42 was a bit of a mixed bag and started off as a console operator on receivers with my opposite number being Ian Fisher.

To my mind the success of Tidbinbilla as a very respected and successful tracking station was due to the "camaraderie" between all employed there and acceptance of any challenge as a team.

The new MSFN Wing (the brick red building attached to the main building in the centre of the photo).

Major Equipment problems

A particularly troublesome problem the station encountered as a result of the upgrade was with the dual transmitter installation. John Heath recalls –

In the course of the check-out of the dual transmitter installation in mid to late 1968, serious interference was observed when both transmitters were operating simultaneously at high power levels. This interference was stable in frequency but variable in amplitude and became known as the Inter-Modulation Product problem. It was immediately evident that the interference would cause serious degradation of the communications links between the various components of the Apollo spacecraft and the stations back here on Earth.

I devised a comprehensive series of tests in an attempt to establish the cause of the interference and to find a way to eliminate it. The results of the Tidbinbilla investigation appeared to prove that the interference was indeed caused by interaction between the two transmitters but it was unclear if this was occurring at the input to the transmitters and amplified by them or were caused by interaction between the outputs of the transmitters themselves. The results of the investigation were sent to JPL in Jan 1969 and I received this TWX DTG 13/0455 Z FEB 1969 in response -

FM R C CHERNOFF/R W HARTOP

TO: HEATH

READ YOUR IM PRODUCT INVESTIGATION REPORT WITH GREAT INTEREST. .....

..... YOUR RESULTS VERY HELPFUL TO ALL CONCERNED. WISH TO CONGRATULATE YOU ON CARE AND INGENUITY OF THESE TESTS.

At about the same time HSK was in the process of testing its transmitter system and reported that it too was experiencing excessive transmitter induced noise, but in its case, it was more in the form of excessive bursts of wideband noise rather than discrete frequencies, and was thought to be caused by damaged transmitter output waveguide flanges. Positive identification of the precise cause of the interference proved difficult in each case and the problems were still present at each of the stations during the Apollo missions.

The IMP problem at the Wing sites was so severe that the MSFN issued a Network Operational Directive in respect of the operation of the transmitters for Apollo 11.

Clause 5 4 2 1 2 of the Directive states -

Eighty-five-foot Antenna Stations -

a. Earth Orbital Phase. All 85-foot stations will radiate at 2 kw per carrier during the earth-orbital phase.
b. Post-TLI. After TLI + 3 hours, all 85-foot stations will radiate at 10 kw per carrier for the remainder of the mission.
c. Wing Stations (GDSX, HSKX, and MADX). Because of undesirable intermodulation products, simultaneous uplink of two carriers by the wing stations is prohibited.

Note. MCC may request any station to uplink at a 20 kw (or maximum) power level in the event of a contingency."

It has not been possible to establish if initially dual uplink operation of the Wing stations was to have been used during Apollo 11 and the other Apollo missions only for it to be discarded because of the IMP problem.

Another problem equipment was the maser. Despite the redundancy afforded by the dual maser installation, their reliability was always something of a hit or miss affair. This was because they operated at approximately 4°K (-269°C), and achieving and maintaining this extremely low temperature for extended periods was not always guaranteed. By far the greatest problem was due to contaminants in the helium gas lines freezing and preventing the required 4° operating temperature being reached or maintained. The only way of removing the contaminants was to evacuate the refrigerant lines for many hours, recharge them with fresh helium through a heat exchanger cooled by liquid nitrogen and try again – there was no way of telling if it would be successful other than to attempt the cool-down again.

Initially the liquid Nitrogen was obtained from the Australian National University but eventually we acquired a machine and made it ourselves. The first signs of there being contamination in the lines was if the impurities in the helium lines froze and made the compressor shut down. If this happened, it tended to occur nine or ten hours into the cool-down and the only solution was to let the maser warm up to room temperature, which took about the same length of time, purge the refrigerant lines, recharge them with new refrigerant and restart the cool-down process.

Major Equipment problems continued

This clearly was a serious operational inconvenience that was largely overcome as Peter Gracie, the Maser technician recalls –

In the event of a maser failure during operations, we managed to reduce the time lag that a maser change-over would take by pre-cooling a spare maser so that it was available for installation in the place of the unserviceable one. Replacing the maser in the SCM was not straightforward as it required the antenna to be tilted so that the replacement maser could be lifted by crane onto the surface of the antenna, and carefully manoeuvred to the SCM access door as the antenna was carefully moved to its zenith position. The failed maser was removed by the same method in reverse, the replacement maser installed in its place, and, as by now, the maser had partially warmed up, the cool-down recommenced. By this method, normal operation could be resumed in about 4 hours instead of the typical 24 hours.

Notwithstanding the hazards associated with this particular exercise, as was the case for much of the work undertaken by the personnel responsible for the antenna structure, and the microwave and transmitter systems installed on it, it was performed without safety harnesses. This would not be permitted under current Work, Health & Safety Regulations.

Earth-orbiting Apollo Missions

The early Apollo flights were earth orbital missions designed to progressively develop the techniques and skills and prove the hardware and procedures that would be required for the lunar landings. These orbits frequently required antenna tracking rates well in excess of 1°/sec. The DSN antennas had been designed specifically for lunar and interplanetary missions which generally required tracking rates on the order of 0.004°/sec for extended periods and a short term maximum tracking rate of 0.85°/sec when the antenna needed to be repositioned for maintenance, etc. The DSN antennas were therefore not suited to tracking spacecraft in earth orbit or at the start of their translunar or interplanetary trajectories, and as a general rule they were not committed to tracking spacecraft until they were more than 10,000 miles from the earth.

The impact of this design limitation became evident when Tidbinbilla was required to track Apollo 9 as described in the section covering that mission.

Apollo 6

Launched 4 Apr 1968; Splash-down 4 Apr 1968. The purpose of the Apollo 6 mission was to demonstrate the ability to achieve a trans-lunar injection trajectory and earth re-entry.

Apollo 6 was a short duration flight of three orbits of the earth lasting approximately 10 hours, during which Tidbinbilla conducted a series of compatibility tests with Honeysuckle. The spacecraft was expected to be within the field-of-view of the Canberra stations only on its first orbit. However, as a result of an incorrect orbital insertion burn the spacecraft achieved an orbit that brought it into the field-of-view of both the Honeysuckle and Tidbinbilla stations on two of its three orbits, which both stations were required to track. The maximum tracking rate on both orbits was within the design limits of the antenna and all wing-prime station “handovers” called for in the Wing-Prime Evaluation Plan for the first orbit were accomplished. Because the stations had not been expected to have had satisfactory visibility of Apollo 6 on the second revolution, no handovers were scheduled for it. However, the opportunity was taken for the prime MSFN station to maintain two-way lock and Tidbinbilla/MSFN three-way lock for the entire period the spacecraft was in view during this orbit.

Apollo 7

Launched 11 Oct 1968; Splash-down 21 Oct 1968. The primary purpose of Apollo 7 was to test the CSM in Earth orbit.

After successfully completing the compatibility tests with Apollo 6, it had been initially intended that Tidbinbilla would be prime for Apollo 7. However, because of the reconfiguration of the DSS 42 control-room that was under way for Pioneer 9, it was decided to cancel this commitment. This provided an opportunity for Tony Keiller to go to Houston for urgently needed MSFN operational training.

