The moon looked beautiful, and so did earth—but the photographic results had very little scientific value for accurate lunar maps

Why our astronauts can't make good pictures

By SIMON NATHAN

Every camera maker and his brother certainly must envy the Victor Hasselblad company and the fact that it was their camera that was used on numerous earth orbits and the first America-around-the-moon flight of this last December.

Every Hasselblad user, including me, is proud to own the very same camera used by our American astronauts. If the late Jimmy Clarke could win at Indianapolis with a Ford powered racing car, then wouldn't I identify with Jimmy if I drove even a rented Ford Shelby Cobra from Avis? You betcha!

The flight of Apollo 8 extends the Hasselblad image from an already extensive camera system to one that is literally *out of this world*.

Ever since GAF's Phil Mikoda got a simple Minolta 35-mm camera aboard John Glenn's Atlas-Mercury flight, it has been the sweet dream of each and every camera-maker to get his brand name onto a space flight. There might be one exception, and this would be the Deardorff Company in Chicago, and even this would have to be checked.

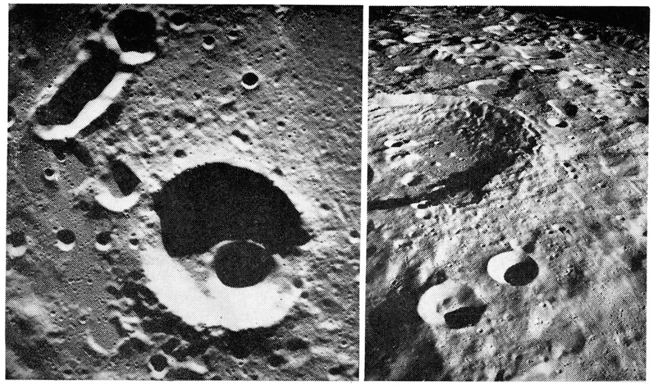
The Autoset, the Japanese Minolta 35-mm camera, was a coup for the product, and it required very little actual modification. Simply explained, the camera was used in an inverted position and the transport lever was enlarged for easier operation.

When you visit Expo '70 at Osaka, Japan, next year you'll be able to visit the Minolta factory in the same city and to see the tree that John Glenn planted in the factory yard. When standing before the tree and realizing that the Minolta was the first camera for the American space flights, ask yourself, "Has the photographic result progressed with the state of the art in space flights, as it has in other technological areas?"

Sadly, the answer is that photography and the photographic results will have to take several giant steps to catch up to the rest of what has been happening. I visited the Manned Spacecraft Center at Houston early this year after the Apollo 8 flight to review space photography, the progress and the state of the art thus far. By NASA's own statement the results had been a smashing success. *But, were they really and truly?*

Originally, the carrying of a camera was almost incidental, an afterthought. There was no great competition to get any particular camera onto the spacecraft. Once they had the first pictures, the idea lightbulb went on. The stated original purpose of the Mercury flight series was to qualify a man in space and to test-fly the hardware.

NASA needed feedback to make the hardware functional, and a man was needed for "viewpoint." The Mercury flights were to be a short series of orbits.



Close-up details of moon (above) taken from Apollo 8 with NASA-Hasselblad 500 EL show what is possible when original film is recovered. Assembled picture (below) was made from 70-mm film, Bimat processed, that was televised back to earth in individual strips from a Lunar Orbiter flight. Ideal scientific map would have quality of close-ups made with photogrammetric camera on original film brought back to earth for precise assembly.

Good moon map would require photogrammetric camera, original film

The views-out-the-window of the spacecraft documented the "gee-golly" commentary of the first humans to get in the vicinity of 100 miles above the earth and to fly complete earth orbits in 1 1/2 hours, or at a speed of about 22,000 miles per hour.

In the early days of space flight, NASA was not so much under the pressure of manufacturers to use their cameras. The great views never before seen by man, except in the mind via Jules Verne, brought about the standard (and uncomplimentary) clichè, "You must have a really great camera to be able to get really great pictures."

NASA's answer was that they were not a flying test lab for the photographic industry, and that photography was incidental. That's what they were saying in the very beginning. Yet once they realized that pictures were worth many thousand of words, and that visual impact helped to tell NASA's cause better than any other technique, pictures became an important part of the project. Just as pictures aided NASA in telling its story, the application of live television brought even more instant impact to this dramatic event.

Now keep in mind that the astronauts are superb pilots who want to fly. Walter Schirra was the first of them who might be called a camera bug, and it is said that he influenced the selection of the Hasselblad simply by being familiar with it and certainly content to use it. NASA got the camera "space hardened," and soon every Hasselblad dealer in the world could claim that he had a camera passing over the store every hour and a half, certainly an unusual selling point.

Astronaut Gordon Cooper was also keen on photography, and he flew the first 70-mm Hasselblad, a *space hardened* 500C with a 70-mm magazine from Cine Mechanics in Los Angeles. This firm actually created two different 70-mm magazines for the 500C for their customer, NASA. One was about the size of the 120 magazine you may now own; it was darkroom-loaded and did not use the cassette-to-cassette technique.

