Man on the Moon: Forty Years On

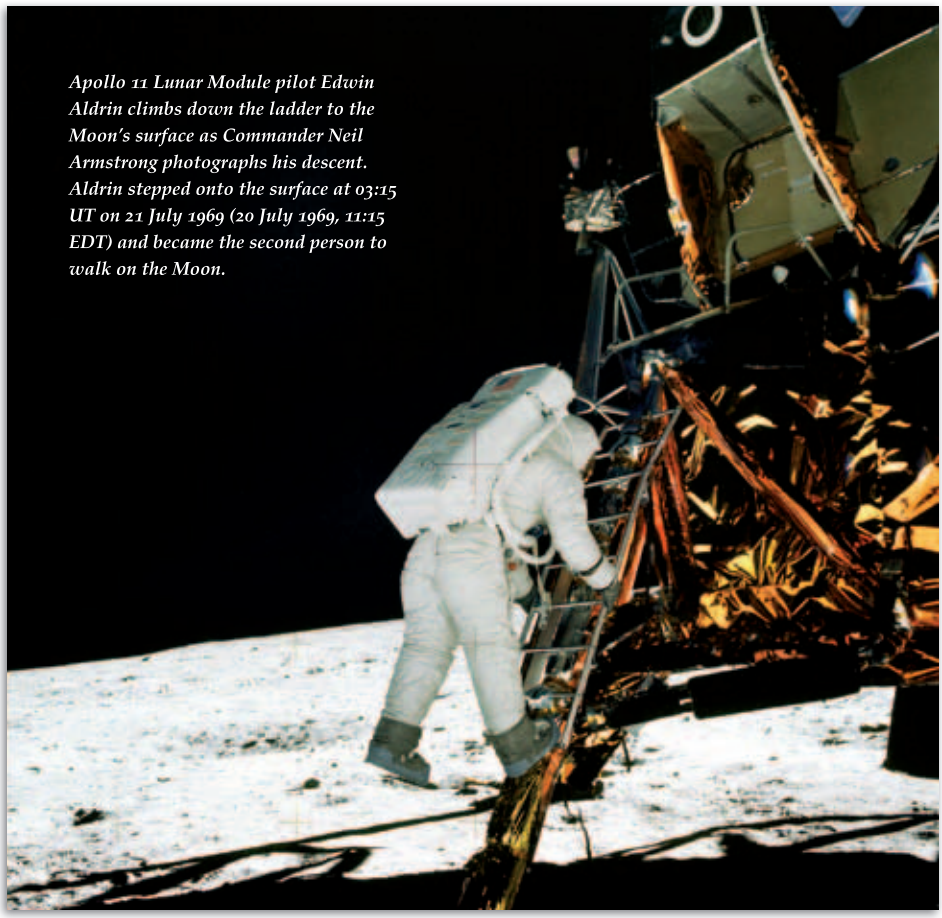
By Wg Cdr Clive Blount

The *Apollo* programme to put an American on the moon succeeded in this aim some forty years ago this June. This article celebrates the technological achievement and supreme effort of the people involved in the programme but also provides some interesting insights into the political motivation for going to the Moon in the first place, the appetite for risk, and the degree of political control of technical decisions. It describes the highlights of the *Apollo* programme, but also puts the undoubted technical successes into the historic context of: the America of the 1960s and the Cold War, and, in doing so, asks the question why such an ambitious programme of Government procurement proved such a resounding success – a minor miracle to our eyes in an era when modern large public procurement efforts are rarely successful and on time. The article ends by discussing why manned interplanetary exploration ended so abruptly, and sums up the 'balance sheet' of the supreme achievement that was the *Apollo* programme.

'In the past 30 years, no human being has set foot on another world, or ventured further upward into space than 386 miles, roughly the distance from Washington, DC to Boston, Massachusetts. America has not developed a new vehicle to advance human exploration in space in nearly a quarter-century. It is time for America to take the next steps'

George W Bush, 14 January 2004

Very few undertakings - even those considered momentous at the time they happen - survive the cynical examination of history unscathed to inspire a continuing sense of awe and wonderment. The NASA programme to conduct manned exploration of the Moon - the *Apollo* 11 landing of which, some forty years ago, is commemorated by this issue of Air Power Review - is, however, one of those outstanding events; a pinnacle of human achievement that remains breath-taking in its audacity, and captures the imagination of each succeeding generation. Ironically, as evinced by George W Bush's speech at the opening of this article, *Apollo* did not lead to further manned interplanetary exploration, Moon 'bases' and exploitation of the Moon's resources, or even any further manned scientific exploration of the Moon after the six *Apollo* landings.