Earth-orbiting Apollo Missions continued

Despite this leaving the station with only one MSFN Ops Supervisor, Houston decided to commit HSK-X to full operational support of the mission. Initially this could only be done by Bruce Window, who, as the only MSFN Shift Supervisor available at the time, had to cover the 17 hour long count-down and operational period. Clearly, this would not be viable for the duration of the mission, so Ron Hargreaves, one of the DSS 42 Operations Supervisors, was called on to help out. Ron had to learn the detail of MSFN operations procedures simply by understudying Bruce in real time – not a good introduction to tracking Apollo! It also proved to be an interesting learning experience for Houston, who seemingly was unaware that DSS 42 was located in a valley with mountains masking parts of its horizon. The station's tracking schedule was prepared without taking this into account and consequently, it was scheduled to track for longer periods than was achievable because of the masking, and it was even tasked to track several orbits during which the spacecraft did not come into the stations field-of-view at all. It took Houston a couple of days to correct this.

The only equipment problem the station experienced during the mission was a leak in the servo hydraulics during one of the orbits. Although it was easily fixed, it increased concern station staff had that the risk of major failure was greatly increased whenever the station was required to track for extended periods at the antenna's maximum rates.

HSK-X was relieved of its MSFN commitment by Mission Control after rev 107 so that DSS 42 could prepare itself for the Pioneer 9 mission that was about to be launched. Apollo 6 and 7 proved to be an exciting introduction to manned flight ops and provided Tidbinbilla with valuable experience of the increased pace and complexity of manned lunar missions compared with the much slower pace of interplanetary missions.

The Window Report

The experience gained tracking Apollo 6 also highlighted the need for a document that fully described the complex set of functional interfaces and configuration options that existed, or were possible, within and between the Honeysuckle and Tidbinbilla sites.

Tom Reid, the HSK Station Director decided that the complexity of this interface made it essential to have such a document and he asked Don Gray, his counterpart at Tidbinbilla, if he could spare someone to fully document the existing installation and also identify any additional options that could be made available if they were connected.

Bruce Window was assigned the task and the comprehensive report he produced, which became known as "The Window Report", was used at Honeysuckle for the next few missions until the required information was officially provided in the form of MSFN Engineering Instructions.

Apollo Lunar Missions

Apollo 8

Launched 21 Dec 1968; Splash-down 27 Dec 1968. The purpose was to undertake a manned circumlunar flight by the CSM. Had the LM been ready, it would have been attached to the CSM so that the mission would have involved a fully configured Apollo spacecraft.

Daily operations at the Wing were shared between the two tracking teams as by now Tony Keiller had returned from his training in Houston and was able to take on that role. Don Gray was HSK-X station director (STADIR).

Tidbinbilla's DSN experience with the Surveyor and the Earth-orbiting Apollo missions had given the teams confidence that they would be able to handle anything that an Apollo mission might involve. This confidence was to be tested for one of the teams on the launch pass of Apollo 8 when the received signal level was so large that it saturated the receiver front end and made auto-tracking unstable. This had been experienced to some degree with Apollo 7 but was far more severe with Apollo 8. Fortunately, the problem was short lived as the rapidly increasing distance between the spacecraft and the antenna, soon resulted in the signal level for subsequent tracks dropping below the saturation level of the receivers.

As the mission progressed the two HSK-X tracking teams at Tidbinbilla developed an element of healthy rivalry, not only between themselves, but also with Honeysuckle. Tidbinbilla's competence was amply demonstrated when it took on the role of prime station for the two days that Honeysuckle was declared unserviceable due to arcing in the waveguide in the feed cone.

Bruce Window recalled the mission –

Daily operations soon became routine, and even the lunar orbit phase proved straightforward. As the mission occurred over the Christmas period the station's kitchen staff under George Clark provided a special meal on Christmas Day. Most of the tracking team were unable to fully enjoy it however as they could take just a few minutes to eat it before returning to their workstations. They did this without complaining, which was another example of the commitment and dedication the staff of that era had for their work.

An unexpected highlight of the mission was listening to the downlink voice channels and hearing each of the Astronauts reading a passage from the Bible during Lunar Orbit 9.

John Heath recalled the excitement and tension that built up at Tidbinbilla as the mission progressed when he wrote shortly after the event –

There was a gradual build-up of tension at both the Honeysuckle Creek and Tidbinbilla stations from the time contact was first made with the Apollo 8 space craft shortly after launch.

Apollo Lunar Missions continued

There was little appreciation at the time however, of the momentous achievement that was unfolding and the fact that we were a part of it. This was to be the first time man had escaped the gravitational pull of the earth, circumnavigated another celestial body and returned safely to earth. Whilst the staff took it as 'just our job', the US Government viewed it rather differently. They were ecstatic over the success of the mission and here in Australia, the US Ambassador celebrated it by holding a reception at the US Embassy in Canberra for approx 400 people – mostly staff from the Honeysuckle and Tidbinbilla tracking stations and their spouses, but also quite a few from other space associated organisations.

John Heath was one of the attendees at that reception. He wrote sometime after the event –

While I am sure many photographs would have been taken that evening, this is the only one I have come across. The man on the left of the picture is Willson Hunter, the NASA Representative, and the other man is the US Ambassador William Crook. I have no idea how the photo came into my possession – perhaps it was because I and my wife are also in it (in the background).

The host and some of the attendees at the Apollo 8 reception at the American Embassy

In Jan 1969 John Heath cut his ties with Tidbinbilla and transferred to DSS 41 at Island Lagoon, Woomera. The circumstances surrounding this were something of a puzzle to him at the time and only became clear many years later. He recalls –

In late 1968 I was asked by Bob Cudmore to transfer to Tidbinbilla's sister DSN Station DSS 41 at Island lagoon, Woomera, to be the Chief Engineer there. Whilst this was an attractive offer career-wise it would have meant I would forfeit any ongoing involvement with the Apollo programme and the new 64m antenna that was under construction at Tidbinbilla – both of which I was reluctant to do. In addition I cannot say that the prospect of living in Woomera had much appeal either, so I declined the request. After being subjected to a lot of pressure, I relented and agreed to go for twelve months to get the Company out of a bind.

By the time the year was up however, I had decided that I was enjoying both the work and somewhat surprisingly, living in Woomera, so much so that I ended up staying for over four years until the station closed in 1973!

My move to Woomera ended my direct involvement in Apollo although I was to become indirectly involved with it on two subsequent occasions, and these are mentioned later. I had always wondered why Bob Cudmore had been so determined to have me make the transfer and I was most surprised when he told me many years later that it had really been Bob Leslie who had wanted me to fill the position.

This made me realise that my involvement in Apollo may never have occurred at all as I had had something of a prickly relationship with Bob Leslie from the outset. This developed when we were in the USA and continued after our return to Tidbinbilla. It reached the stage in early 1965 where it almost resulted in my three year contract being terminated and my earlier than expected return to the UK. At the time we were preparing for our first track of Mariner IV, and we were experiencing problems with two of the RF systems – the transmitter and the maser, that put our ability to track the spacecraft at risk. Allan Lum, who was the RF Section Leader and my boss, was responsible for the transmitter and I was responsible for the maser. These problems led to Allan's unexpected resignation, which presented Bob with something of a problem and led to him asking me if I was prepared to accept responsibility for the transmitter in Allan's place. I agreed to do this and our relationship began to improve from that point onwards to the extent that I was asked to extend my time at Tidbinbilla to cover a major part of the station upgrade for Apollo. This, and the role he played in me becoming the Chief Engineer at Woomera, are two of the many examples of the influence the DOS, and Bob in particular, had on filling the senior positions at the tracking stations.