The larger Cine Mechanics 70-mm magazine did use the standard Graflex (from KS-6 Combat Graphic) cassette. Normally this magazine holds enough film for 70 2 1/4-sq. in. exposures, but with thin based emulsions, this number could go as high as 200.

In essence, the taxpayers such as you and I, were the ones to be sold on the continuing importance of this scientific effort. We know that it costs money to get to the moon, and we know that for time immemorial, man has always had the *need to know*.

Photography, be it your hobby or your profession, has done a lot to keep NASA flying. But the question now is, *has it done as much as it could do?* If this really is to be a scientific mission, should not the results be of greater value to the scientists than to the mass media?

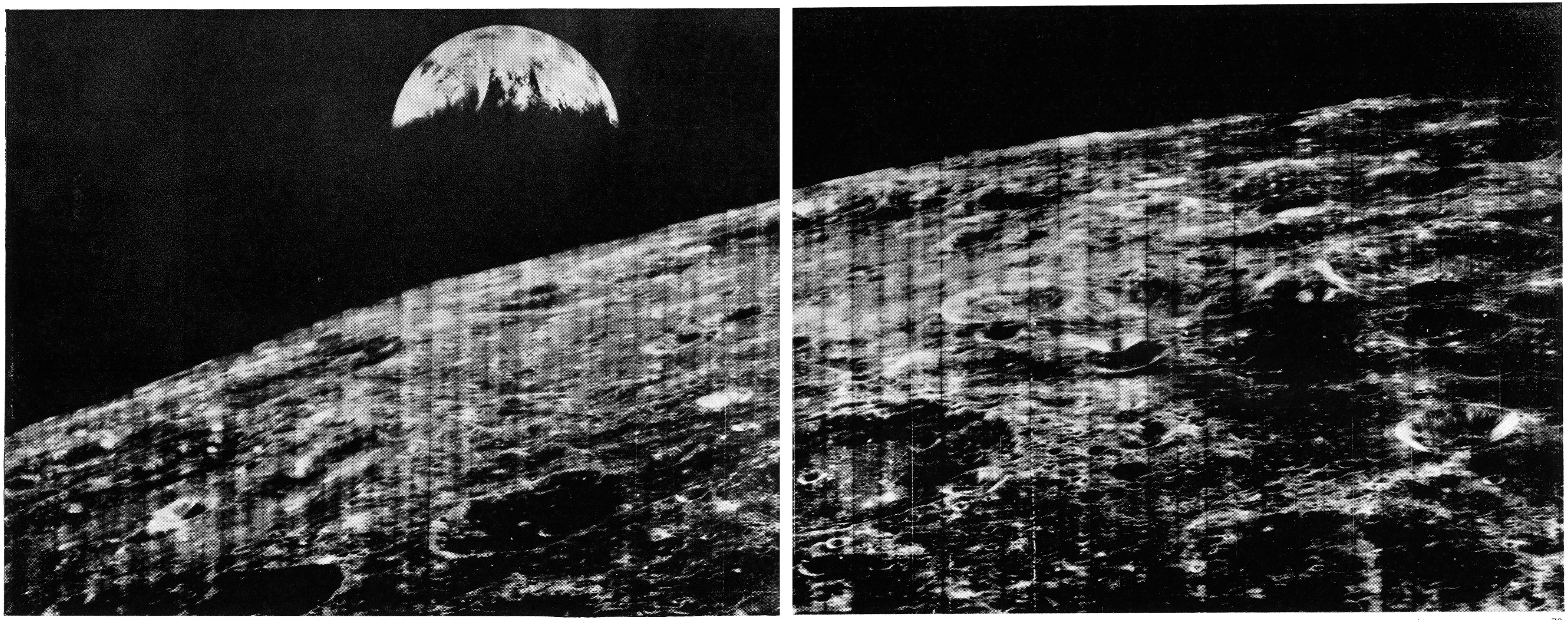
On one flight, the Zeiss Contarex got a ride, and of course, the big public relations follow-up came with understandable pride. The Hasselblad people may have a tree in their front yard planted by Schirra, but we haven't checked on this to see if there is.

Most of the Hasselblad publicity has been for the 500 EL model used on the Apollo 8. On the Apollo 9 was the 500C with a 70-mm back made by Cine Mechanics. The Apollo 8 70-mm back came from Hasselblad, but would not fit onto any Hasselblad model you now own. In other words, the Hasselblad factory 70-mm magazine was modified to work with the modified 500 EL.

