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Chapter 21

LUNAR SURFACE PHOTOGRAPHY: A STUDY OF APOLLO 11*

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The *Apollo 11* mission took place almost two decades ago. For an increasing number of young adults, as well as today's children, it is a matter of history—and not an event that was followed with rapt attention on TV as it happened. The first films brought back from the lunar surface inevitably had a quality which far surpassed the immediate television images, and the standard of many of the photographs taken by Neil Armstrong during the EVA on the lunar surface using the newly introduced Hasselblad Data Camera (DC), while equaled occasionally, was never surpassed during any of the subsequent missions (Plates 1 and 2) When these classic images are examined in books and elsewhere today, it is frequently assumed (and why not?) that they show Neil Armstrong, the first man to walk on the Moon. Without exception, however, the high quality, original still images published hitherto have been of Edwin E. ("Buzz") Aldrin, the lunar module pilot (LMP), and were taken by Armstrong. Pictures of Neil Armstrong himself were taken either from the black and white TV record or as color stills from the 16 mm data acquisition camera (DAC), which was firing at a slow frame rate through one of the lunar module (LM) windows during the EVA (Plate 3). The quality difference between these derivative pictures and the Hasselblad images was inevitably enormous.

One of the great achievements of NASA from its beginnings has been to conduct its frequently dramatic affairs in the full glare of publicity—for good or ill. With an interest in space photography and imaging pre-dating the *Apollo 11* mission, it had always puzzled this author that (apparently) no Hasselblad images of Neil Armstrong were taken during the EVA. This fact seemed to be borne out by an examination of the images released and discussions with photo-specialists at the NASA Lyndon B. Johnson Space Center in Houston. However, as long ago as October 1974 Neil Armstrong responded to an enquiry on this issue by writing [1] that the "70 mm still camera requirements were shared, with my share being about 75%, all according to the plan devised pre-flight for maximum utilization of our limited time. I believe there is one picture with me in the background . . ." Astronauts and former astronauts, no less than researchers and writers, all have livings to earn as

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well as having to devote time to more pressing and current events in the area of their chosen interests. As a result, it has taken until now to examine the subject of *Apollo 11* lunar surface photography in some depth and to identify that one image of Neil Armstrong obtained with the single Hasselblad camera taken out onto the lunar surface.

Plate 1 Neil Armstrong's classic 'visor' photograph of Buzz Aldrin (AS11-40-5903).

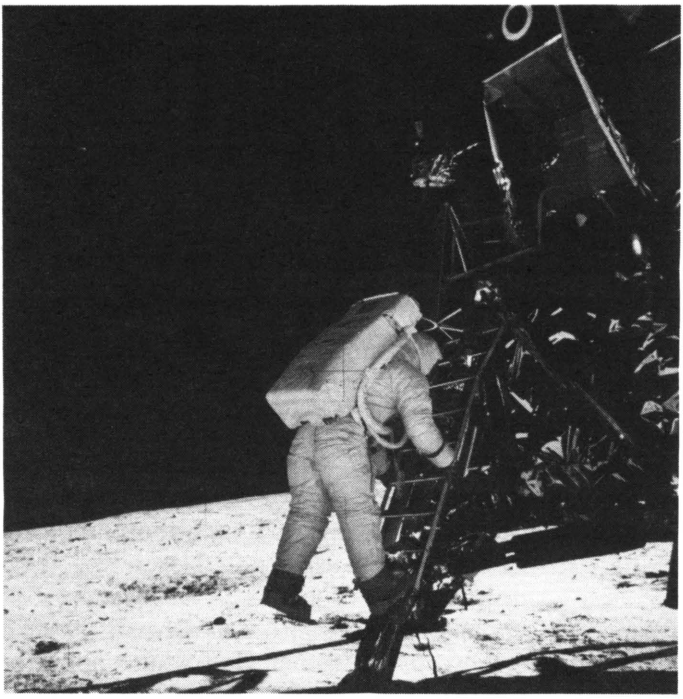


Plate 2 Aldrin about to step off the LM ladder: Armstrong altered the Hasselblad controls to f/5.6 at 1/60th of a second for shadow photography (AS11-40-5868).

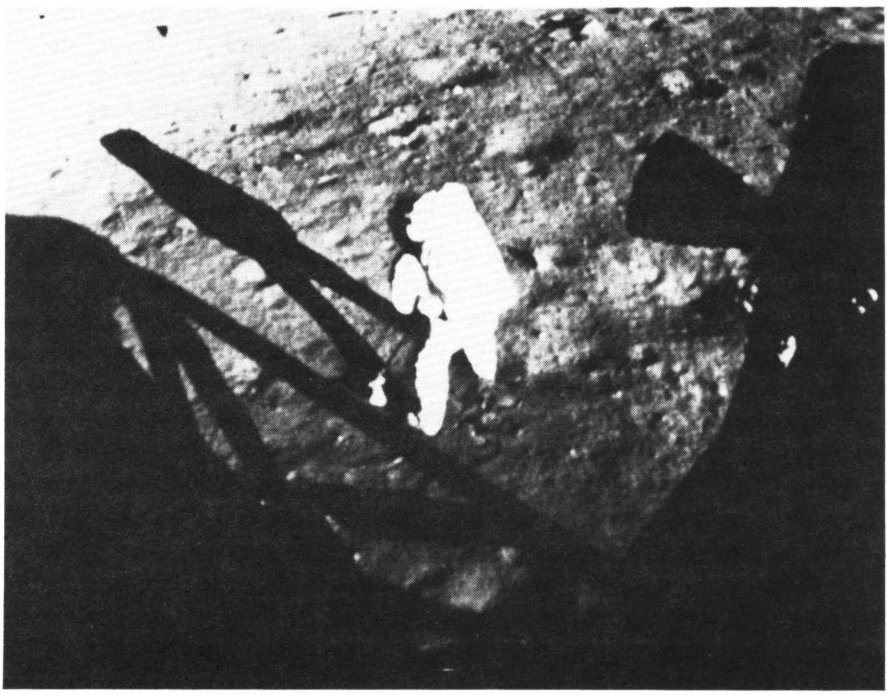


Plate 3 Armstrong collects the contingency sample—a frame from the 16 mm Maurer DAC (data acquisition camera).

Many of the participants have shared their memories willingly—but the passing years have thinned their ranks, and the memories themselves have tended to fade somewhat. Moreover, reflecting the pressure of events in 1969, contemporary or near-contemporary documents have to be analyzed with some care also. Thus, the official NASA press kit for the *Apollo 11* mission [2] stated that the lunar module would contain "two Hasselblad 70 mm lunar surface superwide angle cameras"—whereas this specially developed model had been replaced in the photographic plan some months before by one of the newly introduced data cameras and one of the already flown Hasselblad EL (electric drive) cameras. This was an error that persisted at least as late as April 1970, when the NASA Goddard Space Flight Center published a Data Users' Note on *Apollo 11* Lunar Photography [3]. In prospective or retrospective press releases, Hasselblad AB itself referred to two of its cameras being taken out on the lunar surface (there was only one)—and of Armstrong taking all of the photographs exposed on the Moon, which was not the case [4].

The official NASA catalogue of *Apollo 11*, 70 mm photographs published early in 1970 [5] identified Armstrong as the astronaut descending the lunar module steps. (It was, of course, Aldrin). And Aldrin himself wrote incorrectly in his autobiography [6] of a photo technician coming into contact with lunar dust on a film magazine and having to join those in the Lunar Receiving Laboratory (LRL) as a result. Whereas the NASA technician had been in the LRL by design since before Aldrin and his colleagues arrived there. Sometimes the contemporary errors are a fit subject for humor—as with one of the very helpful NASA press conference transcripts [7] which referred to *Apollo 11* astronauts taking "the magazine off the hazzle black camera". . . which is phonetically close enough to "Hasselblad" to be instantly recognizable. These errors are not recounted in any spirit of superiority but in the hope that what follows will reduce future errors to a minimum.

EVA PHOTOGRAPHIC EQUIPMENT

Two Hasselblad 70 mm cameras were aboard the lunar module *Eagle* when it descended to the Moon's surface. What was by now established as the basic Apollo mission camera—the EL—was a motor driven model that had been extensively modified, partly to meet NASA's safety requirements following the *Apollo 1* tragedy and partly to facilitate astronaut operation e.g. large tabs on controls. The camera's reflex system had been removed: it was fitted with an 80 mm focal length f/2.8 Zeiss Planar lens, and when loaded with Kodak thin-base color films, its magazines permitted up to 160 exposures per loading. This camera first flew in space on the *Apollo 8* mission in December 1968.

During the *Apollo 11* mission, the EL was used from within the lunar module only: to record Columbia at separation; the lunar surface from orbit; the scene around *Eagle* on the surface; and, a small number of images of Armstrong and Aldrin. The film used was Kodak Ektachrome S0168—a film sensitometrically similar to the then generally available High Speed Ektachrome. The speed rating of 106ASA (ISO), together with its inherent lower contrast characteristics, resulted in its becoming the standard lunar surface color film during Apollo. The *Apollo 11*

color magazine used with the EL was designated by the code letter "R" pre-flight, and the images exposed were subsequently given the magazine number "37"—thus AS11-37-5528, the latter being the individual frame identity number. This camera would have been used during the EVA if a fault had developed in the Hasselblad Data Camera. (A magazine of high resolution black and white film was also exposed through the windows of the LM.)

The DC was developed by Hasselblad for NASA in time to fly on *Apollo 11* and to replace the previously designated lunar surface Hasselblad super-wide camera. Basically it was an EL model, but with some significant modifications. In front of the magazine it incorporated a Reseau plate to facilitate the photogrammetric analysis of images (this caused the crosses seen on EVA photographs), and it was used exclusively with a 60 mm f/5.6 Biogon lens which Carl Zeiss had developed in only six months. Externally, the camera had silver anodized trim (to help limit the effects of high lunar surface temperatures). And to free the hands of astronauts during extravehicular activities, it was usually bracket mounted on the RCU—the remote control unit worn on the chest through which space suit environmental conditions were monitored and modified by the crewman (Plate 4). Neil Armstrong himself played a considerable part in the design and development of this bracket [8].