Apollo 9

Launched 3 Mar 1969; Splash-down 13 Mar 1969. The purpose of Apollo 9 was to check-out the LM's ability to separate from and re-dock with the CSM in earth orbit.

Tidbinbilla was scheduled to track one or other spacecraft on two different occasions during this mission. As the tracking rates would exceed the 0.85 °/sec design limits for the antenna on both orbits, Allan Bailey, who was initially the Antenna/Servo Engineer, and had assumed the additional responsibility for the RF systems after John Heath had transferred to Island Lagoon, devised a novel technique using the S-Band Acquisition Antenna (SAA) to solve the problem. The SAA was a monopulse tracking feed with similar auto-tracking capability as the main S-Band Cassegraine Monopulse (SCM) feed. It had been designed however to locate and track spacecraft shortly after launch when their signal levels were high and their trajectories or orbits were not accurately known.

Apollo Lunar Missions continued

To do this it had a beamwidth of nominally 20° compared with the nominal 0.5° of the standard SCM configuration. While this made it much easier to acquire and keep it pointed at the spacecraft, the problem of excessive tracking rates still remained. Allan had realised that by pointing the SAA 10° ahead of the expected position of the spacecraft and driving the antenna at its maximum rate in the direction the spacecraft would take, it was possible to maintain contact with the spacecraft for extended periods. Depending on the orbit, this was frequently long enough to cover the entire period the spacecraft was in view.

Apollo 10

Launched 18 May 1969; – Splash-down 26 May 1969. The purpose of Apollo 10 was to undertake a circumlunar flight to prove all aspects of the CSM and LM operation apart from the actual landing. In the lead-up to Apollo 10 Tidbinbilla was involved in frequent periods of testing and operational exercises with Honeysuckle as well as having to meet its DSN commitments.

After the transmitter Intermodulation problem had been first observed at Tidbinbilla in mid 1968, JPL expended considerable engineering effort trying to eliminate it. A satisfactory solution was thought to have been found which was to insert isolators in the transmitter output waveguide circuitry and arrangements were made to install these at Tidbinbilla in time for Apollo 10.

However, before this was done, further testing at Goldstone showed that the isolators did not fully eliminate the problem and consequently JPL decided not to install them.

Honeysuckle Ops conducted a structured checkout of the intercom system with each operational position prior to the System Readiness Test before each track, or before any simulation exercise. This was a routine and boring check in which every position could hear every other position perform their checks.

In preparation for Apollo 10, Bruce Window recalls –

For one of the System Readiness Tests Comms checks, I conspired with Tony Saville, the HSK-X Comms Supervisor, to introduce a little humour into proceedings. We had every intercom position pre-record their standard responses on tape. When it came time for the first response from the Wing, which happened to be mine, Tony Saville played the tape at twice normal speed so that it sounded like the Chipmunks. While this produced a barely-controlled bout of chuckling from the Tidbinbilla team the response from Honeysuckle was silence. The silence was soon broken however, with John Saxon as HSK Ops 2 saying something along the lines of "Very funny, now let's do it properly". So we did.

One of the many tests included in the SRT was to use a test transmitter to simulate the downlink for Voice and Telemetry, which involved sending a message across the microwave link to HSK SDDS subsection to confirm the link was operational.

Little known by most people, the Astronauts had the ability to send Morse Code messages as a last resort method of communicating with Houston. At the Wing, this Morse Code feature was checked every SRT. As I was a competent Morse Telegraphist I used my ex-PMG morse key to check the system by sending a short plain language message to Laurie Turner, also a competent Morse Telegraphist, in the SDDS area at HSK. Nothing improper was ever sent, we were too conscious of it being recorded!

Apollo 10 was in Tidbinbilla's field-of-view during its first earth orbit and to avoid any tracking instability during this pass the SCM output was fed directly into Receiver 5, bypassing the Maser, while the SAA was fed into Receiver 6. This configuration overcame the instability caused by saturation of the receivers when using the SCM that had been experienced during earlier Apollo missions.

Tidbinbilla tracked the spacecraft in three-way mode for the entire translunar phase and some of the circumlunar period, which included a period of two-way tracking on orbits 16 through 20.

The return flight back to earth was basically uneventful for both of the teams at HSK-X. Only one minor problem was experienced during the mission and this occurred during the CADFISS (pre-track calibrations) for the first trans-earth pass when Transmitter 2 tripped off due to a HV power supply rectifier failure. The cause of the trip could not be found and although it was fixed simply by resetting the cabinet doors, it was subsequently realised that it was an indication that a serious failure was about to occur and did occur during Apollo 11.

Both teams celebrated the end of the mission in the usual way, confident that they would be able to cope with whatever came up during the remaining missions…. including the next one, which was expected to be the lunar landing.

Apollo 11

Launched 16 Jul 1969; – Splash-down 24 Jul 1969. The purpose of Apollo 11 was to make the first manned landing on the Moon.

As was eagerly anticipated, the success of Apollo 10 led to the decision to commit Apollo 11 to a Moon landing. This was to be the culmination of the efforts of thousands of people over more than a decade, and the final preparations of the entire MSFN network for this historic event were intensified in the two month period leading up to it.

Apollo Lunar Missions continued

The Network simulation teams practiced coping with a wide range of contingencies that might occur. Everyone was driven to make sure the mission would be successful to the extent that Tom Reid had the HSK Simulation personnel devise even more unlikely contingency situations and ways to cope with them. Many of these involved Tidbinbilla, who also devised its own contingency situations. Jack Dickinson, an ex-RAF senior technician on Bruce Window's shift, played an important role in this by developing his own simulation equipment. One of the training scenarios he devised involved a helicopter to simulate a spacecraft coming into view over the horizon. All this training ensured that the teams had attained a very high level of proficiency and were well prepared for their role in the first manned landing on the Moon.

The first two days of the mission had been straightforward and uneventful at Tidbinbilla when disaster struck. At 08:25 GMT on the 18 Jul, when Tony Keiller's team was on duty and the station was tracking the CSM in three-way mode, the Transmitter # 2 power supply tripped off. It was quickly established that an electrical short had occurred in the primary 460-V, 3-phase circuitry and this had destroyed a large part of the power supply's control circuitry and had caused some melting and fusing of parts of the metal chassis.

Despite this major problem, Tidbinbilla could have remained fully functional by reason of its second transmitter but Houston decided to interchange the roles of the Honeysuckle and Tidbinbilla stations.