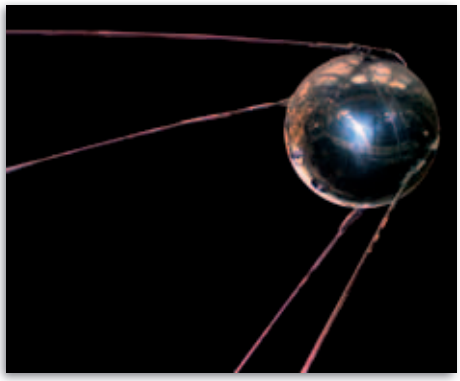


Apollo 11 Lunar Module pilot Edwin Aldrin climbs down the ladder to the Moon's surface as Commander Neil Armstrong photographs his descent. Aldrin stepped onto the surface at 03:15 UT on 21 July 1969 (20 July 1969, 11:15 EDT) and became the second person to walk on the Moon.

Man has remained firmly in earth orbit. However, it can be argued that the achievements of NASA in those early years has led to an increasing awareness of, and dependence on, space in the daily life of our planet, a dependence which the other authors in this 'space' issue of APR will no doubt examine in depth.

My original aim in this article was to describe the *Apollo* programme as a celebration of the technological achievement, and to commemorate the supreme effort of the people involved. My research, however, provided some interesting insights into the political motivation for going to the Moon in the first place, the appetite for risk, and the degree of political control of technical decisions. I will now, then, describe the highlights of the *Apollo* programme, but will also attempt to put the undoubted technical successes into the historic context of the America of the 1960s and the Cold War, and, in doing so, investigate why such an ambitious programme of Government procurement proved such a resounding success – a minor miracle to our eyes in an era when modern large public procurement efforts seem destined to fail… or at least be delivered very late! I will finish by asking why manned interplanetary exploration ended so abruptly, and by summing up the 'balance sheet' of the supreme achievement that was the *Apollo* programme.

Although tentative steps had been made by the United States towards a space exploration programme - including Robert Goddard's early experimental rockets in the 1920s, and the rounding up into American research programmes of German



Russian satellite Sputnik 1 launched 4th October 1957.

rocket scientists at the end of the Second World War - it was the successful launch of the modest *Sputnik I* satellite by the Soviet Union, on 4th October 1957, that galvanised the United States into what became the 'Space Race'. However, the then president, Dwight D Eisenhower, appeared to remain calm, and, possibly with the benefit of knowledge of the secret programmes being run by the Army and Navy, refused to acknowledge the Soviet effort as anything more than a 'ball in the sky'. He was also privy to a deal of intelligence about the Soviet Union that clearly demonstrated the United States' technical and military superiority over the communist bloc. But it was the public perception that was all important and the Soviet success with *Sputnik* became a gift for the democratic opposition, led by house majority leader Lyndon B Johnson. Johnson triggered a masterful campaign of scaremongering that was eventually to lead to the election-winning claims of 'the missile gap' used by presidential challenger John F Kennedy during the 1960 campaign. Johnson was at the forefront of an attack on Eisenhower that ranged from accusations of unilateral

disarmament, to that of allowing America to become 'so hedonistic, so addicted to frivolity, that they will have turned to mush'.[1] The 'Space Race' thus became a political weapon - not just about East versus West but also within domestic politics.

British Prime Minister Harold Macmillan visited Eisenhower on 23rd October 1957 and his memoirs provide an interesting insight into the effect *Sputnik* had on the American psyche. He found that the impact of *Sputnik* had 'been something akin to Pearl Harbour. The American cocksure-ness is shaken'.[2] In one his greatest contributions as Prime Minister, Macmillan was able adroitly to use this American loss of confidence to rebuild the transatlantic relationship, a relationship that had been lying in tatters since the Suez débâcle, and to rebuild British influence in the United States to, arguably, its post-war high. A major result of this achievement was the repeal of the McMahon Act - which had hitherto prevented release of US nuclear secrets – ushering a new period of co-operation on nuclear issues across the Atlantic.

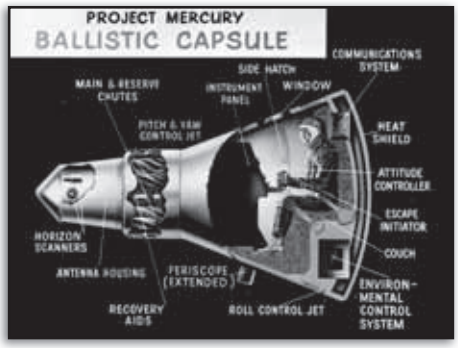
The US eventually followed *Sputnik* with a scientific satellite of its own, *Explorer*, on 31st January 1958, which, boosted by its own motor into a much higher orbit that the Russian satellite, was able to gather vital radiation data in the area named after the director of the experiment, James Van Allen. Although a degree of national honour was regained, there was deep concern in the United States that the Soviet launch capability was much more powerful – with the ensuing security implications if these rockets were used for military payloads. In response, Eisenhower set up the Advanced Research Project Agency (ARPA) to co-ordinate national research and, on 2nd April 1958, established the National Aeronautics and Space Agency (NASA).

United States satellite Explorer 1 launched on 31st January 1958.

X15 mounted to B52 pylon in flight circa 1965.