Exposures were made either by squeezing a large release plate at the front of the camera battery compartment or the trigger on a pistol grip when this was fitted. In the absence of a viewing system or frame, the astronaut had to depend on the wide angle field of view of the 60 mm lens and his own good judgment, both as regards desired coverage of subject matter and focusing to achieve good results. Exposure information on nominal aperture settings according to sun position for the 1/250th of a second shutter speed normally selected appeared on small decals fitted to the camera (Plate 5). The *Apollo 11* DC was loaded with S0168 film, and it was lowered to the lunar surface by means of the LEC (the lunar equipment conveyor), which was a line or pulley arrangement between the lunar module door and the surface. This necessitated film magazines being fitted with a tether ring. At the conclusion of the lunar surface EVA, the magazine of color film was detached from the camera, and the latter with its lens was discarded. (The Hasselblad EL camera aboard the lunar module was also subsequently discarded.) The EVA magazine was designated preflight by the code "S," and after processing the film was given the magazine number 40.

At all stages of the mission, valuable engineering, operational, and scientific information was derived from the 16 mm Maurer Data Acquisition Camera. One of these cameras operated in the command module, and a second in the lunar module where it was fitted to look through the right hand window (Plate 6). This was the camera which recorded the outside scene as *Eagle* descended to the lunar surface, and then the lunar surface activities by both crewmen. Buzz Aldrin had principal responsibility for its operation.

The DAC has often been referred to as a "movie camera," but this is a misnomer in that its basic purpose was to record a sequence of data images at frame rates which could vary from the conventional 24fps to 1fps—the slower frame rates giving

the camera a high volume information capability when used in automatic mode. Thus at 1fps the standard magazine containing 130-140ft of thin base color film lasted for some ninety minutes. The Maurer had a number of features not found on more conventional movie cameras, including completely independent shutter speeds and frame rates, an internal heater, and a green light which pulsed at the frame rate chosen. Six magazines of S0168 Ektachrome 16 mm color film were aboard *Eagle*, and the camera was fitted with an 18 mm wide angle lens.

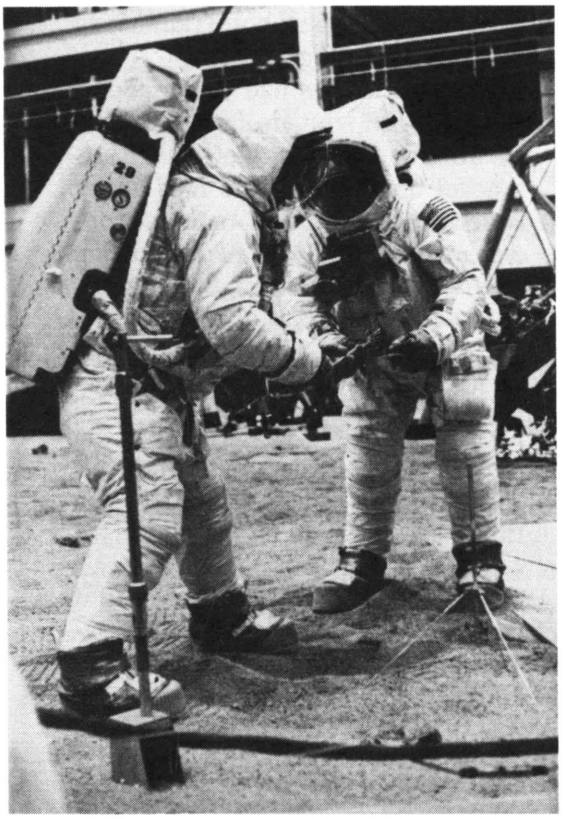


Plate 4 Armstrong (right) and Aldrin in training: note how the Hasselblad is mounted on the mission commander's RCU or chest pack so that both hands are kept free.

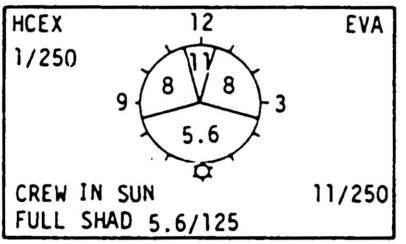


Plate 5 Exposure guidance decal (according to Sun position) as fitted to the lunar surface still camera.

Plate 6 The Maurer DAC is shown mounted in the LM's right hand window, through which it recorded the descent to the lunar surface (AS11-36-5389).

Aldrin was required to alter the DAC framing rates at various stages of the EVA, and these may be studied in Figure 1 where the Maurer is referred to as "SC" (for sequence camera). It is difficult to check accomplishment against the plan, but the result was generally satisfactory, and the air to ground voice transcription records, for example, Aldrin's concern to achieve correct aperture and shutter speed settings for the DAC as Armstrong was descending the ladder in heavy shadow [9]. Subsequent frames were to play an important role in the situation, which is discussed and analyzed later.

Although not directly concerned with the subject of this paper, it is appropriate to note that *Eagle* also carried to the lunar surface a close up camera (ALSCC) built by Eastman Kodak. This was a stereo camera with integral electronic flash that took pairs of pictures on 35 mm color film of areas of the lunar surface measuring 3 inches square. These images were intended to characterize the structure and texture of the loose, fine grained material composing the upper surface of the lunar crust before any disturbance by astronaut movements and geological specimen retrieval. Seventeen dual images were obtained by Armstrong and Aldrin, and the distinctive shape of the ALSCC is clearly seen in a number of the Hasselblad EVA frames [10].

The command module *Columbia* was also supplied with a Hasselblad EL and a Maurer DAC, and good use of these was made by command module pilot Mike Collins, and by Aldrin and Armstrong at times other than the lunar surface EVA. The concentration of this paper on the latter subject is no reflection on either the importance or quality of the photography from the command module (Plate 7).

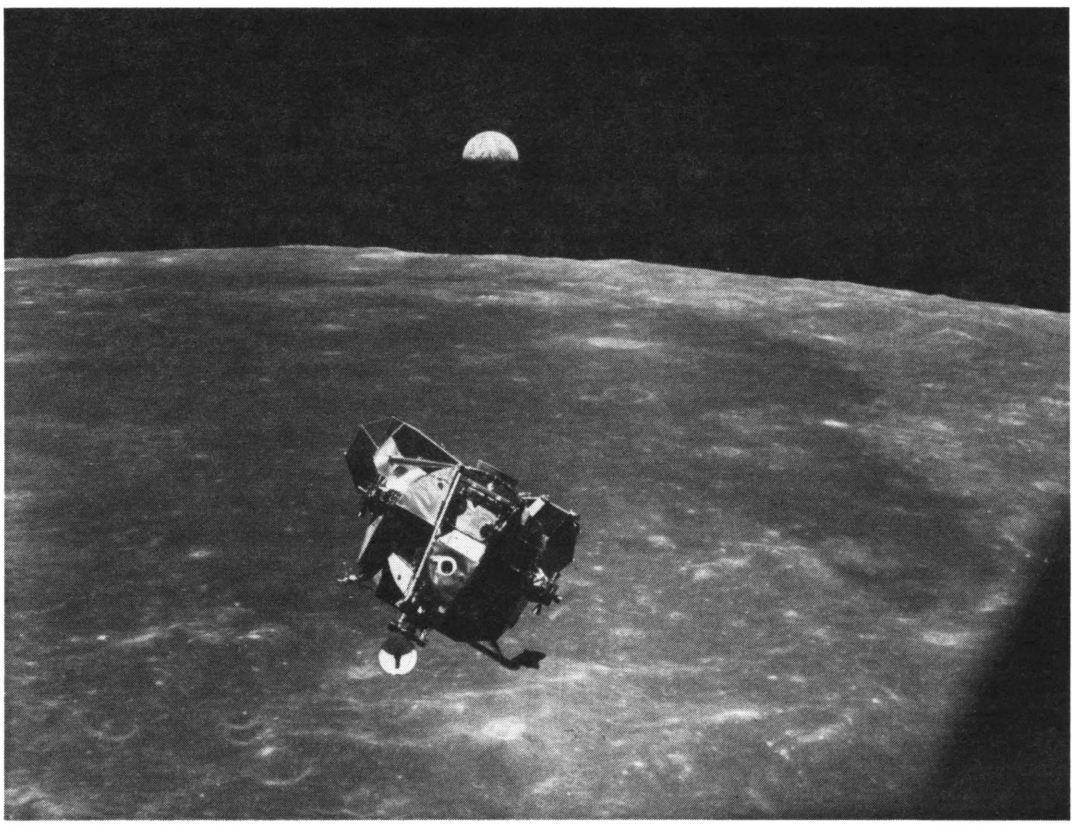


Plate 7 **Eagle** ascent stage and Earth recorded from **Columbia** by Michael Collins (AS11-44-6642).

EVA PHOTOGRAPHIC PLAN

In general, virtually all of the photography was aimed at documenting activities at major stages of the mission whether in orbit or on the lunar surface. During the EVA, such coverage was required to establish the condition of the lunar module—particularly its four struts or legs, the effect of its descent engine plume on the lunar surface, the interaction between the lunar surface and the astronauts' boots, to record panoramas around the LM location, and to aid in documenting geological specimens noted or collected. This was in addition to recording the deployment of the experiments set up on the lunar surface: the solar wind composition experiment (SWC); the passive seismic experiments package (PSEP); and, the laser ranging retroreflector (LRRR).

To avoid lengthy detailing of the photographic activities on the surface, the seven pages of the appropriate section of the operations plan [11] are reproduced here as Figure 1. For those not conversant with such plans, it may help to point out that each sheet shows two sequential sections of the plan for commander (CDR) and LMP side by side, with times at 10 minute intervals indicated, and with tick marks at one minute intervals. All photo activities have been highlighted by the author with single margin marks, but those of particular significance are accorded triple marks.