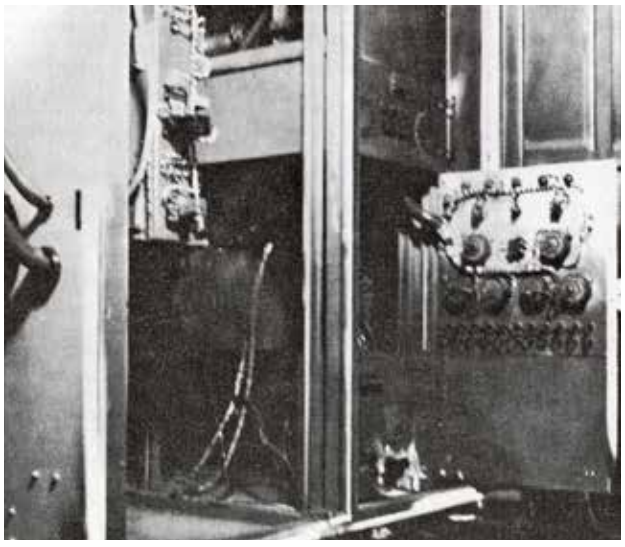
After the power supply had cooled sufficiently, a repair crew headed by Geoff Rose and Allan Blake set to work to determine what needed to be done to make the power supply serviceable again. The damage was found to be extensive requiring the replacement of much of the wiring and many of the components in the cabinet. It was decided that the quickest way to effect the repair was to have someone climb inside the cabinet to remove and replace the damaged components, and the only people who were small enough to do this were Ted Wilcox (Stumpy) and Graeme Stratford.

Keith Aldworth recalls -

I have memories of seeing both Ted and Graeme covered in a black, sooty mess from head to foot emerge from the Transmitter power supply cabinet. They were not the only ones involved in the repair though, as much of the componentry was smoke and heat damaged and had to be removed, cleaned and tested before being re-installed. Several other techs were involved in that and many long hours were spent on the tasks. It stands as another example of the dedication that we all had for what we were doing.

Fortunately, spares for many of the items that had to be replaced were held on station. For those that were not, an urgent search was undertaken to locate them and have them shipped to Tidbinbilla. Good fortune came to the rescue as a source of many of them was found at DSS 41, Woomera in a transmitter power supply that had become redundant several years earlier but kept as a source of spares. Usable components were removed from this and emergency air freighted from Woomera to Canberra with the assistance of the DOS, with other critical components and wiring being shipped from Goldstone.

After a superhuman effort the repair was completed at 13:30 GMT on July 19, and following some eight hours of testing at full power, the transmitter was formally declared operational at 22:20 GMT on July 19 and the station returned to full Apollo support status.



Damaged Transmitter Cabinet

This photo of the damaged cabinet, which is the only one that could be located, does not adequately show the extent of the damage. In addition to the components and wiring that are visible in the photo, there were several other components that had to be removed, tested and in most cases, replaced.

The masers at Tidbinbilla gave it marginally better performance than HSK, and because of this, Mission Control had initially planned on using the Wing to communicate with the Lunar Module for the entire Lunar phase. However, because of the transmitter failure Mision Control re-assigned Tidbinbilla to communicating with the CSM as it orbited the moon.

Bruce Window recalls that when he came on shift and learned of the fire and the change of plan he felt devastated. It was such bad luck and a huge disappointment for the station. Had it not been for the Transmitter Power Supply failure, the kudos that Honeysuckle has been given for being the station that received those first TV pictures of Armstrong stepping onto the Moon would have been bestowed on Tidbinbilla.

Instead, HSK-X was assigned throughout the lunar landing phase to track the CSM with Mike Collins its only occupant. His story too is largely forgotten.

Apollo Lunar Missions continued

Keith Aldworth recently reflected on this -

Communications with Mike Collins in the CSM during the lunar phase of Apollo 11 became our responsibility when we at the Wing were taken off prime for the LM after the TX power supply fire. It kind of baffles me to realise that although his welfare was paramount to the three of them getting back home, he has never been given the credit that I think he deserved. Tidbinbilla kept him in the loop, but it would have been HSK if not for the fire. So much needs to go into the annals.

Honeysuckle Ops often had one of the 4 receivers at Tidbinbilla configured to track the LM as additional backup to their receivers during the most critical parts of the surface activities. Even though the beamwidth of Tidbinbilla's dish was only 0.5 degrees, it was usually possible to get a good signal from the LM at the same time as the CSM was being tracked because of the power of the LM's transmitter.

Bruce Window's team was on shift during the lunar landing and were able to hear the downlink and uplink voice communications between the LM and Houston that were occurring through the Goldstone station. When the descent phase took longer than planned, he recalls how everyone held their breath as Houston proceeded to count down the remaining fuel level in the LM.

Bruce has this recollection of those incredibly tense few minutes -

'When we heard Buzz Aldrin call out "Contact light" we knew they had touched down'. At the same time, Houston said words to the effect that they could all start breathing again, as they were 'about to turn blue'. Everyone who was witnessing the event breathed a sigh of relief - The Eagle had landed.

Bruce's shift had to contend with a very different kind of situation towards the end of the Lunar phase of the Apollo 11 mission when Brian Eagleton, one of the Receiver technicians, turned up for work with a severe case of influenza. Within two days, he had unavoidably passed it on to most of the shift. Bruce recalls that when Bob Cudmore, who was by now the company CEO, learned of this, he brought a bottle of a well-known brand of Brandy that was reputed to possess remarkable medicinal properties, into the Ops Room and offered a generous tot to anyone who felt they might not be able to complete the shift. Bruce was too busy to notice how many of the team availed themselves of the medicine, but everyone managed to complete the track and, more importantly, the remainder of the mission!

John Flaxman, was a member of that tracking team, and he has this recollection of the incident –

On the Apollo 11 mission Tidbinbilla was assigned the task of tracking the main spacecraft (the CSM) as it orbited the Moon waiting to pick up the space tourists, while Honeysuckle looked after the LM as it sat on

the Lunar surface. Unfortunately a dreaded lurgy struck the team and the shift began to wilt as, one by one, we all succumbed to the particularly nasty bug.

Manfully we struggled on, and as missing a shift because you were ill was just out of the question, we reported for duty each day, coughing and sneezing a bit more than before. The mission had reached the critical phase of preparing for the return journey to earth – and a whole shift gone AWOL could have been disastrous.

When the last shift finally came, the team was not a pleasant sight to see – not that we were anything extra special normally, but this day, boy, we really were rough! However, every cloud has a silver lining they say and so it was for us – I can still see in my mind's eye, the image of Bob Cudmore roaming the Ops Room clutching a bottle of Brandy and doling out tots to fortify the troops for this last big effort. Somehow we all finished the shift (as well as the Brandy) and departed for home feeling a good deal happier than we did at the start of the shift – nice one Bob!

HSK-X supported Apollo 11's return to earth well satisfied and proud of the role they had played and the station joined in the celebrations that accompanied the safe return of the astronauts. That was except for Bruce's shift, as most of them couldn't enjoy the end of mission celebrations because they were bedridden recovering from the influenza. Bruce was one of them, as he ended up taking a fortnight's sick leave to recover fully.

Such was the commitment of the Tidbinbilla staff.

Keith Brockelsby provides the following comments on Apollo 11 -

My watch as Chief Engineer at DSS42 during those eventful years was made particularly easy by the competence and dedication of the technical staff. They simply got on with maintaining the station allowing it to perform beyond the requirements of the operational tasks. And when the #2 transmitter power supply failed during Apollo 11 the rebuild was completed with remarkable initiative. I recall placing a miniature tape recorder beside a speaker in the Wing to record the Apollo 11 landing live that was being broadcast over the comms link we had with the MSFN network - believing it would be a "historic moment" whatever happened. I still have that little 3 inch tape with Armstrong's voice saying those famous words! (I haven't attempted to play it for some years now).

Apollo 12

Launched 14 Nov 1969; – Splash-down 24 Nov 1969. The purpose of Apollo 12 was to make the 2nd lunar landing.