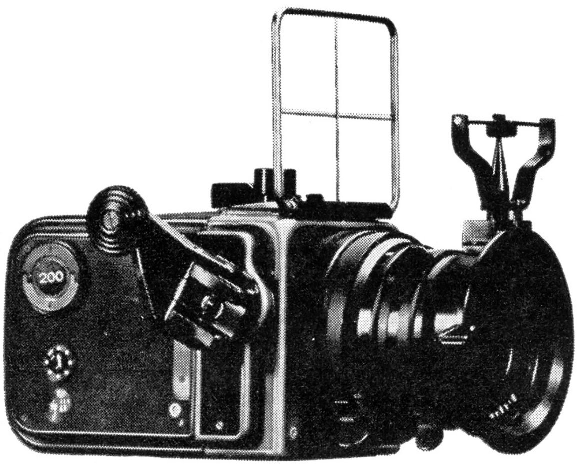
The EL camera used by the astronauts has no moving mirror, and the Compur shutter doesn't work in the sequence that yours does. The shutter has been reduced to firing closed-open-closed. The interlock between shutter speed and diaphragm has been eliminated on this particular version.

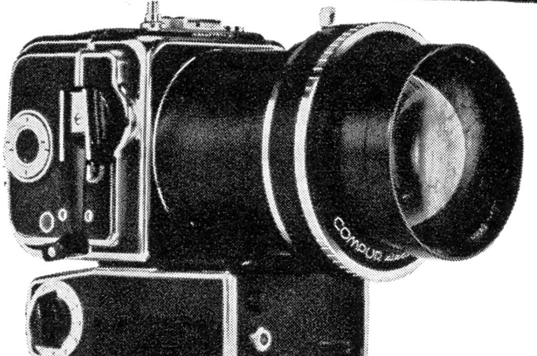
A larger body release is used for switching, or triggering, what we still call a Hasselblad. The Nicad batteries are encased in a non-outgassing material, and the left side of the 500 EL has been factory modified to become a hinged cover over the battery compartment.

Whereas the U.S. list price of the 500 EL with 80-mm Zeiss Planar *f*/2.8 is $910 with one battery (body has room for two, and this is the way NASA flies theirs, in case you want to copy), the cameras NASA buys come in, duty paid

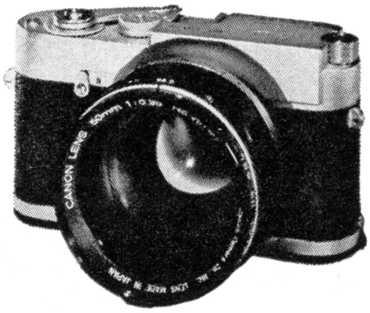


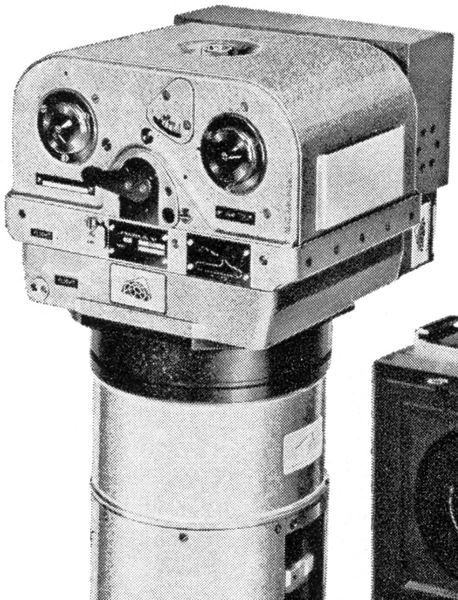
Did NASA really know what it wanted or needed? This impressive array of space cameras was developed, and then never flown on any space flights

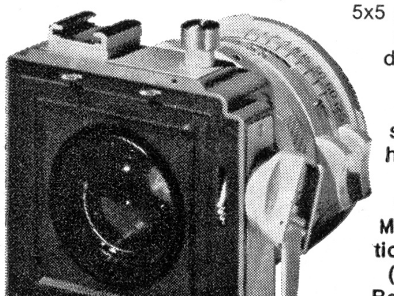




Developed but abandoned is Lunar Superwide (above); 70-mm back with four internal lenses to give fiducial marks, sports finder, rugged crank. Another is Superwide (left) with 100-mm Zeiss f/0.7 in Compur electric shutter (pack at base powers shutter only), designed to record "firefly" effect in outer space.







Unused Leica M body (above) with f/0.95 Canon lens was also designed to get "firefly" effect. Model of 5x5 photogrammetric camera (left) was developed by J. A. Maurer as next generation of space cameras. It has one frame per second remote operation, Image Motion Compensation. UV Superwide (below) with f/3.2 Barnes lens has yet to fly on a mission. It was created by Cine Mechanics.

we assume, at $2,250 each, and they buy them in gangs. There are back-up cameras and training cameras.

Let's look at the 500 EL NASA-Hasselblad training camera. You are the astronaut, and we're handing you an electric camera that once was an SLR. We've eliminated the mirror and substituted a ringsight for aiming the modified Hasselblad. Focusing is now by scale on the anodized lens mount, so if the astronaut fails to remove the Hasselblad lenscap, he'll never see his pictures (nor will anyone else).

If he did remove his lens cap and try to use this practice ("familiarization") camera, you can imagine his progress as a photographer. Whatever qualified as a good result could be scored as pure luck. Since the shutter speeds used come from a choice of 1/125, 1/250 and 1/500 sec, the reduced depth of field makes the guess focusing more of a sport and a gamble than a technique, right?