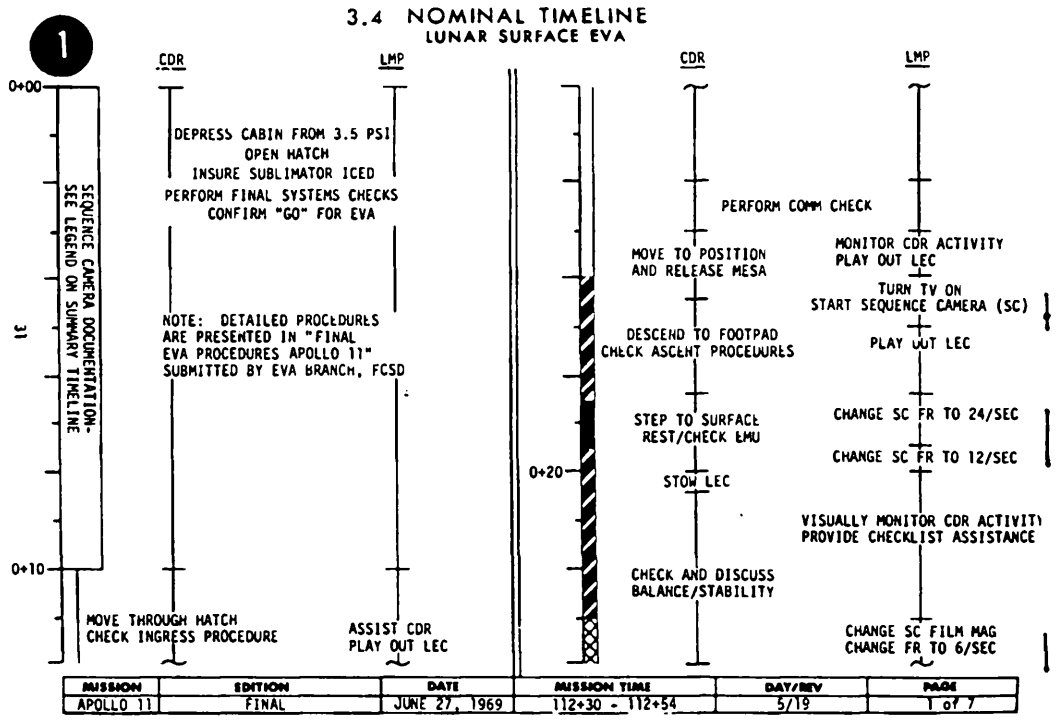
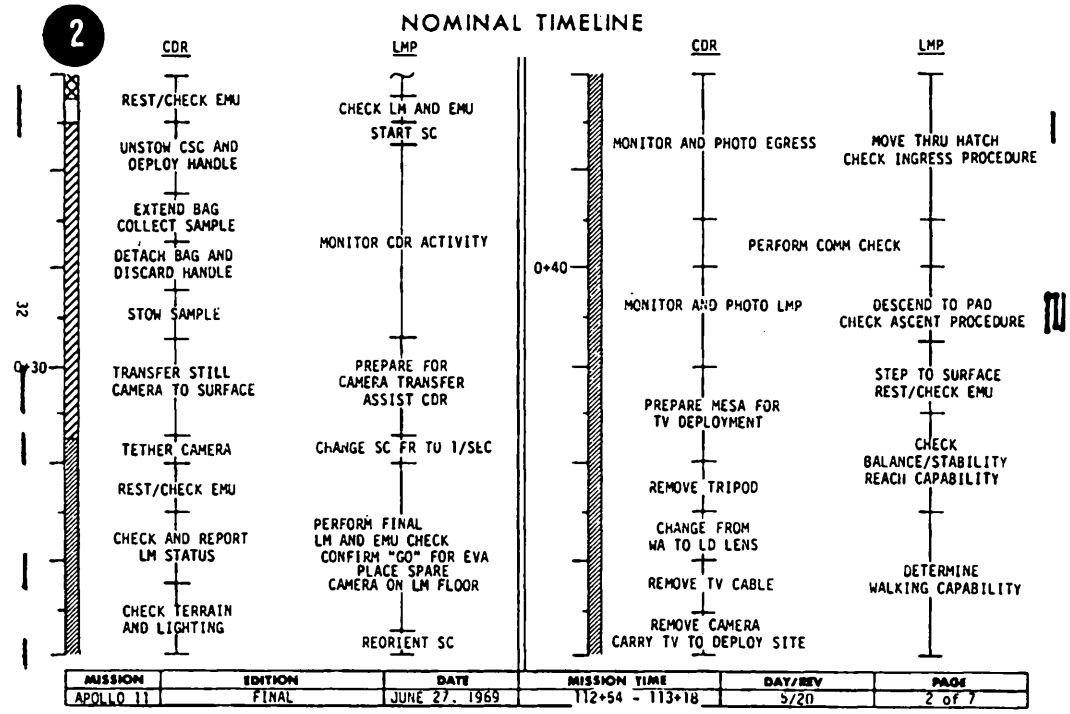


Figure 1 Apollo 11 Lunar Surface Operations Plan - Nominal Timeline.



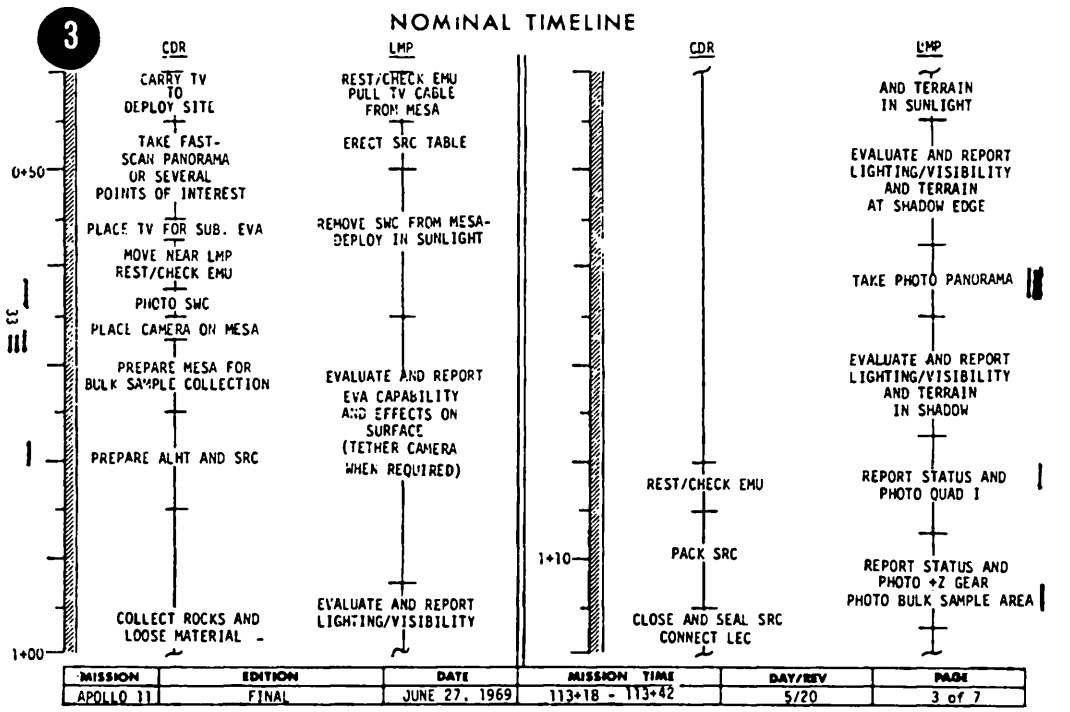
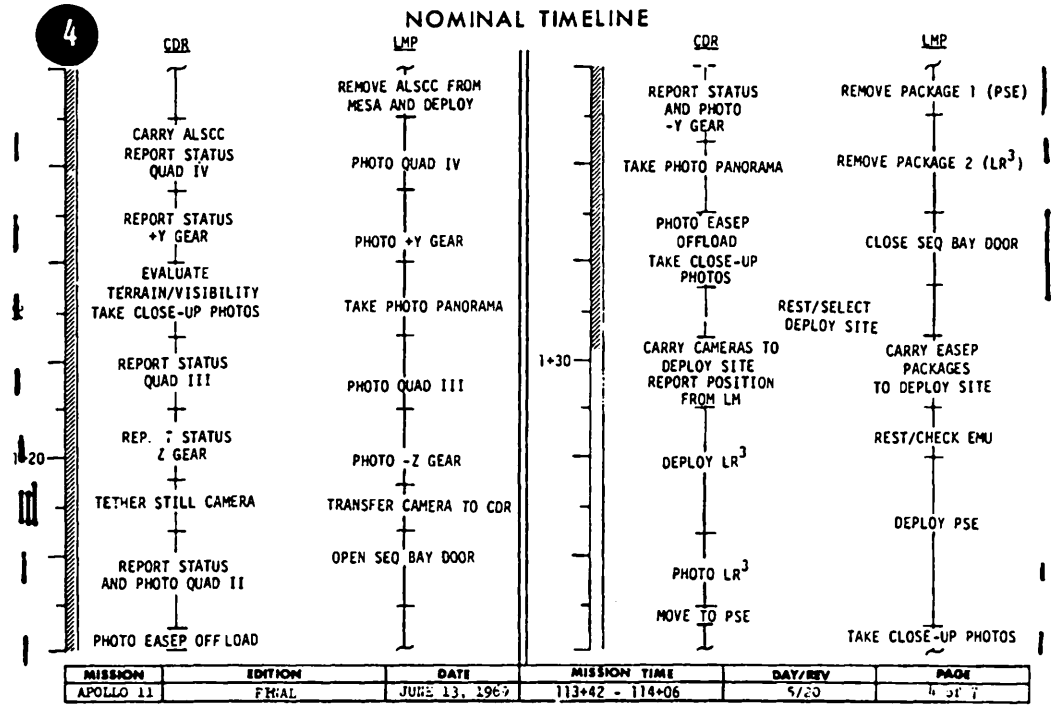


Figure 1 **Apollo 11** Lunar Surface Operations Plan - Nominal Timeline (continued).