With the new 64 meter antenna DSS 43 at Tidbinbilla nearing completion, Tom Reid transferred from Honeysuckle Creek to Tidbinbilla to become the Canberra Communications Complex Director -, a name change that reflected the existence of two antennas at the site and the promise of more to come.

Apollo Lunar Missions continued

Tidbinbilla was assigned to track the CSM and the LM at different times throughout the Apollo 12 mission. During the period the astronauts were on the Moon, they established a unique historical link with Tidbinbilla when they visited the Surveyor III spacecraft – Tidbinbilla had tracked it in April 1967 when it landed on the Moon.

After the successful participation of Parkes in the Apollo 11 mission, NASA requested the Australian Government to make Parkes available to support future Apollo missions. This was agreed and the DOS and SpaceTrack formed a team of the most experienced technical and operational staff from the Wing to provide the required expertise. This was done without adversely impacting Tidbinbilla's ability to meet its tracking commitments as the station teams had by now demonstrated a high level of competency tracking the earlier Apollo missions. Bruce Window was selected to lead the operations team of Jack Dickinson, Peter O'Donoghue and Harry Westwood under Roy Stewart who took on the role of the Senior SpaceTrack Officer on site. NASA had previously installed some temporary equipment at Parkes for Apollo 11, but it was clear that the longer term involvement that NASA now planned for Parkes would require a more permanent installation for the additional equipment. In preparation for this, John Bolton, the Parkes Director, had a small plenum and operations area built into the second floor of the pedestal of the dish.

Racks of MSFN equipment from the tracking ship USNS Vanguard were delivered to Parkes about a month prior to the launch of Apollo 12 and the Tidbinbilla team helped the CSIRO staff install it in the plenum. This equipment, which included one MSFN receiver, SDDS (demodulation equipment), an Ampex video recorder and Monitor, a Mincom M-22 telemetry recorder and communications interfaces for the PMG, would be used on all future Apollo missions. This equipment gave Parkes a telemetry, video and voice downlink demodulation capability similar to Honeysuckle but no uplink capability.

The Apollo equipment in the pedestal with (from left) Harry Westwood, Peter O'Donoghue, Jack Dickinson and Bruce Window in the middle of a track.

During their time at Parkes, the Tidbinbilla team stayed in a motel in Parkes and travelled to and from the dish in SpaceTrack cars to meet the operational commitments.

Voice and teletype communication between Honeysuckle and Parkes was set up by the PMG and NASCOM Deakin. Bruce Window made daily reports to Honeysuckle Ops, based on the advice of Roy Stewart and Jack Dickinson as to progress and their readiness to support the mission.

Because of the Parkes' antenna limits, the Apollo 12 spacecraft was well on its lunar trajectory before the first attempts to acquire it were made. One of the issues the Parkes' antenna operator had to contend with was because its beamwidth was much narrower than the smaller DSN and MSFN antennas and it could not autotrack, finding the spacecraft and tracking it had to be done manually. The availability of sufficiently accurate pointing predictions to perform both of these functions was of concern and sometimes it was necessary for John Bolton to apply corrections to the pointing data received from Houston or JPL.

After the LM had landed, the Parkes personnel acquired the LM and anxiously waited for the astronauts to alight. During their time on the Moon, the two astronauts Pete Conrad and Alan Bean had a long list of activities to carry out, including collecting samples of soil and rocks and deploying the ALSEP package.

Yet another task was to set up a TV camera as Houston wanted much greater and improved real-time television coverage than had occurred on the first lunar landing.

As Al Bean was doing this, he unintentionally managed to point it at the sun and fatally damaged it. Bruce Window, who had worked at a TV station between his time at Minitrack and joining SpaceTrack, saw the image from the camera bloom to white, and immediately realised what had happened saying, "He's pointed it at the sun and b……ed it". The failure of the TV camera was a big disappointment for everyone at Parkes and the many other people who had been expecting to see some spectacular lunar vision.

Parkes performed flawlessly throughout the mission right up to the point where the spacecraft was approaching the Earth and the tracking rates exceeded the maximum slew rates of the antenna.

Four of the five members of the Tidbinbilla team that went to Parkes for Apollo 12 are in this photograph, which was taken by Bruce Window, who was the fifth. They are from the left – 1st – Roy Stewart; 2nd – Harry Westwood; 5th – Peter O'Donoghue and 7th – Jack Dickinson. The others are some of the resident Parkes team.

Apollo Lunar Missions continued

Meanwhile, at Tidbinbilla the mission had also proceeded routinely with the only significant issue being the failure of a compressor motor in one of the two air-conditioning units in the antenna Declination Axis Room at 01:35GMT on November 20. This had no impact on the station's ability to support the mission because the weather was cool at this time of the year and the back-up compressor had ample capacity to cope with the required air-conditioning load.

Apollo 13

Launched 11 Apr 1970; – Splash-down 17 Apr 1970. The purpose was to make the 3rd manned landing. The mission was aborted after an oxygen tank exploded en route to the Moon, and it was to become an incredible rescue mission.

Tidbinbilla had been assigned to track Apollo 13 throughout the mission. When the spacecraft was about half way to the moon, it suffered a major failure that threatened its survival and could so easily have ended in disaster for the three astronauts. There was little the crew themselves could do to correct the problem and their safety was entirely in the hands of a host of people back on Earth some 200,000 km away. Urgent analysis of the problem and the identification of options to correct it were hastily undertaken. These were mainly focussed on keeping the crew alive by conserving vital supplies such as oxygen and battery power, maintaining voice and telemetry communication with them, and determining a new mission trajectory that would return them back to earth as quickly as possible. Through the ingenuity of the mission personnel in the US the astronauts were brought safely back to Earth in what must be the most remarkable rescue mission ever carried out.

Bruce Window, who was on duty at Tidbinbilla at the time the accident occurred, recalls -

The MSFN had originally decided not to involve Parkes in the Apollo 13 mission and consequently, as there was no need to send its Parkes Team there, Tidbinbilla had two full-strength tracking teams to cover the mission and was looking forward to a relaxed series of tracks.

This expectation was further reinforced in the knowledge that Apollo 13 was essentially a repeat of the earlier two landing missions with the most significant difference being to measure the seismic impact of the S-IVB booster crashing into the moon using the seismometer in the ALSEP package left behind by Apollo 12. The Instrument Unit on the S-IVB would be active all of the way to the moon and would be transmitting on the LM frequency.

The launch and early Translunar Coast phase had been uneventful, as had the tracking of the CSM and the IU by Honeysuckle and Tidbinbilla respectively. That was until 55:00 GET, when the astronauts entered the LM to check the pressure of the supercritical

hydrogen containers following indications that they had developed a leak. The crew failed to find a leak and were returning to the CSM when they heard a loud bang. Initially this was of little concern because one of the LM systems when functioning normally often made a similar noise – something akin to the noises a kitchen fridge makes from time to time. Shortly afterwards though, the SM power subsystem began to indicate anomalous operation and it became evident that an oxygen tank had ruptured. The loss of most of the onboard oxygen was potentially disastrous as this was essential not only for powering the fuel cells that generated electrical power but more critically, for the astronauts themselves. The astronauts determined that the extent of the damage was so severe that they had no option but to shut down the failed fuel cell and shortly afterwards the other two. As this left the CSM without electrical power, the three astronauts were instructed to enter the LM and switch its systems on. They were now totally dependent on the significantly reduced support available in the LM for their survival.