Suppose that you were offered the one-year loan of such a blind Hasselblad—what would you do? Would you accept it? And then, if accepted, would you use it for even family pictures? Now let's say that you are a pro, but lacking the mazuma to own a Hasselblad outfit. Would this be useful to you? Of course it wouldn't, so how can we expect the astronauts to gain experience and familiarization on a blind NASA-Hasselblad 500 EL?

Should we train astronauts to be photographers or should we take photographers and train them to fly spacecraft? This is what we're wondering these days.

We do need to make a brief defense of the Hasselblad as a camera. It is definitely a fine camera, and many top photographers world-wide stake their reputation on it each day. It delivers. It is also possible to modify almost any camera on the market today and to make comparable pictures.

However, NASA resists the pressure and presentations of other companies by stating flatly that the Hasselblad is already in the program, that extensive modification has been done, and that the spacecraft are equipped for these particular cameras (this is quite true).

Take, for example, the vehicles flown on Apollo 8 and Apollo 9 missions. At the last minute, it was necessary to switch vehicles. Simply, Apollo 8's crew was to use Apollo 9's craft. The crew from the 8 was trained on the 500C, and the crew from the 9 was trained on the 500 EL, in each case modified versions of our earthly Hasselblads.

Since there was a crew swap, you'd think that they'd change cameras, wouldn't ya? Well, the gear on a spacecraft is planned ounce for ounce, place for place, and so they couldn't even change sandwiches if they wanted to.

The Apollo 8 flight in December, 1968, was spectacular on the home television screen and "aw" (not *awe*) inspiring in some of the boasts for the photography produced. NASA's claim for the scientific data prodded the now-president of the American Society of Photogrammetry to write a letter-to-the-editor of *Aviation Week*.

Here's the letter from Dr. Frederick Doyle, chief scientist of Raytheon/Autometric (Alexandria, Va.) that appeared in the Jan. 27, 1969, issue of this weekly aviation magazine:

"Like everyone else, I followed the flawless Apollo 8 mission with my heart in my mouth. And I have read with avid interest your reports in the January 6 issue of *Aviation Week*. Without in any way detracting from the astronauts' accomplishments or NASA's skill in staging the mission, I would like to point out that the utility of the photography obtained on the mission is being grossly misrepresented.

"The photographs are interesting, pictorial, certainly historic and doubtless will be useful in training lunar landing crews. But they are not, as claimed, 'ten times better than the Lunar Orbiter photographs,' nor do they 'provide more scientific data *(continued on page 120)*

Will this become the first still camera to land on the moon?

Mirrorless NASA-Hasselblad 500 EL (below) is set to be part of LM on Apollo 11 (moon landing) flight. It will have three lenses: 80-mm Planar f/2.8, 100-mm Planar f/3.5, and new 60-mm Biogon f/5.6 (on camera). View of camera back (right) shows Reseau glass designed to insure maximum film flatness and apply fiducial marks on film. Removable lenses are matched only to particular camera, which will be strapped to astronaut's chest. Aboard Apollo 11 spaceship will be different Hasselblad system previously flown, but not compatible with this model.

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than Ranger, Surveyor and Orbiter combined.'

"Neither are they anywhere near adequate for topographical mapping of the sites photographed. The fact of the matter is that a $300 camera was used to obtain the most tangible results from a $300 million mission.

"Not one single lunar photograph —not from Earth based telescopes, not from Ranger, not from Surveyor, not even from Lunar Orbiter—has been taken with photogrammetric mapping considerations primary.

"Apollo 8, as the first mission to provide physical recovery of original film, missed a superb opportunity to obtain really good mapping photography. Worse yet, there are no funded plans in either the Apollo or Apollo Applications Programs to fly a suitable metric camera in a mapping mission.

"That lunar mapping is an accepted objective is evidenced by the large NASA funded efforts at Manned Spacecraft Center in Houston, at Aeronautical Chart and Information Center (ACIC) in St. Louis and at Army Map Service (AMS) in Washington.

"The photogrammetrists in these organizations have done a remarkable job in wringing useful map data from inadequate photography.

"Triangulation of a single 16 photograph strip from Lunar Orbiter requires the measurement of over 12,000 separate image points in order to remove image nonlinearities, to tie the individual framelets together and to provide the required geometrical distribution.

"This is at least 100 times more than would be required with good recovered metric photography. And the accuracy of the results obtained is about six times poorer. The savings in data reduction would pay for a good camera system many times over.

"One of the problems with mapping is that if the lines are finely drawn and the details carefully rendered, it looks like a 'good' map. And the current lunar maps really look good.

"But consider a few facts:

"A comparison of the positions of identifiable points on the ACIC charts of the Kepler region with the same points on the AMS maps showed differences of 2.3 km. in latitude and 1.8 km. in longitude.

"Several Orbiter sites were triangulated twice with different spacecraft ephemerides. Displacements in position approaching two kilometers were introduced.

"One site at the eastern end of the Apollo landing zone was photographed four times and each set was triangulated individually. Position deviations of the individual sets from the mean of the four were more than 1.5 km.