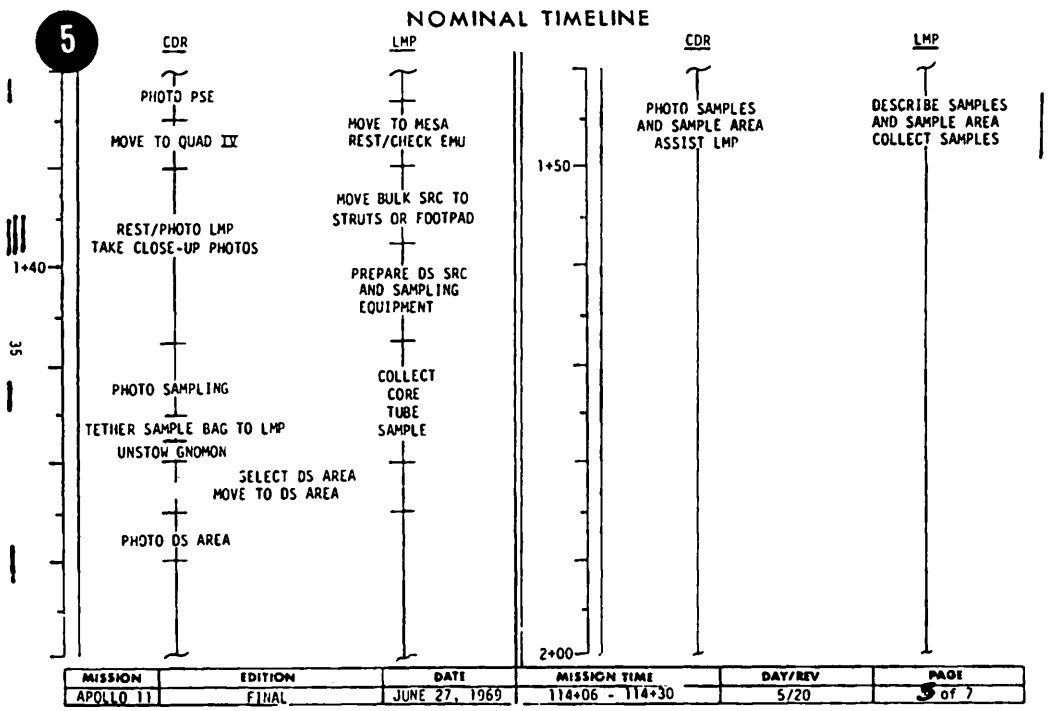


Figure 1 **Apollo 11** Lunar Surface Operations Plan - Nominal Timeline (continued).

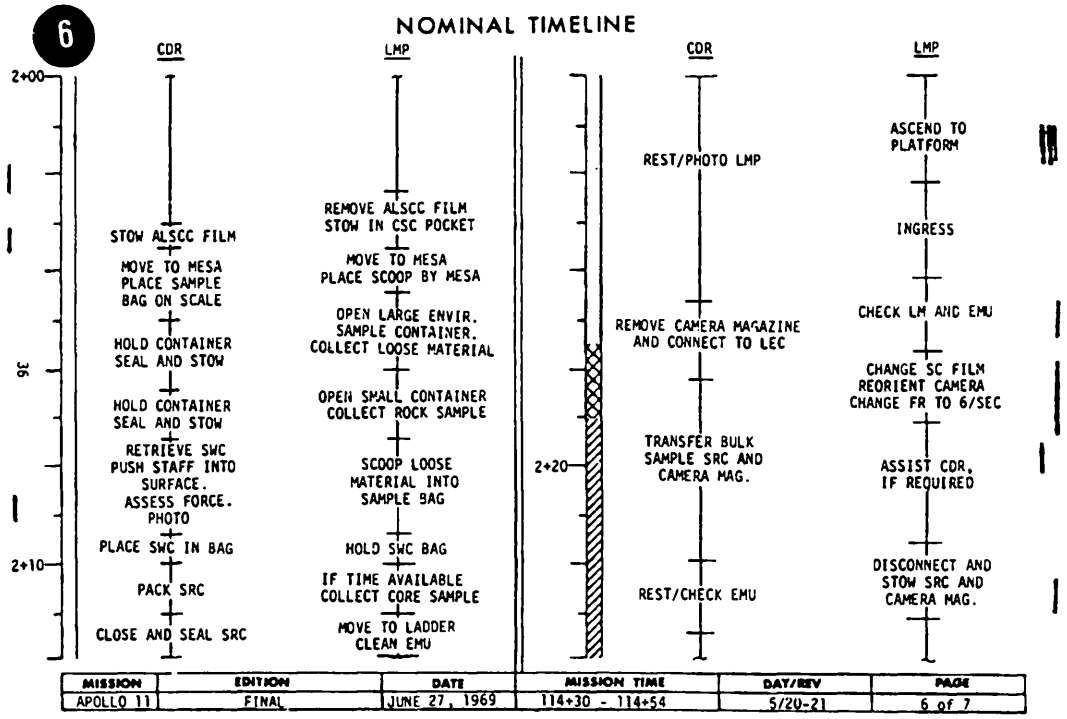


Figure 1 **Apollo 11** Lunar Surface Operations Plan - Nominal Timeline (continued).

A calculation based on the plan indicates that Neil Armstrong's comment that he operated the Hasselblad camera for around 75% of the time was approximately correct. A major feature of the plan was that Armstrong was required quite specifically to photograph Buzz Aldrin (LMP) on three separate occasions—at 0.41 minutes, 1.39 minutes and 2.14 minutes respectively, quite apart from documenting activities that Aldrin was conducting. In fact, Armstrong photographed Aldrin (or Aldrin is in the scene) on no less than 28 occasions out of the total of 128 frames on the film. (One image that he did not secure was the third required above—of Aldrin ascending the LM steps at the conclusion of his EVA.) *At no time during the approximately 25 minutes that he was scheduled to have the Hasselblad during the EVA was Aldrin required by the plan to photograph Neil Armstrong*—at a time when the mission commander was collecting the geological bulk sample, taking close up photographs, and examining the condition of various parts of the LM.

POST-MISSION EVENTS

The release of the historic photographs, for which the media of the world were waiting, was planned well in advance and proceeded efficiently despite the inevitable complications imposed by the quarantine regulations that covered the early Apollo lunar landing missions [12]. All films (together with the lunar rocks) arrived at the Lunar Receiving Laboratory at the then Manned Spacecraft Center on July 25, 1969. This was ahead of the crew.

The film magazines (sealed in plastic containers) had already been through a decontamination lock containing a solution of sodium hypochloride aboard the mobile quarantine facility. As soon as possible after arrival in the LRL, the films were exposed to a fumigant-sterilant gaseous solution of 12% ethylene oxide and 88% dichlorofluoromethane for a period of 16 hours in an autoclave chamber. The films then remained in the decontamination system for a further 24 hours, awaiting the possible growth of bacteria on accompanying control strips. When no such growth occurred, the films were released to the Photographic Technology Laboratory for processing. The decontamination procedure had been carefully checked in advance, but several days before the flight films arrived a test film was ruined: the cause was immediately found, and a modification to the equipment resulted in the subsequently safe treatment of all mission films.

The Photographic Technology Laboratory at MSC was by this time one of the most advanced processing units in the world, but there was still some debate about the handling of the *Apollo 11* films once they had been released from the LRL. Overall responsibility was that of John R. Brinkmann, chief of the PTL, but the task of processing the films was in the hands of Richard W. Underwood, at that time in charge of the PTL's precision laboratory. A proposal had been made that for safety reasons the lunar surface films should be cut up in pieces and processed individually, thereby ensuring the survival of at least some film should disaster occur. This was rejected by Brinkmann and Underwood [13], but a plan was agreed with public affairs and other staff for the decontamination and subsequent processing of films to be separated into two batches of 70 mm and 16 mm film, with the lunar surface EVA film (magazine S) in the second batch, for obvious reasons. This plan was

facilitated by the flight crew noting the priority magazines, and Buzz Aldrin was said to have been particularly helpful in this [14].

Underwood, two NASA PTL colleagues and contractor support staff from the Data Corporation started processing the first films on the evening of Sunday, July 27, 1969 in modified Kodak Versamat equipment. Elaborate safety and control procedures were in force, and the film was checked at several stages by infrared inspection. The initial preparation and processing run took approximately seven hours. Shortly thereafter, the initial media release selection began at the PTL with members of MSC management and Brian M. Duff (head of public affairs) present.

An examination of press cuttings from the US daily printed media shows that the schedule planned in advance by NASA public affairs staff was largely realized. The first still images caught the evening newspapers of Tuesday July 29, and the morning editions of July 30: a frame from magazine R showing the U.S. flag, the outline of an LM thruster, and bootprints on the lunar surface was the most frequently reproduced image. (Interestingly, it was accompanied in many newspapers by new images of Mars sent back by the *Mariner 6* fly-by spacecraft.) Views from orbit followed, and then by Friday, August 1, stills of lunar surface activities from the 16 mm DAC (including Armstrong) and some of the classic Hasselblad images of Aldrin photographed by Neil Armstrong were being seen everywhere. The first color clip from the DAC (of the descent of *Eagle* to the lunar surface) was transmitted on television on the evening of July 29.