At Tidbinbilla, all of the drama surrounding this was heard via the intercom nets coming from Goldstone where its Prime station was two-way on the CSM and LM and its Wing two-way on the IU. Houston instructed Goldstone to retune the LM frequency through the IU to separate them, but this just locked them together. This was the situation when GDS/GDS-X neared their horizon and had to hand over the confusion to the Australian stations. Tidbinbilla was immediately instructed to go 2-way on the IU and try to separate the IU signal from the LM.

As skilled a receiver operator as Jack Dickinson was, he could not separate them. It just so happened that one of the anomalous operational situations Honeysuckle and Tidbinbilla stations had covered in their pre-mission simulations was this one so they knew what needed to be done to correct it. John Mitchell at Honeysuckle asked Honeysuckle Ops to request Houston to have the Astronauts turn the LM transmitter off and after a short period to turn it back on. It took a while for HSK Ops to convince Houston to do this but shortly afterwards the Astronauts turned the LM transmitter off and Jack Dickinson was able to tune the frequency of the IU downlink far enough away from the LM frequency to prevent them interfering with each other.

Houston subsequently decided to turn the IU off and leave it off, but for some reason it was unable to do this and it continued to transmit until it impacted the Moon.

After the IU had crashed into the Moon, HSK-X was assigned to track the LM for the flight back to Earth right up to the point where the Astronauts needed to transfer into the re-entry vehicle attached to the CSM in preparation for re-entry. Although the CSM had suffered a potentially fatal malfunction it still played a vital part in the astronauts return to earth."

Apollo Lunar Missions continued

Following the explosion Houston was desperate to assign whatever resources it could muster to the rescue operation, and requested the CSIRO to make Parkes available to help in this. The CSIRO agreed and the staff at Parkes hastily reconfigured the telescope to receive Apollo frequencies; - a task that usually took about a day was completed in four hours.

In parallel with this, urgent arrangements were made for the Tidbinbilla team to fly to Parkes on a specially chartered aircraft. The team of Bruce Window, Roy Stewart, Jack Dickinson, Harry Westwood and Peter Stewart, were on duty at Tidbinbilla at the time, so they hastily left the station, called in at their respective homes to collect whatever personal belongings they thought they would need and drove to Canberra Airport. It had been hoped their plane would be able to land at the airstrip adjacent to the Radio Telescope, but by the time they reached the Parkes area it was already dark and because the only runway lighting at the strip would have been the headlights of several cars, the pilot decided it was too risky to attempt the landing and diverted to nearby Parkes Airport..

The cars CSIRO had waiting were quickly relocated there and took them out to the Radio Telescope. While this was occurring, the skeleton operations team back at Tidbinbilla, with Ron Hargreaves as the Operations Supervisor, continued to track the IU in two-way mode until it was handed over to the Wing station at Madrid.

When the Tidbinbilla team reached the Parkes telescope the communications links with Honeysuckle Creek were in the process of being established by the PMG. Voice intercom was quickly achieved and Bruce Window, as Parkes Ops Supervisor, provided regular status reports to Honeysuckle as the team brought the rest of the equipment up to operational status. He also advised Honeysuckle of Dr Bolton's need, as was the case with Apollo 12, for accurate pointing data for the dish, and within a couple of hours the spacecraft had been acquired and the downlink voice patched through to Honeysuckle. Telemetry could not be sent to Honeysuckle until the next day when after an extraordinary effort by the PMG, the microwave links between Parkes and Canberra were re-established.

For the duration of their stay at Parkes, the team was accommodated in the on-site emergency quarters. Dr.Bolton, the CSIRO Director at Parkes, made sure that they were well catered for and provided with all meals. The team worked 16 hour shifts for the three days it took the spacecraft to fly round the Moon and attain a trajectory that would ensure it would return to Earth. During this period, the higher gain of the Parkes antenna enabled it to receive crucial telemetry data from the stricken spacecraft at a higher bit rate than was possible with either the Honeysuckle or Tidbinbilla antennas.

The only problem that occurred at Tidbinbilla during the mission was one of its transmitters shut down during a pre-track Systems Readiness Test. The problem, - a fan motor in its Heat exchanger failed resulting in the transmitter over heating, was quickly repaired with little impact on the station's operation.

Mike Dinn, who was on duty as the Operations Supervisor at Honeysuckle at the time the emergency occurred, has these recollections of it -

Before Apollo 13 flew, I heard about the plan to keep the IU/S4B powered up until lunar impact to allow trajectory determination. Although the IU transmitted on the same frequency as the LM this was not expected to be a problem in normal operations because the LM would not normally be powered up until it was in lunar orbit, and this would have been after the S4B had ceased to transmit after impacting the Moon. Despite this, I remember having a SCAMA call to Goddard (I happened to be at Tidbinbilla at the time) about what we might do if we had to cope with both signals at the same time. My answer was – 'No problem - Just shift the frequency of one of the transmitters one way, and the other in the opposite direction'. We had, in fact, simulated this very technique at Tidbinbilla during the Surveyor program, when there was a possibility of two Surveyors being on the Moon at the same time, and transmitting on the same frequency. Although this did not eventuate with Surveyor, we had covered the possibility of it occurring in the future. When the Apollo 13 explosion occurred, I was just getting ready to sit in the HSK Ops1 seat, when I heard over the intercom "Houston we've got a problem". Quite soon after that, the CSM was powered down, and the LM powered up so we now had to cope with identical S4B and IU frequencies.

Goldstone was in two-way mode at the time, but as I recollect, Honeysuckle was soon to go two-way on both spacecraft. It was quite clear as to what needed to be done to separate the two signals, as discussed above. John Mitchell reached the same conclusion independently. As I recall, we successfully separated them. I can't remember which spacecraft the prime and wing stations ended up tracking.

Things were stable for a while but then Houston asked us to tune one of the uplinks to a different frequency. The reason for this was not clear and I immediately realised that it would result in overlapping signals. Despite several attempts to warn Houston of what would happen if we did what they wanted, they insisted we do it and the problem we said would occur happened.

We attempted to separate the signals using the standard technique but were unsuccessful, so I told Houston the only solution was to have the LM downlink turned off for a couple of minutes to enable us to tune the IU to a different frequency. Clearly, this was quite a dramatic request noting the dire situation the spacecraft and the astronauts were in, but Houston eventually agreed, and the LM was switched off.

Apollo Lunar Missions continued

We succeeded in shifting the IU frequency to one side, and when the LM resumed transmitting, we had stable links with both.

Early in the emergency, Houston asked if Parkes could be made available, but I advised them it was not scheduled to support this mission. I'm fairly certain this was because of the northerly declination of the moon during the mission and Parkes' inability to reach below 30° of the horizon meant that the spacecraft would have been in view for only short periods. Despite this still being the case, Chris Kraft was determined to have every resource that could be made available help bring the astronauts back safely. To this end, he asked Don Gray and Tom Reid to help make this happen and Parkes did indeed get involved in bringing Apollo 13 safely back to Earth. This came about only through the commendable efforts of the Parkes personnel, the hastily assembled team from Tidbinbilla and numerous PMG personnel.

But, and I hate to say this, Parkes was not really required. The required bit rate from the LM was well within the telemetry threshold of both HSK and HSK-X. I don't remember any attempt or need to go to a bit rate that would have been possible only with the higher gain of the Parkes antenna. Even so, there was some thought that the narrower beamwidth of Parkes might enable it to spatially separate the LM and IU, but I don't remember this being tried.