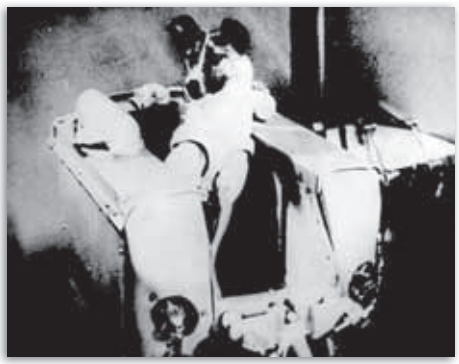
Momentum now increased to develop a craft that could put a man into space. It had long been assumed that the first spacecraft would be a development of the trend of 'higher' and 'faster' experimental aircraft - such as NASA's highly successful X15. However, time was now pressing - if the Soviets were to be 'beaten' - so a 'manned satellite' or 'capsule' was

developed as part of the 'Man in Space, Soonest' (MISS)[3] programme



- announced to the world as project *Mercury* in December 1958. NASA did however start to consider more ambitious targets during 1959, with work beginning on developing techniques that could eventually lead to a lunar landing. 1960 was, however, an election year and all parties were aware that, although Eisenhower had ordered the acceleration of the US space programme and had authorised spending to develop the *Saturn* booster, significant spending on space was likely to be delayed until after the election. As stated previously, Kennedy used the perceived Soviet superiority in space and missile technology to good effect during his election campaign:

'The first man-made satellite to orbit the earth was named Sputnik, the first living creature in space was [the dog] Laika. The first rocket to the Moon carried a red flag. The first photograph of the far side of the Moon was made with a Soviet camera. If a man orbits the earth this year his name will be Ivan'.[4]



Laika in Sputnik 2 circa 1957.

He expanded the 'race' metaphor even further: '...we cannot run second in this vital race. To ensure peace and freedom, we must be first'.[5]

In fact, as Vice President Richard Nixon protested, the United States was not behind at all - with some 26 Satellites and 2 space probes launched since Sputnik, compared to the 6 satellites and 2 probes of the Soviets. Eventually elected, this space race mentality and the notion of a

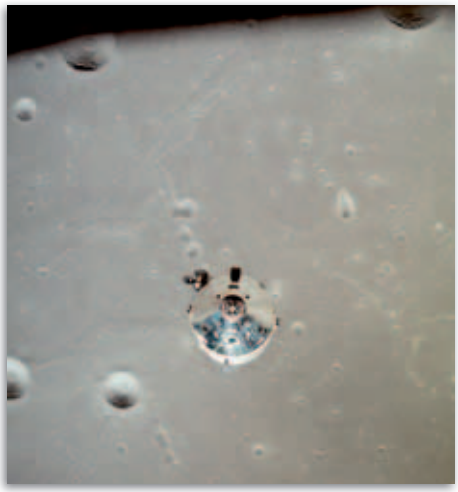
Cosmonaut Yuri Gargarin being taken to Vostok 1.

'missile gap' were to haunt Kennedy throughout the early stages of his presidency as he became faced with a series of ever more testing issues. The deep south was embroiled in turmoil over racial segregation, the crisis in Laos was threatening to trigger off the 'domino effect' in South East Asia[6] and the disastrous invasion of Cuba at the 'Bay of Pigs' left the incoming administration appearing very weak in the face of communist aggression.

To cap it all, just one week before the Bay of Pigs fiasco, the Soviet Cosmonaut Yuri Gagarin became the first man into space, conducting a full orbit. The ballistic, sub-orbital, *Mercury* flight by the first American in space, Alan Shepard, did little to reset the balance. On 25th May 1961, Kennedy gave his famous speech to Congress, billed as his second 'State of the Union' address, in which he committed the Nation to a 'great new enterprise' with the words:

'I believe that this nation should commit itself, before this decade is out, to landing a man on the Moon and returning him safely to the earth... '.[7]

Once Kennedy had issued the challenge, the NASA scientists had to develop mission profiles that could meet the stated goal while minimizing risk to human life, cost, and whilst not asking the impossible of emerging technology or, indeed, the fledgling astronauts. Four modes of lunar mission were considered: the **Direct Ascent Option** (A Huge Rocket travelling directly to the Moon; landing and returning as a unit); the **Lunar Surface Rendezvous** (Using two spacecraft in succession – one as a 'tanker' of fuel to enable the launch from the Moon of the other); **Earth Orbit Rendezvous** (Using multiple rockets each carrying various parts of a direct ascent spacecraft into earth orbit. After docking, the spacecraft would have landed on the Moon as a single unit) and **Lunar Orbit Rendezvous** (LOR) (A single spacecraft composed of modular parts would be launched into lunar orbit. A command module would remain in that orbit, while a landing vehicle would descend to the Moon and then return to the command module). We now know the latter, LOR, was eventually selected. Primarily, this was because it required only a small part of the overall spacecraft to land on the Moon, thereby minimizing the mass to be launched from the Moon's surface for the return trip - and therefore the size of spacecraft and amount of fuel that would be required.