The picture selection process from Monday, July 28, and through the next few days raised a problem central to the subject of this paper. Brian Duff had returned to the MSC as head of public affairs ten weeks before the first lunar landing, when he replaced Paul Haney. He was immediately pitched into handling media affairs for the *Apollo 10* mission in May, 1969, and could scarcely take breath before *Apollo 11* was launched. Almost eighteen years later, he recounted [15] the hectic session in the PTL at which the first 70 mm and 16 mm films were examined (though presumably this was typical of a number of sessions as the batches of films became available):

> Everyone was yelling and everyone had a candidate. Finally, someone—I hope it was me—said 'shouldn't we try to get a picture of the first man on the Moon?' That settled things down and we started looking for the best 70 mm shot of Neil. Soon we were looking for any shot of Neil. Finally George Low, the Apollo manager, or Bob Gilruth, the Center Director, suggested I call Neil and ask him . . . . I have a very strong memory of the phone call. I felt it was a very great presumption to awaken Armstrong in the LRL with such a question but it was obviously necessary.
>
> I remember saying: 'Neil, this is Brian. When did you give the camera to Buzz?' I distinctly remember him saying: 'I never did.' I said 'Thanks'. . . and hung up. I told the others and we concentrated on the best possible picture of Buzz. . . .
>
> I am certain of what he [Neil] told me in the Lab . . . . we poured over every bit of film in the days that followed. There would have been no hesitancy in releasing a photograph later if we had found one. I don't think any usable photography of Armstrong exists other than [stills from] the 16 mm motion picture photography. . . .

Table 1
APOLLO 11 EVA LUNAR SURFACE PHOTOGRAPHY

(Magazine "S" - Ektachrome S0168 color film: frame codes AS11-40-5844 to 5970). This annotation based on examination of 70 mm copy of entire film and details given in *Apollo 11 70 mm Photographic catalog* - MSC Internal Note No TJ-70-104. (NB: Panorama designations are taken from location map published in *Apollo 11 - Preliminary Science Report: NASA SP-214* included here as Figure 2)

Frame No:	Identification	Frame No:	Identification
5844	Lunar surface from orbit	5845	Earth from lunar orbit
5846	Surface from orbit/LM thruster	5847/8	After landing - surface/crater through LM window
5849	Surface/LM shadow through LM window	5850/5858	Panorama 1 (see note below)
5859/60/61	LM +Z strut/crater	5862/3	LMP on LM porch
5864	DPS/+Z strut	5865	-Y strut
5866 to 5869	LMP descends to surface	5870/71	LM strut/LM shadow
5872/5875	LMP/SWC (solar wind composition experiment)/Flag		
5876/5880	Lunar surface/footprints/boot	5881/5891	Panorama 2 (includes extra frame 5882A)
5892	-Y strut/jettison bag	5893	LM quad
5894	LM quad (underexposed)	5895/6	Struts/pads (underexposed)
5897/5900	+Z strut/plaque (underexposed)	5901	+Y strut
5902/5903	LMP/+Y strut: classic LMP full length/visor image		
5904	Out of focus shot of EMU/PLSS	5905/5916	Panorama 3 (5916 includes crew member)
5917	Strut	5918	+Y strut
5919	+Y strut	5920	+Y strut
5921	DPS (descent propulsion system) area	5922	LM quad
5923/5924	LM ascent stage/Earth	5925/6	-Z strut
5927/8/9	LMP at SEQ (scientific equipment bay)	5930/41	Panorama 4
5942/51	LMP carrying/deploying EASEP (early Apollo scientific experiments package)		
5952	LRRR (laser ranging retroreflector)	5953	PSEP (passive seismic experiments package)
5954/5961	Panormama 5 (includes several images of ALSCC - Apollo lunar surface close-up camera)		
5962	CDR's shadow/LM in distance	5963/5964	LMP/SWC/core tube sampling
5965/6	LM skirt (underexposed)	5967/5970	SWC staff (last frame fogged)

In retrospect, it is clear that Neil Armstrong either misunderstood Duff's question or answered it pedantically, for the operations plan did not call for him to *give* the Hasselblad to Buzz Aldrin but to place it on the LM MESA (modularized

equipment stowage assembly) (see the plan timeline for 0.53 minutes), though the plan makes no specific reference to Aldrin picking up the camera. In the air-to-ground voice transcription, Aldrin made several references to using the camera (see below), and at 04.14.52.01 mission elapsed time said: "And, Neil, if you'll take the camera, I'll get to work on the SEQ bay." (16)

Thus, there is no doubt that Buzz Aldrin used the Hasselblad, although Brian Duff's account above is one element in the belief held by informed members of the Johnson Space Center to this day that no original, still image of Armstrong was taken during the EVA. Subsequent events made any analysis of the situation difficult. After a non-stop series of post-mission briefings, the crew was released from quarantine on August 10. A general press conference was held two days later, following which a number of domestic U.S. trips were made by the astronauts, including visits to home towns, the White House, and the Congress, before which each astronaut delivered an address. On September 29, they and their wives left on a 45-day world tour to 27 cities in 24 countries. The demands made on them thereafter continued at an intense level, although each, at a fairly early stage, appears to have decided that the future lay outside NASA. Preparations for the *Apollo 12* mission in November, 1969 were already proceeding apace, so work pressures on members of the MSC staff, and the problem of the availability of the *Apollo 11* crew, particularly to deal with matters of what seemed detail, presumably accounted for the issue not being resolved at that time.

Irrespective of the passage of time, the face remains: Buzz Aldrin had the Hasselblad—so did Neil Armstrong appear in any of the images taken?

ANALYSIS

A 70 mm film strip of all of the images exposed using Hasselblad magazine 40 on the lunar surface has been examined closely and at length. A subject summary appears as Table 1. Supplementary information was derived from the TV and sequence camera film records, and by a study of the operations plan, as well as the air-to-ground voice transcript, both of which have already been noted. The operations plan is, of course, a record of intention and not of fact, but it provides a valuable framework for analysis. Most importantly, copies of all relevant images were submitted to Neil Armstrong and Buzz Aldrin during the course of 1987, and their responses were obtained in writing in the former case [17] and by telephone in the latter [18].

The nominal timeline (Figure 1) shows Aldrin taking up the Hasselblad camera at approximately 0.55 minutes into the EVA and relinquishing it at 1.21 minutes. Intended subject coverage during this period may be seen from the timeline. A more detailed description of the intended operations [19] refers to a soil mechanics study in which Aldrin was to take a stereo pair of "boot penetration" and then of "adhesion (photo boots)." While not appearing in the nominal timeline, these images are readily located as frames 5876-5880. Frame 5876 is a photograph of an undisturbed area of the lunar surface requiring the Hasselblad to be pointed straight down at right angles. Frames 5877 and 5878 are views of a single bootprint from slightly different angles (the required "stereo pair"), while 5879 and 5880 are

different views of a boot showing part of a print to the right side (Plate 8). Both astronauts have confirmed this image sequence as having been taken by Buzz Aldrin, who also stated that the Hasselblad was hand-held and not mounted on the RCU – an obvious requirement to enable the camera to be pointed directly downwards (Plate 9). Since frame 5875 has from the beginning been reliably identified as Aldrin standing by the U.S. flag, *frame 5876 may be regarded with complete confidence as marking the commencement of the LMP's use of the Hasselblad.*

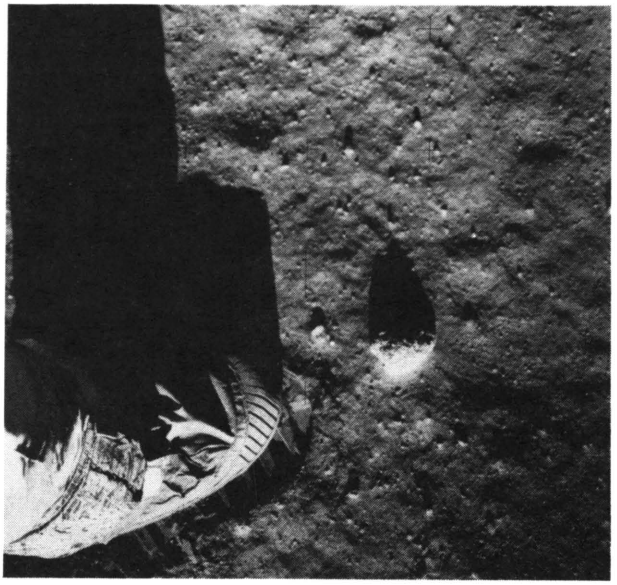


Plate 8 Aldrin photographed one of his own boots as part of the soil mechanics experiment (AS11-40-5880).

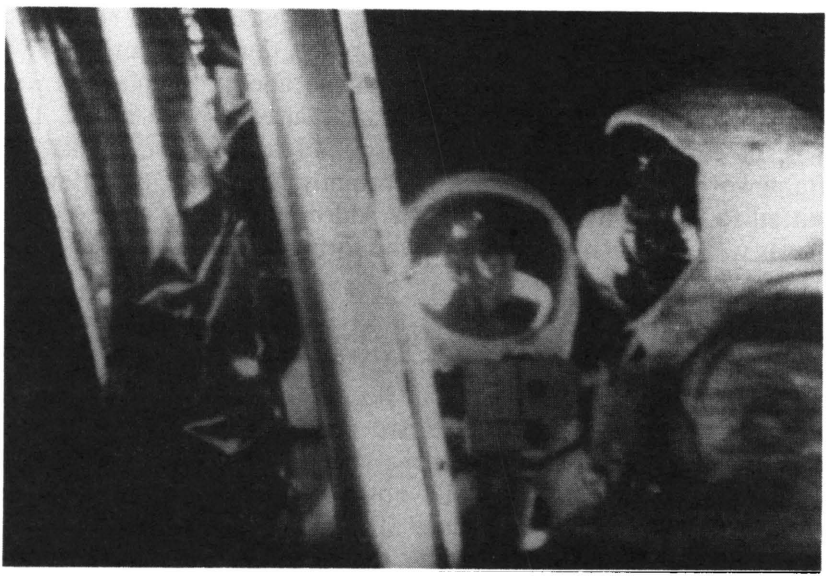


Plate 9 Aldrin and Armstrong from the TV record. The NASA caption identifies Armstrong at left but this appears to be in error since Buzz Aldrin states he never wore the camera on his chest (S69-39563).