I can understand Houston wanting to call up any resource that could be available, including comms, in such dire circumstances, and it is quite possible that had there been further degradation in the comms links, the increased performance of the Parkes antenna would have been of critical importance. But as I said, this was not the case.

In the lead up to the Apollo 13 mission, it was realised that the new 64 m antenna under construction at Tidbinbilla would completely block the microwave link with Honeysuckle Creek. As this link was essential for the two stations to communicate with each other it was hastily relocated to do this. The original position of the microwave tower is as shown in the centre foreground in this photo. The new location, which resulted in a slightly degraded performance compared with the original location, was at the other end of the main building.

The microwave link tower in its original location adjacent to the new Comms Centre

Apollo 14

Launched 31 Jan 1971; – Splash-down 9 Feb 1971. The purpose of Apollo 14 was to make the 3rd manned landing.

This was a routine mission with the only thing of note as Keith Aldworth recorded -

Mal Lee joined the team that went to Parkes for Apollo 14. This mission was the first to transmit colour TV from the Moon. He brought a colour monitor with him and a clever little circuit that he had designed to make the sequential scan colour TV from the Moon compatible with the monitor. I recall that as being very successful and popular with everyone who had the opportunity to view it.

Apollo 15

Launched 26 Jul 1971; – Splash-down 7 Aug 1971. The purpose of Apollo 15 was to make the 4th manned landing.

This proved to be a very interesting mission as it included the first use of the Lunar Rover which enabled the astronauts to explore a much greater area of the Moon's surface. Parkes and the Tidbinbilla team were again called on to support the mission.

Keith Aldworth was one of the Tidbinbilla personnel who went to Parkes for this mission and he recalls –

During the mission, we worked very long hours. We were only one team, so we had to do everything - Pre-cals, tracking and post-pass wrap-up. Twelve to fourteen hours shifts were the norm. Hence, at times when the work demand was low, opportunities for power napping occurred and we took full advantage of them. Here I am with my colleagues enjoying such an opportunity -

Post mission, we were always anxious to get back to Canberra but we had to decommission the equipment to enable the Parkes permanent personnel to reconfigure the Telescope so that it could resume its primary radio-astronomy work. While this usually took only a few days, we found it rather arduous after working very long shifts during the missions.

Meanwhile at Tidbinbilla, Tony Keiller and Bruce Window, who had not gone to Parkes for Apollo 15, led their shifts and performed all that was required by Honeysuckle Ops to support Houston's mission requirements.

Apollo Lunar Missions continued

Apollo 16

Launched 16 Apr 1972; – Splash-down 27 Apr 1972. The purpose of Apollo 16 was to make the 5th manned landing.

By now tracking Apollo had become a routine exercise and Apollo 16 like the preceding two missions was undertaken without any operational difficulties.

Apollo 17

7 Dec 1972; – Splash-down 19 Dec 1972. The purpose of Apollo 17 was to make the 6th manned landing.

Towards the end of 1972, DSS 43 became operational and it was assigned its first tracking role on Apollo 17. Thus Apollo 17 was the only mission that was supported by the three Canberra stations – the dedicated MSFN station at Honeysuckle Creek, the hybrid MSFN/DSN station at Tidbinbilla and the newly built DSN station DSS43 at Tidbinbilla.

Mike Dinn recalls -

This was the first mission supported by DSS 43. I was in the US at the time, participating in the final stages of system design for DSS 43. I and Tom Reid decided that DSS 43 would be sufficiently finished to support Apollo 17, even though the Master Equatorial Unit had not yet been installed. And in any case, it would be a good project milestone to aim for. I coordinated the support plan with GSFC and Houston. Mission Support was perfect.

Bruce Window too recalls the role of DSS 43 in Apollo 17 as follows –

I went to JPL in September 1971 at the request of Tom Reid, the Complex Director, and Frank Northey, the DSS 43 Deputy Station Director, to work with the JPL staff responsible for planning the installation and commissioning of the new 64 metre antenna at Tidbinbilla. I spent 6 months on this task and on returning to Tidbinbilla I was made responsible for overseeing the implementation of the new RF equipment and cabling on the antenna. Tied in with this was the task that Mike Dinn was given, which was to produce a JPL document defining the operational interface requirements with Goddard and Houston for this support.

Some weeks before the launch of Apollo 17, all of the equipment and cabling except the Master Equatorial Unit had been installed. Equipment acceptance tests had been commenced and most had been completed. The RF system was basically operational, but not fully checked out to acceptance standards. Based on my experienced in Apollo operations and my knowledge of the stage the DSS 43 equipment commissioning had reached, I considered that DSS 43 was capable of supporting Apollo 17. Station Management in conjunction with the relevant Section Engineers agreed, and this was proposed to JPL and the MSFN, and DSS 43 was committed to tracking Apollo 17 on a 'best-efforts' basis. For the mission, two of the Block IV Receivers were configured with

MSFN VCOs which enabled communications with the CSM, LM and the Lunar Rover frequencies to be received. Pointing data was supplied by JPL in a format compatible for use with an AZ/El antenna because the installation of the Master Equatorial Unit at the centre of the dish pedestal was not finished. I had some pleasure in sitting at the Ops Desk of DSS43 for this mission considering all the work we had done to get there, and also looking back at my times at HSKX and Parkes.

Thus DSS 42 and DSS 43 were committed to supporting Apollo 17 concurrently, with Tony Keiller and Ron Hargreaves leading the operations teams at HSK-X, and Bruce Window leading the DSS 43 team, which included Jack Dickinson on the Receivers and one of the more experienced Antenna Operators. The new DSS 43 systems performed perfectly and provided excellent telemetry data to Honeysuckle without any problems. HSK-X also had an excellent mission without problems.

DSS 41 helps out with Apollo 17

In mid 1972, John Heath was to have one last association with Tidbinbilla and Apollo. At that time he held the position of Company Manager and was busy completing the plans for the closure of the station that was to occur at the end of 1972. This planning had to ensure that sufficient staff was retained to meet two critical objectives – meeting the station's tracking commitment until its last scheduled track on 22 Dec 1972; and subsequently for the removal of the systems etc that JPL wanted to be sent to its other stations in the ACT, Madrid and Goldstone. A phone call from Canberra to the Station Director in August 1972 was to have a major impact on his plans.

John recalls –

Although DSS 41 Island Lagoon was to close at the end of the year, it was still required to track Pioneer 10 full time until 22 December, and the retention of staff to do this in a remote location like Woomera was seen to be a potentially serious problem.

Towards the end of 1972, construction of DSS 43 was nearing completion and it was about to become operational. This would require an increase in staff numbers and the pending closure of Island Lagoon was seen as a rich source for these and I was asked to consider releasing the equivalent of a full Operations Team.

Clearly, the loss of any member of a tracking team let alone a complete team would have an adverse impact on a station's ability to meet its tracking commitments. Nevertheless, through the commendable cooperation of all the members of the tracking teams, I was able to release the equivalent of a tracking team and also fulfil our tracking commitment. Over a period of a few weeks, the staff who transferred to Tidbinbilla in the September timeframe to become involved in Apollo 17 were, as far as I recall – Peter Pistoor, Mike Somerville, Tony Price, Dave Hollingsworth, John Murray, Allan Yorke, Les Acton, Frank Adcock, Zoltan Beldi and Roy Livermore.