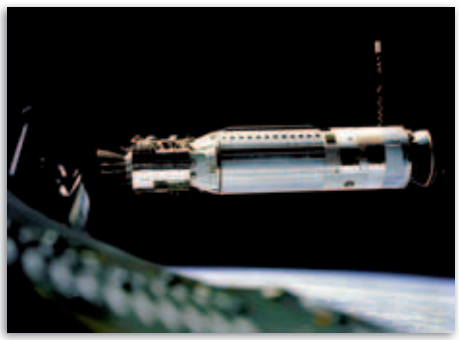
Command Module Columbia over Craters Taruntius K, Taruntius P, and Dorsum Cayeux in north central Mare Fecunditatis (Sea of Fertility).

In 1961, however, direct ascent was generally the mission mode that had the most support within NASA, as the prospect of performing in-orbit rendezvous, never mind actually docking, in Lunar Orbit, was a very tall order - especially as we must remember that neither had been attempted in Earth orbit at this stage. (In fact an American was yet to even achieve an orbital flight!) However, the debate raged among NASA's forward-thinking scientists and engineers and, on 11th July 1962, NASA's formal selection of LOR was announced. This was a fundamental decision that enabled the eventual success of Apollo; space historian, James Hansen confirms this:

'Without NASA's adoption of this stubbornly held minority opinion in 1962, the United States may still have reached the Moon, but almost certainly it would not have been accomplished by the end of the 1960s, President Kennedy's target date'.[8]

On thing was certain; whichever mode was selected to get to the Moon, it was clear that a number of techniques would have to be developed alongside the hardware, and it was this development activity that formed the bulk of the objectives set for the follow-on to *Mercury* – Project *Gemini*. The *Gemini* spacecraft was larger than the *Mercury* capsule and carried two astronauts. An number of milestones were achieved during the programme, including in-orbit rendezvous (*Gemini 6/7*), Extra-vehicular Activity - 'Spacewalk' - (*Gemini* 4 onwards), Docking (*Gemini* 8) and record breaking long duration flights of 8 days (*Gemini 5*) followed by 2 weeks (*Gemini 7*). It was also during these *Gemini* flights that most of the leading astronauts that were eventually to go to the Moon gained their early space experience.

On June 3, 1965 Edward H. White II became the first American to step outside his Gemini spacecraft and let go, effectively setting himself adrift in the zero gravity of space.



Armstrong and Scott performed the first successful docking of two spacecraft, joining the Gemini to the Agena target vehicle.

President Kennedy signs Proclamation 3504, authorizing the Naval quarantine of Cuba- 23 October 1962.

Less than a year after Kennedy's challenge, with the *Mercury* programme still in its early stages, Kennedy faced one of the biggest foreign policy challenges of the era - the Cuban missile crisis. For the now famous 'thirteen days' in October 1962 the world 'held its breath' on the brink of what was potentially to become the first superpower nuclear exchange. Kennedy handled the crisis masterfully and faced Khrushchev down, following this with other successes over Berlin and nuclear weapon testing. Suddenly the Soviets looked less threatening - the need to

demonstrate mastery in the expensive arena of space exploration started to lose its urgency. In addition, the cold war focus was moving away from direct confrontation between the superpowers, evinced by the increasing US involvement in the burgeoning crisis in Southeast Asia.[9] Then, on 22nd November 1963, NASA lost its single greatest protector when John F Kennedy was assassinated.[10]

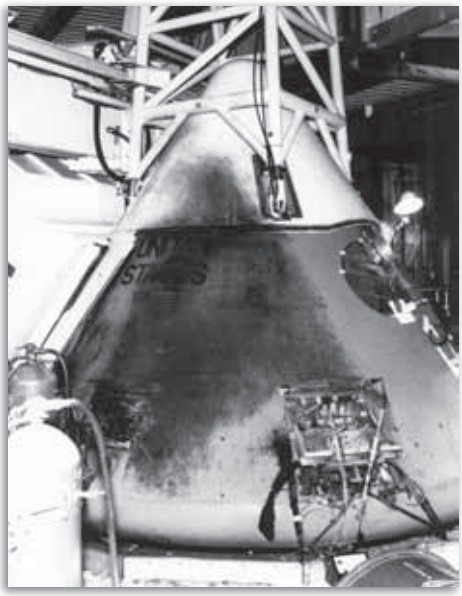
The race to place a man on the Moon within the decade now became further complicated as questions began to be asked about the massive requirement for federal funding of the programme – with the usual 'pork barrel' politics of allocating major projects in the constituencies of key politicians. In particular, there was focus on the decision to build the Manned Spacecraft Centre in Texas, home state of the now president, Lyndon B Johnson. Questions were asked about the allocation of a significant amount of work to the construction company Brown and Root, who had been supporters of Johnson. As Piers Bizony says, in 1967 a young Republican Senator was outspokenly critical:

'Why such a huge contract has not been adequately audited is beyond me. The potential for waste and profiteering is substantial' [11]

40 years later, the young senator – then Secretary of Defense Donald Rumsfeld - was less critical of the government activities of Brown and Root (now part of the Haliburton Group) in Iraq!