At approximately 1.05 into the EVA, the nominal timeline requested a photo panorama and the detailed plan [20] a 12 photo panorama (from position 20 feet in front of the +Z pad)." (This is the LM strut or leg bearing the ladder.) At 04.14.31.29 elapsed time, the voice transcript records Aldrin as saying "The panorama I'll be taking is about 30 or 40 feet out to . . . . the plus-Z strut" [21]. This panorama occupies frames 5881 to 5891, with an additional frame within the sequence, identified as 5882A, yielding precisely the requested twelve photographs. The Preliminary Science Report [22], published after the mission, reproduced a mosaic of this panorama on pages 104/5, and identified it as the second of five panoramas taken. It was also placed on a map of the site containing the location of most of the frames exposed in the Hasselblad. This map is reproduced here as Figure 2. A second map in the Report [23] showed a "recovered" trail for Aldrin close to his panorama viewpoint.

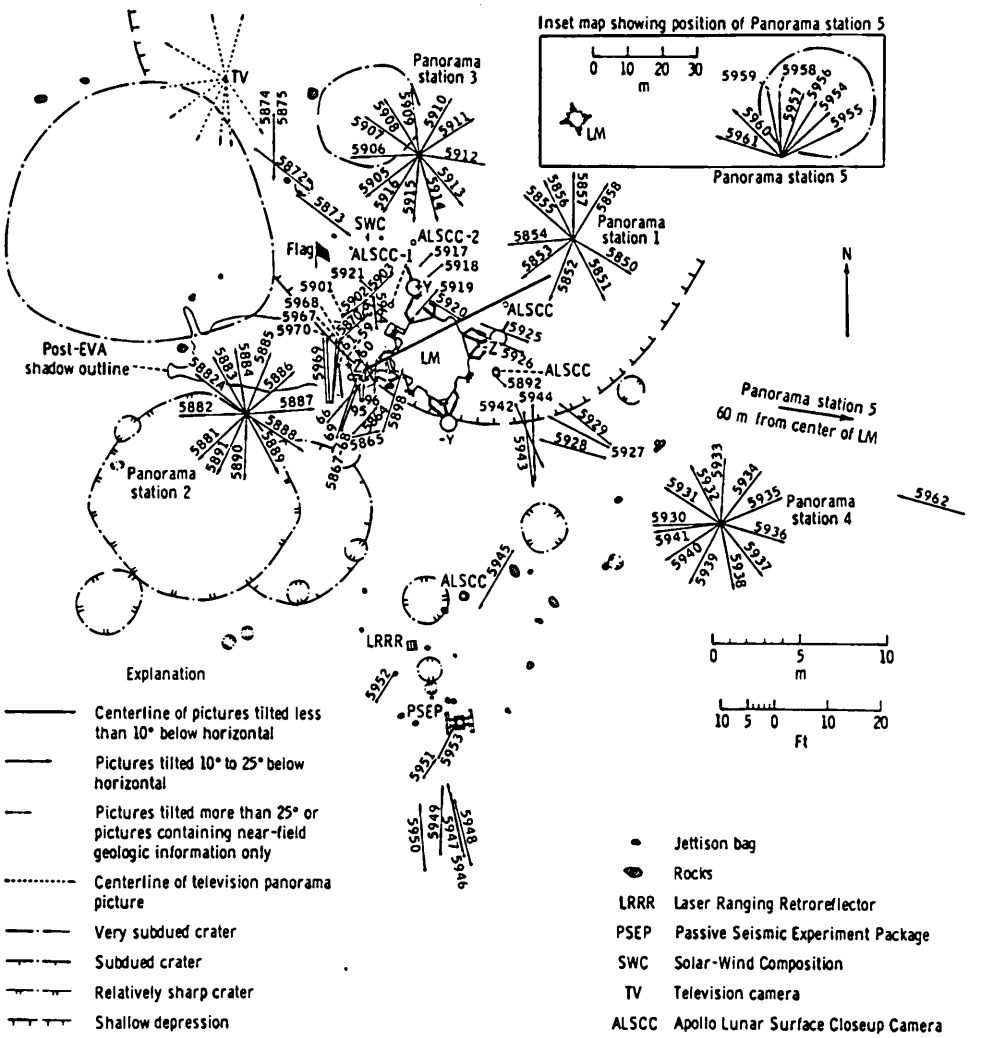


Figure 2 Preliminary map of EVA photographs and TV pictures taken at **Apollo 11** Landing Site (taken from **Apollo 11** Preliminary Science Report - NASA SP-214, p.51).

Of major importance in this panorama is frame 5886, which shows an astronaut working in the MESA area of the LM with the +Y strut beyond and the U.S. flag with the SWC staff off to the left. This must be Neil Armstrong—an identification substantiated by the fact that for part of this period he was working at the MESA while collecting the bulk geological sample, which the second PSR map (referred to above) confirms was located in the precise area shown in this frame. Since Neil Armstrong's records were in storage at the time of these enquiries, his confirmation of frame 5886, as being that to which he referred in his original correspondence, was described as being "without guarantees," but Buzz Aldrin was in no doubt whatsoever. *The frame may therefore be identified reliably as being the only Hasselblad frame of Armstrong on the lunar surface*—though as part of a panorama taken from some distance away, it cannot rival many of Armstrong's pictures of Aldrin for composition and impact. It may also be added that while for obvious reasons this frame has been little requested over the years, it is now identified to inquirers by the picture research staff at NASA's Johnson Space Center as being of Neil Armstrong (Plate 10).

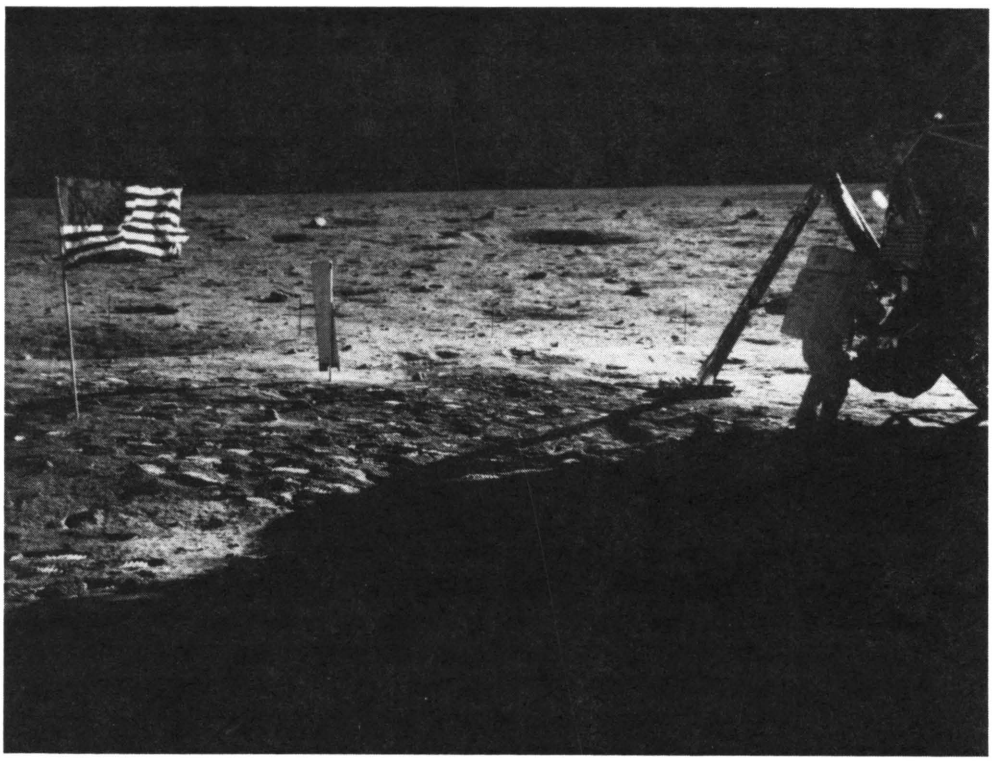


Plate 10 As he works at the NASA, Neil Armstrong is photographed by Aldrin: this identification after 18 years may be regarded as authoritative (AS11-40-5886).

Subsequent to the panorama are ten frames of parts of the LM as requested by the nominal timeline, though other than a tentative photo reconstruction is difficult. At 04.14.34.13 elapsed time, Aldrin reported [24] that he was near the minus- Y strut taking some photographs, and this strut appears as frame 5892. He subse-

quently referred to getting some pictures of the "aft part of the LM," and then made an ambiguous comment about a panorama [25]. At 04.14.48.04, he reported photographing the plus -Y strut (his words are mistakenly attributed to Armstrong in the transcript), and this subject does appear in frame 5901. A few minutes later, he mentioned having taken a "stereo pair" of one of the pads: this does not appear in the transcript, but it was deciphered from the tape of the EVA. Frames 5985/6 could well be this pair. At 04.14.52.01, the Hasselblad was handed back to Armstrong [26].

The annotation (Table 1) shows the subject of the frames exposed in this sequence. The detailed operations plan called for Aldrin to examine and photograph the plus-Z strut in some detail, and that strut (showing the commemorative plaque) is the subject of frames 5897-5900. Buzz Aldrin believes he did not take these photographs, so his last Hasselblad image on the lunar surface is in doubt. It must be somewhere between frames 5892 and 5901 (fortunately this point is not too critical), since frame 5902 is one of the classic images of Aldrin photographed by Armstrong, who retained the camera thereafter [27].