"Comparison of elevation profiles from Orbiter data with existing maps showed differences of up to 5 km.

"Apart from the obvious inadequacy of the mapping, these discrepancies should be evaluated against the requirement that to have geophysical significance, positions and elevations of topographic features need to be known to about 15 meters.

"In 1964-65 the NASA Office of Space Science Applications (OSSA) had a photographic advisory team. In summer 1965, and again in summer 1967, NASA convened national study conferences on Lunar Science and Exploration. All three groups emphasized and agreed upon the interdisciplinary requirements for lunar mapping.

"All three groups concluded that a 6 in. focal length, 9x9 in. format metric camera should be flown in a near polar orbit to obtain photography from which a uniform map accuracy of at least 15 meters could be attained.

"This is a standard aerial mapping camera which would operate, unmodified, in the Apollo command module environment. It costs less than $26,000. Problems of integrating it with the spacecraft are minuscule compared to those which have been solved.

'Snapshots taken out window'

"Let us hope that NASA will see fit to stage an adequate lunar mapping mission in the very near future. But if this cannot be done, let us at least not be deluded into thinking that hand held snapshots taken out the window like a tourist, with an uncalibrated camera, are going to solve the scientific problems which justify our lunar exploration program."

I traveled to Alexandria, Va., to talk with Dr. Doyle and to discuss the letter that had caused such a stir in the scientific community. Was he right in what he said, or was it sour grapes, and at that, after the fact? Fred Doyle maintained that he'd been making these very same statements in 1965 and again in 1967 at the appropriate scientific meetings.

But briefly, let's go back to the camera. The Hasselblad system now offers four different styles of film supply, and variations within these.

First, there is the normal, paper-backed 120 film for which the camera was originally designed. Manufacturers have their own ideas within ASA standards as to thickness of backing paper (affecting its flexibility and stiffness), thickness of the emulsion and support (called film), the physical spool, and also important, the technique by which the film end is anchored to the supply spool.

Hasselblad-wise, the reverse curl of the film before exposure and the paper backing of the 120 roll itself are enough to make any technical photographer bellow and groan. Toss away several quarters and unroll a bobbin of 120 b&w film. As you examine the roll toward the area where the 12th exposure falls, you are likely to be horrified.

Second, we have 220 roll film, which is a double-length roll of 120 film, paper leader and trailer, no paper backing. This can produce sharper pictures within the framework of the film's reverse curl.

Third, is the Hasselblad sheet film holder, probably the flattest film possible, and a somewhat slower modus operandi. Fourth, there is the 70-mm back for the Hasselblad, first shown at the 1963 *photokina,* and recently available in limited quantities.

Earth likes its own portrait

On that very first Hasselblad flight (NASA calls them by other names), the 70-mm results were actually from a *long roll* of 120, thin emulsion Ansco (now GAF) color film. The magazine was darkroom-loaded.

It was easier to explain the length of the roll as 70-mm for two reasons. First, NASA was negotiating and promoting the use of 70-mm for future flights, and at the time, no working 70-mm magazine was available. It was as simple as that.

Needless to say, any pictures taken from a point higher than man has ever flown before are of definite interest. Everyone likes pictures of himself, and our planet is no different.

Pictures of the moon from the earth, pictures of the moon from close-up (within 70 miles at this writing), and pictures of the earth from *real* infinity, are all highly treasured. *But to say that they have scientific value is an outlandish claim.* If you are speaking of their psychological effect, then they have great value to NASA in keeping up the public interest in its activities.

However, with the same effort and the advice of the photogrammetrists given three years prior to the moon orbit, it would seem that someone in NASA Photographic would *listen.*

Even the average television viewer understands that the photos of the surface of the moon were to be used to locate and map the site where we could land our American astronauts.

Here is what Dr. Doyle said before

he was elected president of the American Society of Photogrammetry, and it happens to be the same thing that he is saying after his election.

"The Hasselblad basically is not a mapping camera. It has an uncalibrated lens, that is to say that one does not know what the distortion of the lens is." Doyle allowed that the Hasselblad lenses are *now* calibrated, because lenses used have been sent to Raytheon for calibration.

I did not mention to Dr. Doyle that NASA had also submitted the Apollo 8 camera gear to the National Bureau of Standards for calibration some four months after the actual flight. NASA does have lens calibration data for the Zeiss lenses as supplied by Zeiss, but now really, this doesn't make it a mapping camera.

Information covered the values for radial distortion calculated on the actual focal length. Doyle maintains that calibration is finding out how the lens performs after it is built. Once this is known, you can take it into account in calculations and measurements you do on the pictures.

The difference between calibrated and *calibratible* is what we are talking about. Interchangeable lens and film magazines are great for the sophistication of earthbound photography. In no way does Simon Nathan, longtime Hasselblad user, imply or suggest that there are flaws in the Hasselblad.

Salutes camera, nixes NASA

Again and over again, I have saluted this fine camera system through publication of professional pictures taken with Hasselblad assists. My questions, or quizzical look, go to NASA and all they overclaim for it.