Secretary of Defense Donald Rumsfeld.

Although it appeared to outsiders that the programme was progressing well, as the mid-60s dawned fundamental problems were appearing, with a number of significant technical and programme management challenges. In particular, relations between North American - a major contactor – and NASA were particularly strained, with a plethora of programme and quality control issues emerging. In addition, NASA senior management became convinced that innovative new management procedures could save the day - whereas the effort involved in incorporating these new techniques merely distracted key personnel from the key engineering issues. The 'idea' of Apollo rapidly became out of synch with the harsh technical realities on the ground. As the first manned flight of Apollo approached, NASA personnel, particularly the astronauts, became increasingly frustrated



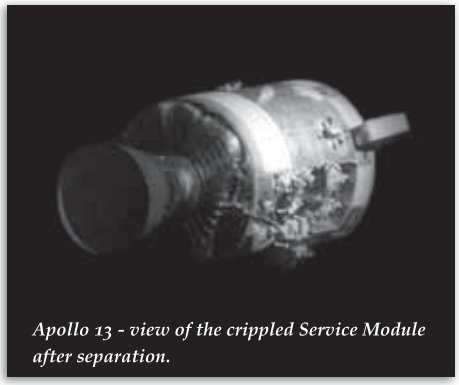
Apollo 1's Command Module a day after fire.

with the number of technical issues and work-rounds associated with the spacecraft. The problems came

catastrophically to a head on 27th January 1967 when, whilst undergoing ground testing on the launch pad, an electrical fire in the capsule rapidly became a conflagration in the pressurized 100 per cent oxygen environment destroying the capsule and killing the three crew.

The Apollo 1 fire represented a watershed in the programme. NASA were allowed to conduct the enquiry but were now obviously in a spotlight; the fire had destroyed confidence in the agency across America. Despite the fact that 9,400 US soldiers were killed in Southeast Asia that year, on a 'mission whose management was uncertain, whose purpose was undefined, and whose execution was flawed'[12] , the death of the astronauts was taken as evidence of high incompetence within the agency. While establishing responsibility for the accident was far from straightforward, a major conclusion was that: 'deficiencies existed in Command Module design, workmanship and quality control.[13]

After the fire and the subsequent enquiry it is little short of miraculous that the programme was able to regain its demanding timeline with only 21 months elapsing before manned flights recommenced. Major changes in organization and approach were implemented and a series of unmanned launches tested out the command module and its *Saturn* boosters. It is a testament to the thoroughness of the reorganization that, three years later, when *Apollo* 13 executed an emergency shutdown of the command module after a crippling explosion in the service module *en route* to the Moon, water condensation gathered for four days but did not cause any shorts or sparking when the spacecraft was powered up to enable re-entry. Moreover, it was possible for investigators to establish the cause of the explosion from the comprehensive engineering documentation, limited photography and telemetry alone without access to the service module itself.



Apollo 13 - view of the crippled Service Module after separation.

Apollo 7 S-IVB rocket stage in Earth orbit on October 11, 1968. Cape Canaveral and Merritt Island, Florida, can be seen beyond the left side of the lower end of the S-IVB.

Apollo 7 heralded a return to manned flight with a successful comprehensive 11-day engineering test flight in earth orbit launched on 11th October 1968. However, by mid-1968, it became clear that Lunar

Module (LM) development was behind the main programme, and it was unlikely that Grumman would be able to provide a flight-ready vehicle in time for *Apollo* 8 - the mission was designed to test the LM in earth orbit before subsequent missions reached for the Moon. Director of the *Apollo* Spacecraft Programme Office, George Low, proposed that, rather than perform another simple earth orbiting mission, they send *Apollo* 8, without LM, around the Moon over Christmas. Initially greeted with some skepticism – Webb was reported to have reacted with the words: 'Are you out of your mind? You're putting our Agency and the whole *Apollo* project at risk!'[14] The stress of the personal grilling suffered by Webb during the *Apollo* 1 enquiry, some accusations of corruption and Lyndon Johnson's announcement that he would not seek a second term in office led political appointee Webb to resign and, on 12th November 1968, his replacement, Tom Paine, announced his courageous decision that *Apollo* 8 would be going around the Moon.

On 21st December *Apollo* 8 was launched to take the first humans on an interplanetary voyage; what astronaut leader, Deke Slayton was later to describe as 'the greatest single gamble in space flight then, and since.'[15] On Christmas Eve, *Apollo* 8 entered Lunar Orbit and passed behind the Moon for the first time of its ten eventual orbits. The crew was busy with many tasks - including an examination of possible landing sites for future missions[16] - but also found time for two activities that were to have political implications. The first was a reading from Genesis,

Rollout to the launch pad of the Apollo 8 Saturn V on October 9, 1968.

with the crew wishing '…. A merry Christmas, and God bless all of you - all of you on the good earth.'[17] There were many objections to the use of the religious text in a US government funded mission - although Burrows suggests it was a deliberate slight at the 'godless commies.'[18] What we were seeing, however, was the early development of the concept of the world as an ordered whole, on a fragile planet, which resonated deeply worldwide. The other activity - the taking of the famous 'Earthrise' photograph - is now considered to have given considerable impetus to the burgeoning environmental movement that had been boosted by the recent publication of such books as Silent Spring by Rachel Carson[19] and the increasing number of man-made ecological disasters - such as the *Torrey Canyon* grounding only a year earlier. The 'Global Village' was emerging in world consciousness.