DISCUSSION

In *Apollo 11*, everything was subordinated to the requirement that two men should descend to the lunar surface and return safely into lunar orbit and thence to the Earth. At one time it appeared that only one crew member would make an EVA for a short period of time to gather rocks, and that no experiments would be deployed [28]. In the event the two crew members conducted an intensive program of activities, which allowed no spare time or idle sightseeing in an EVA period of slightly over 2 hours, 40 minutes. Both astronauts referred subsequently to these demands in their different ways—Aldrin stating that "(my) strongest memory of those few hours as the first men on the lunar surface was the constant worry that we'd never accomplish all the experiments we were scheduled to do. Philosophy and emotion were not included and, in fact, were discouraged" [29]. While Armstrong referred to there being "a lot of things to do, and we had a hard time getting them finished. . . We had the problem of the five year old boy in a candy store. There are just too many interesting things to do" [30]. Towards the end of the EVA, mission control was estimating ten minutes only for the documented sampling of lunar rocks, so it was little wonder that the astronauts later noted that the sampling was conducted very rapidly with "no attempt . . . made to actually document the samples by voice or photography" [31].

As Mercury became Gemini, and Gemini developed into Apollo, the photographic program for crews (expressed in greatest detail in a photographic and TV procedures document) became ever fuller and more tightly structured. The overwhelming emphasis was on operational, engineering, and scientific documentation photography, but nonetheless many fine "news" images were obtained on missions. Brian Duff has given [32] an intriguing insight into securing these:

> It is . . . misleading to think that everyone in NASA agreed about the importance of public affairs or public affairs photography. Part of the 'right stuff' image was not to care about that sort of thing, and the only argument which worked was to equate it with 'continued Congressional support.' From the outside it may have looked like a well-oiled machine,

but on the inside it was what I call 'creative tension.' My recollection of those days is of a constant battle with my friend Deke Slayton and other engineers, scientists and astronauts to get another small concession to 'public affairs photography' for 'my friends in the press.' It may surprise you to know that it was necessary to demand that color film be carried to the Moon on *Apollo 11*. It was not considered 'scientifically accurate' in its ability to depict color, and monochrome film was specified. Only when it was asked whether NASA could accept a black and white photograph of the first man on the Moon on the cover of *LIFE* was it agreed to include a quantity of color film.

Notwithstanding this, Duff indicated [33] that the demands of the media were usually met:

For most of us the eventuality of getting no pictures of either [Aldrin or Armstrong] was unthinkable. You will be horrified to hear this, I know, but those kind of 'touristy' snap shots were not programmed into the time line. They were supposed to be taken as a matter of course in among the 'scientific' or 'documentary' photography. And they almost always were. If we missed great human interest shots, and we almost certainly did, we probably were not the wiser.

There was, in fact, something of a paradox here because, while the astronauts always stressed the need to meet mission requirements (whether in photography or elsewhere), in their comments they were not slow to mention more popular forms of photography. Thus Buzz Aldrin referred [34] to both scientific photography "and standard home pictures for the folks back on Earth" being taken during his *Gemini 12* EVA in 1966—and exiting the LM during the Apollo mission "to join Neil, who, in the tradition of all tourists, had his camera ready to photograph my arrival." Michael Collins recounted [35] how, when the crew entered lunar orbit and saw the Earthrise, it was a "truly dramatic moment that we will scramble to record with our cameras"—and how, after the TEI burn on the return journey, "we whip out our cameras and start taking pictures of the lunar surface, just like tourists leaving Venice who suddenly discover they have three rolls of film left." Astronaut Don Lind made a humorous comment on the subject [36] when commentating on a training film of Armstrong and Aldrin at a pre-mission briefing: "They change [the Hasselblad] about the time they start the LM inspection. The reason for that is that then both of them get pictures taken of themselves. No, the real reason is that it balances the work load. . . ."

While it has been demonstrated reliably that one Hasselblad image of Neil Armstrong does exist, this picture—together with stills from the sequence camera films—compares unfavorably with the numerous splendid images that Armstrong took of Aldrin. The latter addressed this fact in his autobiography: "As the sequence of lunar operations evolved, Neil had the camera most of this time, and the majority of the pictures taken on the Moon that include an astronaut are of me. It wasn't until we were back on Earth and in the LRL looking over the pictures that we realized there were few pictures of Neil. My fault perhaps, but we had never simulated this in our training . . . . every minute was busy." Aldrin recounted being photographed by the U.S. flag, and then preparing to change positions with Armstrong so that he could be similarly photographed, when mission control announced that President Nixon wished to speak with them. After that, they went on to other activities [37].

While Aldrin's explanation about not having "training" to photograph Armstrong may seem thin to outsiders; other more outward going astronauts have confirmed the constant race against time during a lunar EVA, and the intense drive to meet mission requirements [38]. Some NASA employees and other correspondents have speculated whether the absence of pictures of Armstrong reflected pique on the part of Aldrin at not being first on the lunar surface—a matter that received considerable attention in the U.S. media in the spring of 1969. This seems most unlikely for, as we have seen, Aldrin was concerned about optimum settings on the DAC to record Armstrong's descent down the LM ladder and his initial activities on the lunar surface—and also took an excellently observed portrait of Armstrong in the LM after the EVA (Plate 11). These actions are scarcely compatible with the alleged attitude.

Plate 11 A post-EVA portrait of Armstrong in the LM by Aldrin (AS11-37-5528).

Neil Armstrong's own attitude is equally interesting. He was clearly not concerned with being photographed or, if he were, considered it improper to demonstrate such feelings. We may speculate that the "right stuff" requires that an event be performed well, and for it to be known to one's peers that such is the case—but that recording the occasion on film is of no consequence. Armstrong's subsequent attitude to researches of the kind on which this paper is based is consistent with this attitude: a courteous preparedness to help as far as possible, but with a slightly amused inability to comprehend why anybody should be interested in such irrelevant details. This presumably accounts for the fact that, after the *Apollo 11* mission, Armstrong (and the same is true of Aldrin) appear at no time to have enlightened public affairs staff at MSC as to the existence of a Hasselblad image of the mission commander on the lunar surface—which, while not markedly superior to the sequence camera stills, at least provided a different viewpoint.

Another aspect of this matter concerns the U.S. media. It is the most demanding in the world, but at no time does any correspondent seem to have asked why the picture releases of Armstrong were so poor compared with those of Aldrin. This would not have concerned the television channels for which the DAC clips were most suited, but the printed media might have been expected to raise the issue. A possible explanation is that the staggered release of images resulting from the quarantine demands, taken with all the other activities, such as the fast approaching *Apollo 12* mission, limited awareness, and therefore any consideration of picture quality *per se*.

CONCLUSION

It remains perplexing why the lunar surface operations plan did not call for Buzz Aldrin to take any photographs of Neil Armstrong. If that plan could require Armstrong specifically to take three photographs of the LMP as well as of procedures in which Aldrin was involved (and so would figure in the images), in the admittedly much shorter time that Aldrin had the camera, it would seem equally valid for Armstrong's collection of the bulk sample and a record of the mission commander working at the MESA to be regarded as valid subjects for a series of "operational" photographs. There seems little doubt that if such requirements had been placed in the operations plan, then Aldrin would have obtained photographs of considerably better quality than the sequence camera stills.

In retrospect, it is easy for the researcher to take a measured look at the failure to obtain high quality images of Armstrong and to criticize public affairs staff (as well as mission planners) for not realizing the likely outcome. This point was made to Brian Duff who responded frankly [39]:

> [The realization] was not likely to happen in the supercharged atmosphere of the first lunar landing. I for one could hardly believe we were getting past one incredible hurdle after another. The astronauts were on the surface of the Moon a relatively short time. They had a great deal to do, and no one was about to ask them questions or ask them to do anything that was not absolutely necessary. If someone had realized what was happening, we could have relayed a suggestion up to Neil to hand Buzz the camera, but no one did realize it. The communication from the surface was sparse on *11* compared with latter missions. *And we all believed we were getting photographs of both men. . . .*

And again later [40]:

> We simply did not spot the potential for missing good photography of Armstrong. If we had, we would have asked that it be fixed through normal channels, and it would have been fixed. Blame lack of attention; blame pressure of events; blame a presumption that procedures followed on earlier flights would be followed again. All contributed. There was no single fault . . . it was a series of simple human oversights.

From *Apollo 12* onwards, both crewmen wore Hasselblad cameras on the lunar surface, so each tended to appear in a considerable number of operational photographs—to say nothing about the time honored flag saluting ceremony. On *Apollo 12*, Alan Bean, the lunar module pilot, was also specifically required to photograph the commander, Pete Conrad, with the Hasselblad as the latter egressed onto the LM porch and down the ladder [41].

Starting with *Apollo 13* (although the oxygen tank explosion aboard the service module on that mission precluded a descent to the lunar surface), the problem of identifying the two astronauts during the EVA was solved by the provision of broad red bands on the arms, legs, and helmet of the commander's EMU (space suit). This problem had been raised on a number of occasions from *Apollo 11* onwards, but the earliest document located on the matter is a memorandum dated December 10, 1969 from Julian Scheer, assistant administrator for public affairs at NASA HQ in Washington, to James McDivitt, manager of the Apollo spacecraft program at MSC at that time. A number was one suggestion made, but Scheer expressed a preference for "some kind of arm band." Apparently McDivitt had some objections, but the MSC Director Gilruth favored the proposal [42], and it was implemented within a matter of weeks.

There is no need here to stress the magnitude of the Apollo achievements—and particularly those of *Apollo 11* and every individual associated with its success. An estimated audience of more than 500 million citizens of the world witnessed Neil Armstrong's descent down the LM ladder, and the subsequent events as they were televised in "real time." In that sense, all of us who watched were privileged onlookers in an experience given to none but immediate participants of earlier, equally historic, events.

But time passes, and, as permanent records, stills from the television transmission provide little more than "atmosphere" (Plate 12)—while frames from the DAC or sequence camera have inevitable deficiencies in portraying the activities of the first man to walk on the Moon. A Hasselblad frame showing Armstrong has now been reliably identified, but it cannot compare with many of Armstrong's images of Buzz Aldrin. All too often, therefore, those seeking quality images to illustrate humankind's first departure from the bounds of Earth show Aldrin—sometimes, at least, in the mistaken impression that it is Armstrong.