The ability to release this many staff was only possible because the remaining operations teams at Island Lagoon agreed to work without a break for approximately three months – yet another example of the dedication the 'spacetrackers' of that era had for their work. I have a copy of the Monthly Operations Report for December 1972 – the last one I wrote, and it records that for the month the station had met its scheduled Pioneer 10 tracking commitment of 230hrs 30 minutes for all bar 12 mins – a commendable success rate of 99.9%.

Roy Livermore was one of the first to transfer to DSS 43 and he recalls -

I transferred to DSS 43 from DSS 41 in time to be involved in Apollo 17. I helped maintain and operate the computer for pointing the antenna.

Acquiring the Apollo spacecraft soon after launch was an exciting time. This was accomplished using timed predictions sent by JPL at the fantastic (for those days) speed of 2000 bits per second and saved in a computer. The way this data was used was interesting. First a punched paper tape was made and verified, and wound on to a spool. The spool was then loaded into a photo reader and read into the pointing computer.

As the time interval between predictions was 5 minutes, the computer calculated a smooth parabolic curve between them and the results sent to the antenna 100 times a second. The antenna was then positioned at the computed acquisition point and once the signal was acquired the received data sent to JPL.

Which station received those first TV pictures?

The Australian-produced film 'The Dish' has created some controversy with the way it portrays the role Parkes played in supporting Apollo and the impression it gives that Parkes was the station that received the remarkable footage of Armstrong stepping on to the Moon. The true story of that historical event is somewhat different!

Mike Dinn explains -

The nominal flight plan for the period immediately following the landing was for the astronauts to have a rest/sleep period. This would have resulted in the "first step", and subsequent EVA, occurring in Parkes' view. However, as they did not use the rest period, when they exited the LM they were in view of both Honeysuckle and Goldstone but not Parkes (because of its 30 degree lower elevation limit). Consequently, TV of the commencement of the EVA was available only from Goldstone and Honeysuckle until the moon rose into Parkes main beam. Parkes was then used for the rest of the EVA.

For a detailed discussion of this topic, see https://www.hq.nasa.gov/alsj/alsj-TVEssay.html

When the Apollo missions were being planned, NASA decided not to televise the landing but as the launch date for Apollo 11 approached, it changed its mind, and hastily added this capability to the LM. Weight and space constraints on the LM, made it necessary to design a special compact, light-weight camera which, because of the available space, had to be mounted upside down.

Consequently, the upside down images it produced needed to be inverted before they were broadcast to the World. This was to be done at the receiving stations back here on Earth with the simple operation of a switch.

The first TV pictures received by Houston were from Goldstone and Honeysuckle and were of the Astronauts preparing to climb down the ladder before stepping on to the Moon. The operator at the Goldstone station however, had forgotten to set the switch in the position that would have made the picture the right way up, and as Honeysuckle's pictures were the right way up and had better contrast, Houston switched to Honeysuckle in time to record Armstrong taking that first step. Consequently, it was Honeysuckle that brought the pictures of man's first step on to the Moon to the World.

It is interesting to note however, that the original Mission Plan was for Tidbinbilla, because of its better performance, to communicate with the LM during the lunar landing phase of the mission and had it not been for the transmitter failure it experienced, it would have been Tidbinbilla that provided those now famous pictures.

Parkes did however play a major role in receiving the TV images because once the LM had come into its field of view, the better quality of its TV was clearly evident and was used for the remainder of the time the astronauts spent on the Moon.

The curtain falls on Apollo

The USA had planned to send a further three Apollo missions to the Moon in the year or so after Apollo 17 and had in place the trained crews and the hardware ready for these when they were cancelled. It is not entirely clear as to why this occurred. Various unauthenticated reasons have been suggested including the success of the earlier missions made them unnecessary, the emerging demands of the Skylab and other Programs, and the need to reduce overall expenditure on space projects.

Whatever the reason or reasons, the end of the Apollo Program was to have a profound impact on Honeysuckle Creek and Tidbinbilla. In the case of Honeysuckle, it went on to support Skylab for several years, after which it was converted to become part of the JPL Deep Space Network as DSS 44 in February 1974. It performed this role until December 1981, when its antenna was relocated to Tidbinbilla where it continued to be involved in interplanetary programs as DSS 46 until its closure in December 2009. Its antenna remains fully assembled at the Tidbinbilla complex.

In the case of the MSFN Wing at Tidbinbilla, it was decommissioned by the MSFN and the equipment removed.

With the completion of the Apollo 17 mission and the end of the Apollo Program, the ‘big switch’ was switched to the DSN position for the last time and DSS 42 reverted to its traditional role of tracking spacecraft that reach ever deeper into the universe. It continued to do this with distinction until its closure in 2000.

DSS 43 too, after its short involvement with Apollo, took up its intended role of interplanetary exploration and commenced its primary role of pushing back the frontiers of space even further than DSS 42 was able to do – a role that it is still performing today over 50 years later, and one it is expected to perform for many years to come.

An important link with history

One of the few remnants of DSS 42 that remains is the quadripod structure which is located in a quiet corner near the visitors centre at Tidbinbilla. This structure was part of the original DSS 42 antenna that was used to track Apollo, as well as every other lunar and interplanetary program the US undertook during the station's thirty-five year operational period from 1965 to 2000

John Heath comments –

I cannot look at this photograph of the quadripod without an acute sense of nostalgia as back in the 1960s I had reason to climb up it on several occasions to examine the hyperbola reflector. It is of considerable interest to recall that the microwave energy that brought telemetry and TV pictures of some of the Moon landings back to Earth actually bounced off its surface, to find their way via the masers and receivers at Tidbinbilla, and the microwave link to Honeysuckle, where it was processed before being sent to Houston and broadcast to the World at large.

We can thank Peter Churchill, who was at one time Station Director at Tidbinbilla, for ensuring that this link to Apollo was not scrapped as was virtually everything else associated with the early days of space tracking in Australia. He should be commended for having the vision to save something of real historical significance.

One small contribution by Tidbinbilla to one great achievement by the USA

Whilst all the Apollo Missions were remarkable achievements in their own right, and Armstrong's first step the unquestionable pinnacle event that is etched into the minds of all those who witnessed it, it was Apollo 8 that was for many the most exciting and satisfying of the missions. When pressed to explain why they think this, the usual answer is that Apollo 8 was the first time men had left the Earth's gravitational field knowing that they may never return, - they could easily have flown past the Moon and gone into orbit around the Sun for the rest of eternity. It was also the first time man had orbited another celestial body and had seen the Earth through his own eyes to be what much of humanity fails to comprehend – rather than it being a large place, it is but an insignificant object in the vastness of the universe.

It is evident from the foregoing recollections that Tidbinbilla made a valuable contribution to the Apollo Program, one that included the expertise that enabled Parkes to support the program.

It is also evident that, as the Apollo program unfolded, the many people at Tidbinbilla and the other establishments who participated in the program, did so without realising they were participating in what was destined to become one of the most significant events in human history. They simply went about their jobs with little regard for this and it was not until many years later that they, and the public at large, came to appreciate the true significance of the events they were part of.

It is hoped these recollections go some way to document the excitement and above all else the sense of dedication and commitment to 'getting the job done' that existed at the time – something that all involved can look back on with pride. It is also hoped that they will go some way to setting the record straight on the largely unrecognised role Tidbinbilla played in the incredibly successful Apollo Program.