Apollo 9, launched on 3rd March 1969, was an earth orbit check out of the

View of the Apollo 9 Lunar Module "Spider" in a lunar landing configuration photographed by Command Module pilot David Scott.

LM, before *Apollo* 10 performed a full rehearsal of the Moon landing mission; with the LM descending to within some 47,000 ft above the Moon's surface. The LM at the stage was still too heavy to land on the Moon and a rapid weight

At 9:32 a.m. EDT, the swing arms move away and a plume of flame signals the liftoff of the Apollo 11 Saturn V space vehicle and astronauts Neil A. Armstrong, Michael Collins and Edwin E. Aldrin, Jr. from Kennedy Space Center Launch Complex 39A.

loss programme was in progress at Grumman in order to meet the next Mission. In the latter stages of his presidency, Johnson had grown increasingly disillusioned with the space programme and the newly elected President, Richard Nixon, remained at arm's length, publicly, from the programme. When *Apollo* 11 was launched, Nixon was not present at the launch, leaving the VIP box to his vice president, Spiro Agnew, and ex-president Lyndon Johnson.

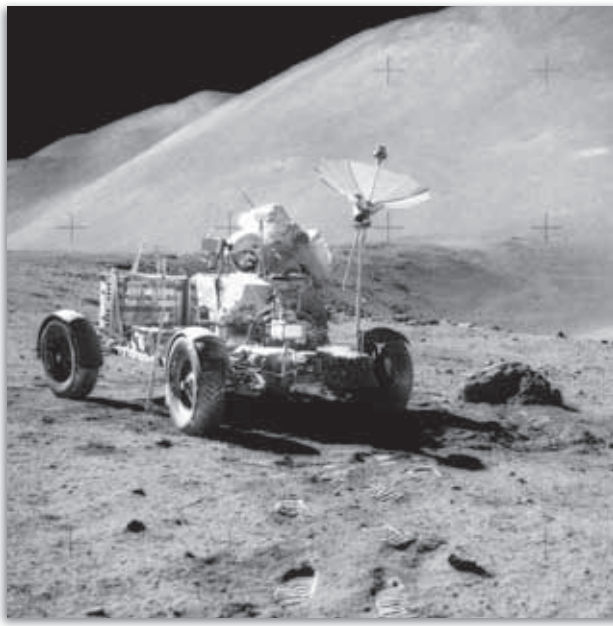
At 15:17hrs (Houston time) on 20th July 1969, the *Apollo* 11 Lunar Module *Eagle* touched down on the Moon after a nail-biting approach, and with

approximately 20 seconds of fuel remaining. After about six hours of checks and a foreshortened rest period, Commander Neil Armstrong made that 'one small step for [a] man'

Astronaut Alan L. Bean, Lunar Module pilot for the Apollo 12 lunar landing mission, holds a Special Environmental Sample Container filled with lunar soil collected during the extravehicular activity (EVA).

onto the Moon's surface at around 21:55. He was followed by Buzz Aldrin and they together walked on the Moon's surface for some two and a half hours. President Nixon was now keen to be associated with the success and was able to speak with the astronauts on the surface of the Moon directly from the oval office.

Now Kennedy's challenge had been met, it was time to make the major scientific leaps of the *Apollo* programme. The aim was for crews to spend increasingly longer on the lunar surface and to explore further from the LM. The crew of *Apollo* 12 spent just short of 8 hrs walking on the lunar surface and conducted a full set of scientific experiments. The saga of *Apollo* 13 has now taken its place in space history but, at the time of the launch, the public interest and excitement had waned. The television broadcasts from the spacecraft in trans-planetary space were not carried by any of the major news networks. All this changed, of course, when the explosion occurred - leaving the world watching in suspense for some 63 hours before the incredible teamwork and technical ingenuity demonstrated by NASA and the spacecraft contractors brought the astronauts home safely.[20] The remaining missions increased the amount of scientific work exponentially, with the addition of



David R. Scott, Commander of Apollo 15, works at the Lunar Roving Vehicle (LRV) during the third lunar surface extravehicular activity (EVA) of the mission at the Hadley-Apennine landing site.

the lunar rover on *Apollo* 15 enabling long distances to be traversed on the lunar surface. *Apollo* 17 was without doubt the acme of manned space exploration with a total of 22 hours spent outside the LM on the lunar surface and some 19.3nm travelled in the rover. This mission also saw the first of the 'non-pilot' astronauts, geologist Jack Schmitt, walk on the

Moon. Despite the outstanding success of the mission, the newly-elected Republican administration's distrust of 'big government' federal spending, the strains of Vietnam, reduced public interest and, possibly most importantly, the emergence of possible détente with the Soviets, conspired to drastically reduce NASA's budget. The commander of *Apollo* 17, Gene Cernan, thus became the last man to stand on the Moon.