The emphasis on mission requirements as regards photography, astronauts' personal attitudes to the taking of "public affairs" photographs, and Neil Armstrong's own lack of concern about being photographed with the Hasselblad, are all understood—but on the occasion of the first lunar landing they should all have been subordinated to the need to secure some of the best possible images of

Armstrong. NASA quite properly devoted time to consideration of *symbolic activities* to be performed on the Moon by Armstrong and Aldrin—and, indeed, a committee was set up to consider this matter [43]. In a like manner, it is evident in retrospect that more attention should have been paid to ensuring a high quality, *symbolic* record depicting the first human to walk on the surface of another body in the solar system—for the historical significance of the event transcended in importance all aspects of the technology that achieved it.

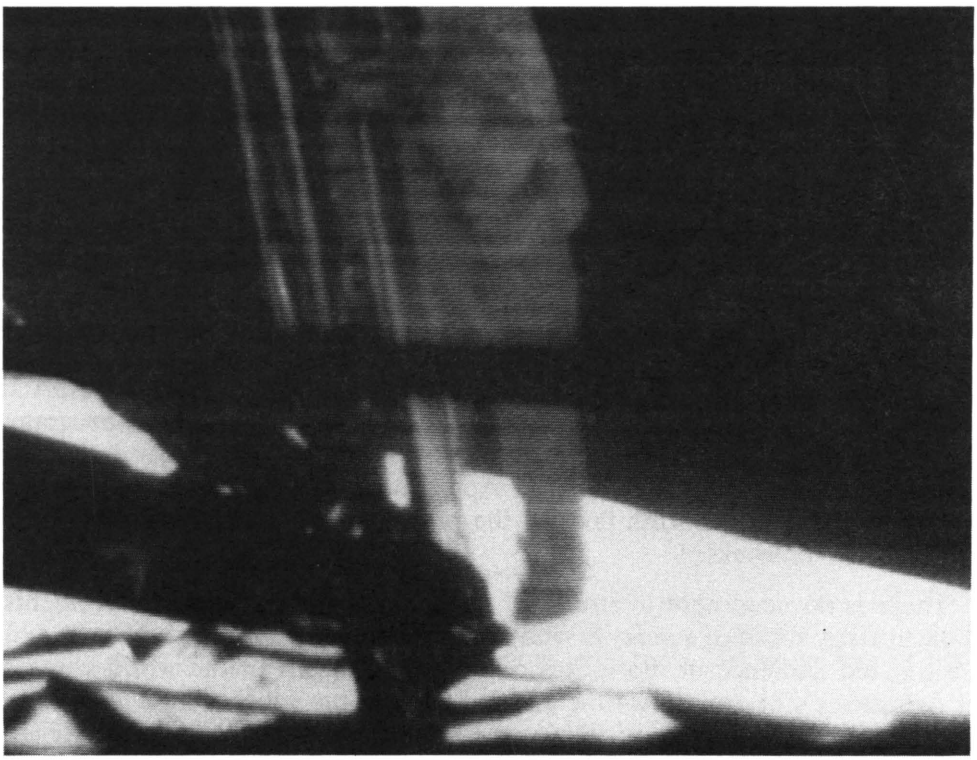


Plate 12 Neil Armstrong prepared to step down to the lunar surface - a still from the TV record (S69-42583).

ACKNOWLEDGEMENTS

The author is indebted to Neil Armstrong and Edwin ("Buzz") Aldrin for responding to questions in a helpful manner, which led ultimately to identification of the lunar surface Hasselblad photograph of the former. Former astronauts Alan L. Bean and James A. Lovell also provided valuable detail and background information. The flow of documents from Lee Saegesser of NASA's History Office in Washington and from David Compton, historian at the Johnson Space Center, was considerable and seemingly without end. This researcher—like many others—owes them a great deal. Brian Duff responded willingly and fully to numerous questions and gave a vivid insight into the "atmosphere" of the summer of 1969 in Houston, which almost certainly could not have come from any other source. A long-time friend—Dick Underwood, formerly of NASA's Photo Technology Laboratory—also responded in his typically helpful manner by thinking back 18 years to the dramatic hours at the laboratory when the lunar surface films were being processed.

Others who gave assistance were two media "veterans" in the U.S., Roy Neal of NBC TV and writer Richard S. Lewis; Les Gaver at NASA headquarters and former public affairs officer at MSC Paul Haney; and—inevitably—Mike Gentry and Lisa Vazquez of the Stills Photo Library at the Johnson Space Center, who provided their customary speedy and efficient service. Finally, an exchange of views with Keith T. Wilson was helpful.

Research of this kind is a continuous process, and any additional information or corrections of inadvertent errors will be received gratefully by the author.

REFERENCES

1. Letter to the author, October 3, 1974, Armstrong was at this time Professor of Aerospace Engineering in the University of Cincinnati.
2. Apollo 11 Lunar Landing Mission - Press Kit (Release No 69-83K); published at the MSC for release Sunday July 6, 1969; pp.79-80.
3. National Space Science Data Center (ID No. 69-059A-01).
4. Hasselblad - First Camera on Moon; Press Release No. 8, September 1969.
5. Apollo 11 70 mm Photographic Catalog (MSC Internal Note No. TJ-70-104); January 1970.
6. Return to Earth, Edwin E. Aldrin with Wayne Warga; Random House, 1973; p16.
7. Lunar Surface Operations Plan, MSC Press Conference Transcript, July 3, 1969. (Participants Don Lind, Ted Foss and Jack Riley).
8. Letter from Neil Armstrong, *op. cit.*,
9. Apollo 11 Technical Air-to-Ground Voice Transcription (GOSS NET 1); Prepared for the Data Logistics Office Test Division, Apollo Spacecraft Program Office; MSC July 1969.
10. For more detailed information on Apollo and earlier photographic equipment see: (a) Photo Equipment for Manned Space Flight Handbook; MSC Internal Note MSC-CF-E-68-12; June 20, 1968 (b) Apollo Experience Report - Photographic Equipment and Operations During Manned Space Flight Programs, Helmut A. Kuehnel; NASA Technical Note Tn D-6972; September 1972. (c) The Camera in Space, H. J. P. Arnold; British Journal of Photography - issues dated March 5, 12, 19 and 26, 1971. Also The Camera in Space, H. J. P. Arnold; Spaceflight - Vol. 16 No. 12, December 1974.
11. Apollo 11 Lunar Surface Operations Plan (Final), prepared by LS Operations Office, Mission Operations Branch, Flight Crew Support Division; MSC June 27, 1969. (More detailed information was contained in the Photographic and TV Operations Plan - Final prepared by the same group; June 18, 1969).
12. (a) Public Affairs Plan, Apollo 11, July 1969; memorandum from Julian Scheer, assistant administrator for public affairs, NASA Washington to PAO staff. (b) Photographic Briefing Transcript, MSC, July 26, 1969. (Participants Julian Scheer and Richard W. Underwood, Photographic Technology Laboratory.)
13. Letter to author from R. W. Underwood, May 20, 1987.
14. Photographic Briefing Transcript, *op. cit.*, pp. 31E/2-3.
15. Letter to the author, April 2, 1987. Duff had several tours of duty with NASA. He is now Associate Director/External Affairs at the National Air and Space Museum in Washington, DC.
16. Air-to-Ground Voice Transcription, *op. cit.*, p.398.

17. A number of letters were exchanged, but that from Armstrong to the author dated June 8, 1987 was the most important.

18. Telephone conversations on August 7 and 13, 1987.

19. Lunar Surface Operations Plan, *op. cit.*, Section X, p49.

20. *ibid.*, Section X, p.50.

21. Technical Air-to-Ground Voice Transcription, *op. cit.*, p.395:

22. Preliminary Science Report, NASA SP-214; MSC, 1969.

23. *ibid.*, p.52.

24. Technical Air-to-Ground Voice Transcription, *op. cit.*, p.395.

25. *ibid.*, pp.396 and 397.

26. *ibid.*, p.398.

27. For a general evaluation of mission photography (with particular emphasis on lunar surface color) see Apollo 11 Mission Report MSC-00171, November 1969; pp.11-23 to 11-26. This was published subsequently as NASA SP-238. Brief crew comments appeared in Apollo 11 Technical crew Debriefing (U), Vol. 1, July 31, 1969; pp. 10-24 to 10-38.

28. Chariots for Apollo, Grimshaw *et al.*, NASA SP-4205 1979; p.320.

29. Return to Earth, *op. cit.*, picture caption facing p.217.

30. Apollo 11 Postflight Crew Press Conference Transcript, August 12, 1969, MSC; pp.8-9.

31. Preliminary Science Report, *op. cit.*, crew observations p.38.

32. Letter to the author, April 2, 1987.

33. Letter to the author, May 26, 1987.

34. Return to Earth, *op. cit.*, pp.180 and 234.

35. Carrying the Fire - An Astronauts' Journeys, Michael Collins; Farrar, Straus and Giroux, 1974; pp.393 and 421.

36. Lunar Surface Operations Plan, MSC Press Conference Transcript; *op. cit.*,

37. Return to Earth, *op. cit.*, pp.236 and 237.

38. The author is particularly indebted to Alan L. Bean, lunar module pilot of Apollo 12 and commander of the second Skylab mission, for discussions on this and related matters.

39. Letter to the author, May 26, 1987.

40. Letter to the author, July 8, 1987.

41. Apollo 12 Flight Plan - Final, October 15, 1969, MSC; p3-93.

42. Brian Duff realized the need for the two crewmen to be distinguished clearly when anxiously searching through the first Apollo 11 picture releases. It was he who records McDivitt's initial criticism of the idea. (Letter to the author, April 2, 1987.)

43. For example, see a memorandum on the subject to George Mueller (associate administrator for manned spaceflight) from Willis H. Shapley, associate deputy administrator of NASA, April 19, 1969.