One problem with the Hasselblad system for lunar mapping is that it does not provide an adequate stereo base for making topographic maps and extracting contours.

And if the flight of Apollo 8 around the moon wasn't for the purpose of observing and photographing potential landing sites, then what in the heck was it? To say that it wasn't a mapping mission is certainly valid, if you don't try to extract maps from the photographs taken. Even Hasselblad would tell you that they could provide a better mapping camera, given the specifications and time to execute same.

Suppose they cop a plea and say that the Hasselblad was taken for its off-the-shelf availability. Then why not use film from a local camera store in Houston (or Cape Kennedy)?

"This is not a mapping mission" was the standard NASA explanation for those challenges of up to three years before Apollo 8 that started with, "Why doncha?" Dr. Doyle says, "This is justified. There is nothing that says that NASA has to fly a mapping mission, but what really bugs me is to have them indicate that this photography is going to be used for mapping or that this is the objective for taking it.

"The reason this bothers me is that we're going to go back and say we need some more lunar photography, and somebody, a congressman or even a private citizen, is going to say, 'Why do we need more photography? Look at all of this wonderful stuff you got from Apollo 8, Lunar Orbiter, and everything else . . . why do you need more photography to make maps?' And the fact of the matter is that the photography that has been made is inadequate for making maps."

Maps were neat, but good?

Why are their maps bad? Dr. Doyle replies: "One of the problems about a map is that if the lines are nicely drawn and the figures are put on there very neatly and the marginal data looks like it's well organized, and so on . . . this looks like a good map. The maps that have been made really look like good maps."

But what is the standard for a moon map? We know that if we have a map of the earth we can go out to measure all data quite accurately.

On the moon, Dr. Doyle points out, we have not yet the opportunity to do this, but what we can do is to make accurate calculations to provide data for projecting this information. This is done by comparing data from the various missions.

All of this assumes you have a common denominator. Raytheon, NASA, Air Force, Army, and Navy all do this type of extensive comparing. The discrepancies detailed in the *Aviation Week* letter by Doyle are based only on Raytheon's findings, and it is speculated that the others are equally ecstatic, though percentagewise less outspoken.

"The map of the far side of the moon," Doyle says, "looks like a very nice map. It has all the craters on it and all the grid lines on it and all the numbers, and so on . . . You'll remember what they said, that they couldn't identify a damn thing on the far side. Look carefully at what it says on the map—it says that the positions may be off by several degrees, and several degrees is several hundred kilometers, and that's how bad the map really is."

The far side map was made by Lunar Orbiter, an unmanned mission that took 70-mm photographs,

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processed them via Bimat, and then transmitted the images back to our planet by television. It was this map the astronauts carried on Apollo 8.

Doyle maintains that even when looking at that map, they couldn't identify the things on the ground. They were just that far off from where they thought they should be.

"The ones that I see don't look like the ones on the map," was Doyle's explanation of the astronaut's utilization of the poor quality map they had on Apollo 8. Now let's sort this out right now. NASA says that we need maps and photo studies of the moon and contemplated landing sites, but the landing on the moon is not a mapping mission.

The scientists are shouting "By golly, we sure do need accurate maps." The scientific types have been making this clear for a number of years before the moon flights, and it would appear that NASA has declared itself the winner.

In fairness to all, Frederick Doyle notes that there was no extensive triangulation in assembling a map from the TV-transmitted Lunar Orbiter images. The map was simply pieced together. A further effort is being made to obtain additional information from the unmanned take. Near-side coverage was better planned, so we have better sequences.

Reseau glass being added

However, the triangulation of Lunar Orbiter material doesn't have any photogrammetrists jumping up and down for a turn to work something out. As Doyle puts it, "Nobody has much confidence in the results to be obtained from it. Photography was simply not planned for that mission. Nothing further came from the Apollo 8 mission to help the cause."

One further modification of the Hasselblad is coming up. It's the addition of a Reseau glass into the back of the camera body that will have contact with the film for better film flatness. Again this will be a NASA-Hasselblad 500 EL, and still different from the pair on Apollo 8.

The latest Reseau-Hasselblad will have each lens matched to the glass pressure plate. Lenses will be interchangeable, but not in the camera-to-camera sense. Perhaps removable would be a better description. The 60-, 80-, and 100-mm lenses will be calibrated to this single camera body. The film magazine will be interchangeable because each camera must make more than the single load of 160 exposures of color film.

It is easy to color code the lenses and camera bodies so that mix-up can be minimized. It is speculative, but I can already envision the line at Marty Forscher's shop, with hundreds of cameras choking his lobby.

It is likely that this will be the final modification for the Hasselblad in the space program. This is not to say that the camera is all washed up or will be retired once we've hit the moon.

One disclosed mix-up suggests some further needs in our space cameras. There was this roll of 70-mm black-and-white film (Kodak No. 2485) which is classified as an ASA 2,000 recording film. Through a mix-up of film magazines, it was exposed at ASA 80. If one magazine was a part of a mix up, it's likely that there's got to be a second magazine that was also incorrectly exposed. This was a roll of 70-mm Panatomic X, rated at ASA 80.