Following the success of the *Apollo* program, NASA planned several new missions for the, now surplus, *Apollo* hardware. The *Apollo Applications Program*, proposed up to thirty earth orbital missions, primarily using the space designed for the

Geologist-Astronaut Harrison H. Schmitt is photographed standing next to a huge, split boulder at Station 6 on the sloping base of North Massif during the third Apollo 17 extravehicular activity (EVA-3) at the Taurus-Littrow landing site.

lunar module in the *Saturn* rocket to carry scientific equipment. Only two of the planned missions were implemented: the *Skylab* space station (May 1973 – February 1974), and the *Apollo-Soyuz* Test Project (July 1975).

Skylab Orbital Workshop in Earth orbit as photographed from the Skylab 4 Command and Service Modules (CSM) during the final fly-around by the CSM before returning home. The Skylab Orbital Workshop fulfilled its mission before being deorbited in 1978.

Skylab's fuselage was constructed from the second stage of a Saturn IB, and the station was equipped with the *Apollo* Telescope Mount, based on a LM. Astronauts were ferried into orbit in an *Apollo* command module; the station itself had been launched with a modified Saturn V Booster. Skylab's last crew left orbit on 8th February 1974, and the space station itself returned to Earth in 1979 - by which time it had become the oldest operational *Apollo* component. NASA also developed a programme to identify possible 'spin-offs' from spacecraft development in the NASA 'Technology Utilization Programme' whose aim was:

'To identify and hold up to the light the many items of space technology that could be or had been adapted for uses in the civilian economy. By 1973 some 30,000 such uses had been identified and new ones were rolling in at a rate of 2,000 a year'.[21]

Photograph from the Apollo spacecraft in Earth orbit during the Apollo-Soyuz Test Project (ASTP) mission. It shows the Soviet Soyuz spacecraft contrasted against a black-sky background with the Earth's horizon below.

The Apollo programme was successful in achieving the explicit aim declared by Kennedy and more. The programme captured the imagination of the nation and it became a supreme national effort. At the peak of *Apollo* production, in 1967, over 400,000 people were engaged working on an aspect of the *Apollo* programme.[22] This National support eased the massive allocation of federal funds required for success, although it remained, very much, a programme of the cold war, designed to assert US superiority over communism. As the Cold War 'thawed' in the latter stages of the programme, funding and support became increasingly problematical. In its latter stages it became rapidly overtaken by the war in Vietnam in the public consciousness.

So what did it all cost? The NASA budget reached an annual peak of $5.1 Billion in 1964 where it remained for some 4 years.[23] In 1964, James Webb, as NASA administrator, in effect held sway over 5 per cent of the entire federal budget.[24] The eleven-and-a-half year programme:

'….. cost $23.5 Billion, landed 12 men on the Moon, and produced an overwhelming amount of evidence and knowledge. Technologically, it generated hardware systems several orders of magnitude more capable that their predecessors'.[25]

Although the colossal material cost of the *Apollo* programme is stunning, we should not forget that there was also a cost in human life. Astronauts Gus Grissom, Ed White and Roger Chaffee were burnt to death in the *Apollo* 1 Fire and no less tragically; Astronauts Elliot See, Charlie Basset and CC Williams were killed in T38 Flying Accidents whilst in training for Space Missions.

Apollo 1 Saturn V Apollo 204 Command Module Fire tragically killed Astronauts Gus Grissom, Ed White and Roger Chaffee.

NASA administrator George Low

summed up the all-enveloping endeavour that was *Apollo* with the words; 'There will never be another *Apollo* in anyone's life'[26] and looking back it does all seem slightly unreal. Going to the Moon has, at face value, changed little for a large number of human beings. In 2002, Arthur C Clarke was asked which event in the Twentieth Century he would never have predicted. He replied,"That we would have gone to the Moon and then stopped".[27] So why did the Americans stop? Well, essentially, for the same reason that the programme was so successful in the first place. The *Apollo* programme was a *political* programme - through and through. It was successful because the political impetus to beat the Soviets enabled mobilization of a massive national effort in terms of both funding and manpower. However, within two years of his 'before this decade' speech, Kennedy had faced Khrushchev down over Cuba and Berlin and made progress limiting the nuclear arms race; America was regaining its mastery of world affairs. Once the political rationale had gone, there was insufficient scientific or technological impetus to keep the huge national momentum behind the programme going. 'The greatest feat of human exploration had been undertaken for exactly the wrong reason'.[28] Nevertheless, in my view, the Apollo programme remains the greatest human adventure of the last 1000 years and will remain so until circumstances enable someone to take on George Bush's challenge at the opening of this article – whether it is again America remains to be seen.

Bibliography

Piers Bizony, *The Man Who Ran The Moon: James Webb, JFK And The Secret History Of The Apollo Project*, (Icon Books: Cambridge,2007)

Roger E Bilsten, *Testing Aircraft, Exploring Space: An Illustrated History of NACA and NASA*, (John Hopkins University Press: Baltimore, 2003)

William E Burrows, *This New Ocean: The Story of the First Space Age*, (Random House: New York, 1998)

Eugene Cernan and Don Davis, *The Last Man on the Moon*, (St Martin's Press: New York, 1999)

Andrew Chaikin, *A Man On The Moon: The Voyages of the Apollo Astronauts*, (Penguin: London, 1998)

Michael Collins, *Carrying the Fire: An Astronaut's Journeys*, (Farrar, Strauss & Giroux: New York, 1974)

Francis French and Colin Burgess, *Into that Silent Sea: Trailblazers of the Space Era, 1961-1965*, (Univ of Nebraska Press: Lincoln, 2007)

Francis French and Colin Burgess, *In the Shadow of the Moon: A Challenging Journey to Tranquillity, 1965-1969*, (Univ of Nebraska Press: Lincoln, 2007)

James R Hansen, *First Man, the Life of Neil Armstrong*, (Simon &Schuster: London, 2005)

Alistair Horne, *Macmillan 1957-1986*, (Macmillan: London 1989)

Lyndon Baines Johnson, *The Vantage Point: Perspectives of the Presidency 1963-1969*, (Holt, Rinehart and Winston: New York, 1971)

Gene Kranz, *Failure Is Not an Option*, (Simon & Schuster: New York , 2000)

Richard W Orloff and David M Harland, *Apollo: The Definitive Sourcebook*, (Praxis: Chichester, 2006)

Arthur M Schlesinger Jr, *A thousand Days: John F Kennedy in the White House*, (Andre Deustch: London, 1965)

Alan Shepard and Deke Slayton, *Moon Shot*. (Turner publishing: Atlanta, 1994)

Notes

[1]William E Burrows, *This New Ocean: The Story Of The First Space Age*, (Random House: New York, 1998) p191
[2]Harold Macmillan's Diaries. Quoted in Alistair Horne, *Macmillan 1957-1986*, (Macmillan: London 1989) p 55
[3]**http://history.nasa.gov/SP-4003/ch3-2.htm** accessed 29 Mar 09
[4]Quoted in Burrows, The New Ocean, p304
[5]*Op cit*
[6]Clive Blount, *Britain, the USA and South East Asia, 1961: A Case Study in Anglo-American Decision Making*. (MPhil Thesis, Cambridge University, 2008) pp23-29. RAF CAPS website **http://www.airpowerstudies.co.uk**.
[7]President John F. Kennedy, joint session of Congress, May 25, 1961 See **http://www.jfklibrary.org/HistoricalResources/Archives/ReferenceDesk/Speeches/JFK/003POF03NationalNeeds05251961.htm**
[8]Hansen, James R. (1995). *Enchanted Rendezvous: John C. Houbolt and the Genesis of the Lunar-Orbit Rendezvous Concept*. NASA. **http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19960014824_1996007704.pdf**. Accessed 28 Dec 2008.
[9]Blount, *Britain, the USA and South East Asia*, 1961.p28-31
[10]Piers Bizony, *The Man Who Ran The Moon: James Webb, JFK And The Secret History Of The Apollo Project*, (Icon Books: Cambridge,2007)p 123
[11]Bizony *The Man Who Ran The Moon*. P 59
[12]Bizony, The Man Who Ran The Moon. p 162
[13]NASA Report on Apollo 204 Fire. **http://www.hq.nasa.gov/office/pao/History/Apollo204/find.html** Accessed 6 Apr 09.
[14]Bizony, The Man Who Ran The Moon. p 211
[15]Alan Shepard and Deke Slayton, Moon Shot. (Turner publishing: Atlanta, 1994) p228
[16]For detailed mission objectives of all the Apollo missions, see, Richard W Orloff and David M Harland, *Apollo: The Definitive Sourcebook*, (Praxis: Chichester, 2006)
[17]Orloff and Harland, *Apollo: The Definitive Sourcebook*, p221
[18]Burrows, *The New Ocean*, p420
[19]Rachel Carson. *Silent Spring*, (Houghton Mifflin: Boston 1962)
[20]For a most comprehensive account, see: Gene Kranz, *Failure Is Not an Option*, (Simon & Schuster: New York, 2000)
[21]Roger Bilsten, *Testing Aircraft, Exploring Space: An Illustrated History of NACA and NASA*, (John Hopkins University Press: Baltimore, 2003) p78
[22]Bilsten, p74
[23]*Op Cit*
[24]Bizony, *The Man Who Ran The Moon*. p x
[25]Bilsten,) p103
[26]Andrew Chaikin, *A Man On The Moon: The Voyages of the Apollo Astronauts*, (Penguin: London, 1998) ,p551
[27]Quoted in frontispiece to Orloff and Harland
[28]Burrows, *The New Ocean*, p433