You're back, but are pictures?

So magazine "G," which contained the ASA 2,000 black-and-white material, was approximately five to six stops overexposed. What would you do if you had such a film to develop and you were just back from an expensive trip to the moon on which your uncle had paid all expenses?

The Data Corporation, Dayton, Ohio, was responsible for processing the color and black-and-white taken from the Apollo 8 flight, so they tabled the previously mentioned two 70-mm b&w rolls until the normal material had been processed. After all, the world was waiting for its portrait and you can't keep it waiting.

Data Corporation sent its Harry Parsonage, director of Photo Science department at Dayton, to Houston. He decided on a technique that involved prior bleaching of the image before the actual development. The process consisted of prebath, bleach, a neutralizer for the prebath, development, stop, fix, and final wash.

The technical basis for the process was that each silver halide crystal in the emulsion has been rendered developable via this extreme amount of overexposure. In other words, what Data decided to do was bleach off the external latent image and to destroy it completely. The internal latent image was then to be developed since it still held a proportional relationship to the goofed-up exposure.

Processing of NASA's black-and-white film is normally done on a Kodak Versamat, but for this special processing it was done on a Nikor reel. Why? Because of the number of steps involved in the special technique.

The Versamat utilizes seven tanks for its sequence of three solutions, known to you as developer, fixer, and wash water. The breakdown is as follows: the first two Versamat tanks are for development, the next three for fixation, and final two are for wash.

This particular black-and-white load was the normal 4 mil thickness and the NASA magazine can hold about 24 feet of this in the 70-mm magazine, or 40-45 feet of the 2 1/2 mil thinner emulsions, which make the magazine's capacity 200 shots.

Had this roll of overexposed film been developed normally, its "curve" would have been darn near a straight line. Had it been developed by inspection, the first reaction would have been to drop the temperature or cut the developing time; this would have resulted in nothing usable.

Test films were instead shot over western Texas, where the subject matter was not unlike the surface of the moon. Data Corporation's Russ Zimmerman, ever the scientist and R.I.T. grad, said that most of testing was done via sensitometry over a four-day period. The test film that was flown was then developed after the calculations had been done.

Second slip-up programmed

In accord with the above information, there were some frames (from a dim light experiment) that had been exposed correctly, so these were clipped off and developed normally. Since the cut was made by measurement, it so happens that a couple frames of the overexposed stuff did get normal development and a gamma of "zero" instead of the .9, achieved via Data Corporation's salvage job. Data's developer is their secret. The bleach was a simple dichromate bleach. The developer is a modified version of a commercially available developer.

The non-photographic astronauts programmed the second roll that was incorrectly exposed by initiating the first switch inadvertently. Bill Anders was instructed to do a terminator-to-terminator exposure series, and he was charged with changing the exposures from *f*/2.8 to *f*/11 at the sub solar point (directly under the sun) and then back to *f*/2.8. A change was to be made every 20 seconds.

Bill decided to average the exposures by using *f*/5.6, and made the whole pass at this aperture. Other duties were taking his time and it was decided to handle the photography this way rather than eliminate it.

(On other U.S. space flights, some photography missions were never done. One legendary rumor had it that a certain astronaut faced a court martial for failing to obey orders, but it was felt unwise at the time to put a national hero on trial for refusing to remove a lens cap and take some silly pictures.)

Back to the terminator-to-terminator pass. This meant that the imagery at the terminators were two stops under and two stops over at the sub solar point. Ground planning called for an exposure change every 20 seconds. Now do you have a picture of what was to be processed: *f*/2.8, *f*/4, *f*/5.6, *f*/8, *f*/11, *f*/8, *f*/5.6, *f*/4, and finally, *f*/2.8?

Take a red pencil and underline each *f*/5.6. That's where the correct exposure falls. An extended range, low contrast developer was called upon to do the salvage work.

Is zebra too slow?

Thus in addition to photogrammetric cameras, we now see that we could use Automatic Exposure Control (A.E.C.). Meanwhile, we could compromise with a color coding of the film magazines. One NASA committee favors zebra-striping the film magazine for high speed black-and-white emulsion, while another NASA committee maintains that the zebra is totally inappropriate because the zebra isn't a high speed animal.

But anyway, while an Apollo spacecraft hovers overhead, two American astronauts will walk about the moon. In fact, this may be on tonight's TV news. The first of the two who touches the lunar surface will be known as "the first man on the moon." Naturally, he'll be holding the American flag.

But it's the second astronaut in this team that we're interested in, because he's the one with the camera. Look closely and you'll see that the NASA-Hasselblad 500 EL has a lens not known to camera fans.

It is a 60-mm Biogon *f*/5.6. Normal, moving mirror Hasselblads could not use this lens. Remember that the NASA modification has eliminated the moving mirror, so that there is a lot of room in the camera body for the back part of this lens.

The lens checks out beautifully, the basis for comparison being other short focal length lenses available for the electric Hasselblad. Since a part of the lens is inside the camera body, it also makes for a more compact camera. Space aboard a space ship is a precious commodity.

A Lunar Surface Hasselblad Superwide was shown at the 1968 *photokina* at Cologne. A 70-mm Superwide with a sportsfinder, its crank handle was quite rugged, and the shutter speed and aperture rings were minus the usual interlock. The film magazine would not fit onto your Hasselblad, because it pivoted from a ledge at the bottom of the camera and it had a 90-degree lock like the NASA 500 EL version.

Oh yes, and the magazine was calibrated to count to 200. It had the same lens that Superwide owners brag about, the 38-mm Biogon *f*/4.5.

The astronaut could change shutter speeds with his gloves on, if need be, because the aperture ring and shutter speed ring had separate pinch locks. Otherwise, it's like your own camera. However, six such cameras purchased reportedly cost NASA $9,000 cash, plus a quick $60,000 in developmental costs. I think that Marty Forscher would have brought it in for a price that a work-for-a-living photographer could actually pay.

Experimental modifications on the Lunar Surface Superwide include a marking system of four fiducial marks projected on the film. There was also to be a polarizing filter adapter with three positions attaching to the front of the lens and removable by the astronaut once on the lunar surface.

Superwide is bumped, too

Now are you all ready for the *news?* This camera *will not* be used for the moon landing. It's been replaced by the lens mentioned earlier, the *f*/5.6 Biogon, specially installed in a mount for the no-mirror NASA 500 EL.

This would indicate that there are more than two viewpoints on the matter, for sure. It could be that the new Biogon reflects the information quoted off the wall at the National Bureau of Standards in Maryland. Here's what I copied verbatim:

"This photograph taken by Lunar Orbiter I shows the moon in the foreground and the earth in the background. The National Bureau of Standards has shown that optical properties of glass used to make lenses can be changed by prolonged exposure to the high energy radiation encountered in space. Changes of refractive index could degrade lenses on cameras for space exploration."

Actually, none of these trade-offs in equipment really matters if we get the result. It would seem that the Hasselblad is the right camera for NASA once they staff the moon. Meanwhile, a lot of earthlings still believe that photogrammetric cameras would be more useful to help land a Hasselblad on the moon.

Back to Dr. Doyle of Raytheon/Autometric. He has more than criticism of what's been done ("wrong" he wails) and has his own suggestions for mapping the moon. The bubblegum card manufacturers aren't going to like this very much, because there will be no spacemen to immortalize.

Given a mapping mission to accomplish before they light the fuse at Cape Kennedy, Doyle would send an unmanned vehicle into polar orbit

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around the moon for at least 28 days, photographing the entire moon in one mission. Then, he says, "I'd bring it back to earth and recover the film."

This has not been done before, but could be if agreed upon. Astronauts don't have to be on board to turn those switches, and the fact of the matter is that having them there does put a lifetime-limit into the project.

Doyle speculates that a Russian space spectacular would be to send an unmanned mission into orbit around the moon, equipped with photogrammetric mapping cameras, and then to bring back the recovered film.

It seems that the whole lunar program is scientific and mainly in answer to man's curiosity about his world. If it really is to succeed—be it scientific, military, or even commercial exploration—then it's time to get serious photographically.

NASA is now shopping for the next generation of cameras for its projects. It'll be a 5x5-in. photogrammetric camera, capable of one frame per second, remote operation, and I.M.C., known as Image-Motion-Compensation. Among others, J. A. Maurer, Long Island City, is developing a basic model in this competition.

Again, we are just about half-way there in this equipment compromise by NASA. Dr. Doyle suggests taking a 9x9-in. photogrammetric camera with a 6-in. focal length lens—mainly because, "It is adaptable to the existing photogrammetric mapping instrumentation used throughout the world. It should be flown at 93 kilometers in altitude, polar orbit, taking pictures every third orbit.

"This equipment would provide sufficient resolution," he continues, "so that you could prepare maps at a scale of 1:100,000 for the whole moon and sufficient geometrical information to establish a control net adequate for making maps at a scale of 1:50,000. What that means is that the positions on the moon, the latitude and longitude of the points identified on the photograph, would be located with a precision of 17 meters."

"It would also enable the mapmakers to prepare contours at 50 meter intervals. It would enable us to have the moon better mapped in two years than the earth has been to date."

Not only would the results be photographically (photogrammetrically) superior, but in the words of Frederick Doyle, "You'd do it far, far cheaper because you don't have to have a big life support system to keep the poor bastard alive up there. You are not restricted in the lifetime that the thing can stay up there."

Lively quotes aside, Dr. Doyle says that we should decide what the assignment really is and then select the proper camera equipment. Appropriately, his thinking matches ours.

The Autometric operation of the Raytheon Company works for the military, NASA, state governments, and foreign nations in area of scientific mapping. Dr. Doyle signs in as chief scientist there. His views are well supported throughout NASA and the photogrammetric community.

He cries out in anguish when he hears of the multimilliondollar stereo camera projects for the lunar walk around, when so little additional money put into the moon-mapping effort would give results infinitely superior to what now must be considered almost borderline worthless.