U.S. Gov't

Entry Date 5-12-93

Data Base HDOCNDX

Index # INS.0206036

ORAL HISTORY INTERVIEW

DATE OF DOCUMENT [Date of Interview] = 02-10-71

OFFICE OF PRIME RESPONSIBILITY = JSC

NUMBER ON DOCUMENT = 00

TYPE OF DOCUMENT [Code for Interview] = 1

PROGRAM [3-letter Program Archive code] = INS

AUTHOR [Interviewee's Last Name] = KUEHNEL

LOCATION OF DOCUMENT [Numeric Shelf Address] = 091-2

SUBJECT OF DOCUMENT: [use relevant bold-face introductory terms]

Oral history interview with Helmut A. Kuehnel
[full name of interviewee]

about Photographic equipment development for
[main focus of interview]
manned space flight.

Title: 1963 - Flight Crew Operations
[interviewee's current and/or former title and affiliation]
1968 - Mission Operations Branch, Flight Crew Support Div, Flight Crew Oper

Interview conducted by Robert B. Merrifield - Staff
[interviewer's name/position]
Historian **at** MSC.
[location of interview]

Transcript and tape(s). [for inventory only: # pages 19; # tapes ___]

U.S. Gov't

CONTENTS:

Biographical - [date/place of birth; family background] ______________________

Education - ______________________

Career Path - ______________________

1962 Mercury 6 -

Topics - Cameras handheld or mounted inside cockpit; Ansco Autoset (obsolete now); Eastman Kodak color negative film; Mercury 7 - robot recorder; Mercury 8 - 70 mm Haselblad; synoptic terrain/weather photography; camera modifications for EVA; cameras on Gemini flights; cloud + sunlight problems; introduction of spot meter on Gemini V; sequence camera used spacecraft power; scientific camera; super wide angle camera; organizational responsibility for camera dev; film types, loading + preparation; crew training; photo equipment for lunar surface + rock samples; Haselblad factory modifications; lens development; Apollo 7 cockpit photos; Apollo 8 moon photos; internal photos + high resolution; Apollo 9 maneuver documentation; Apollo 11 lunar landing dust cloud problem; electric cameras

(over)

Photographic Technology Lab; coop w/ USGS; photography & science.

Interview with Helmut A. Kuehnel
2/10/71

This is an interview of Helmut Kuehnel on photographic/~~development~~ equipment for manned space flight. The photographic equipment we are concerned about is primarily handheld equipment used by the flight crews. Not exactly handheld, it's photographic equipment used inside the spacecraft cockpit. All of the systems we will talk about are capable of being handheld, but in many cases they are bracket mounted and boresighted to a particular spacecraft axis. Back to the first Mercury flight - the first camera we used was a modified Ansco auto-set This camera was modified in ~~this~~ our organization at that time called the Spacecraft Operations Branch. Primarily the work was done by Mr. Ken Glover. He had been assigned the task of coming up with a easy to use camera for the first Mercury orbital mission. This outfit was started approx 9 months before the Mercury 6 mission actually flew. The mission flew in February 1962. The primary task assigned to Mr. Glover at that time. By the way, Mr. Glover is not with us any more. He is working at Langley Research Center. The primary task assigned to him was to come up with a camera that could be operated totally with one hand ~~for~~; that required minimum pilot attention, and obtain reasonable photographs. Photographs of what was ill defined. We knew we wanted some pictures of the earth - not only those pictures that ~~would~~ were taken by automatic camera earlier in the Mercury unmanned flights, but we wanted the astronauts to have the capability to photograph what he ~~tought~~- thought were phenomena of interest and of scientific or general significance. The camera was an Ansco Autoset which I guess is obsolete now. It did have automatic exposure control and the basic modification to the camera was to strip down the camera, remove unnecessary dressing on the camera such as the chromium, letherette, and generally paint the camera in a dull black to avoid reflections inside the spacecraft. Also to examine internal parts and relubricate internal parts of the camera so we would not get into situations of vacuum welding etc., which we didn't know too much about at the time. We were extra cautious in these areas. The camera had a handle fitted to it and the handle had a trigger operated by the index finger which tripped the camera and and advance lever operated by the thumb, so you could cock the camera for the next exposure. ~~With this camera~~ The film used during that flight was an Eastman Kodak color negative film. The main things photographed were terrain, features, weather features, and we have ~~xx~~ obtained the first photo of the orbital sunset phenomena which is quite a bit different from what we see on earth and has been the subject of much scientific concern since we returned those first pictures. The terrain and weather photos also are the subject of much concern on the part of the meteorologists and geologists. ~~and many~~

On Mercury 7, we changed cameras to a robot recorder ~~and~~ which had effectively the same modifications done as we did in Mercury 6 and the same type of photography was accomplished with a little expansion in the degree of photography and a little better definition of what exposure settings to use. Again this was an adventure into space and we were pretty ignorant as to what to expect as far as atmospheric penetrations are concerned. a little more rapidly now, in Mercury 8 we introduced a new camera and it was a 70 mm Haselblad camera with an 80 mm lens ~~filmed~~ The introduction of this camera was primarily promoted by Wally Schirra and Gordon Cooper. The reason for selecting the Haselblad camera was that in reviewing the pictures taken with the earlier cameras which were 35mm format and both had 55mm focal lens, and they were both of the medium to low price cameras to start so they did suffer some from resolution color correction ~~and~~ etc. The Haselblad camera was chosen because it had an oustanding reputation as a leader in the field of 70mm cameras. It was the camera widely used by professionals and high acclaimed by the photographic users and industry. We picked a good name camera with a good reputation and the Haselblad is in the category of a high priced camera. The basic camera at that time probably cost around \$3-400 which is compared with ~~to~~ \$50-60 for the other cameras before modifications. The modifications made on the Haselblad were similar to those made on the previous camera. We removed the leatherette, the chrome and we did remove the reflex viewing system. The Haselblad camera is basically a single reflex camera. Within the confines of the Mercury spacecraft there was no room to use the reflex system and there was concern about the failure of the reflex system during the vibration situations. To play entire thing safe, the camera was modified by removing the reflex mechanism and also basically inspecting the rest of the internal mechanism without much change made to it at all. This work was done by our McDonnell support at KSC and one of the engineers who works for KSC, Red Something. As far as usage of photography was concerned, we drew the attention of the geologists and meteorologists and we had started to embark upon a photographic program called Scenoptic terrain photography and Senoptic weather photography. This photography is written up in many journals.

From Mercury 8 we also used the same camera on Mercury 9 and we used one additional camera on Mercury 9. This was the robot camera again with a very fast F.95 lens. The purpose of introducing the robot camera with the fast lens was to obtain dim light ~~pehenema~~ phenomena photography such as _______________ a program which has continued through the Gemini and ~~Mercury~~Apollo Program and Mr. Duncleman from GSFC has been actively involved as a user of this photography. This experiment was conducted again in modified form on Apollo 14 which we just finished flyingt That terminated the Mercury program and as a quick summary - in the Mercury program we started out with a very modest camera ~~and~~- ~~xyix~~ which had limitations and we ended up with a very good quality 70mm camera. We did obtain useful terrain and weather photography, and definition photography, dim light photography and other photography of general scientific interest, which has been looked on by many investigators.

Going ~~xix~~ into Gemin i now - Starting in Gemini we thought we would have somewhat different ~~photography~~- photographic problems. For one thing, we were going to do EVA, rendezvous,-~~and~~-- in Gemini - in other words, we were going to do dynamic things in space. When you talk about doing dynamic things, that means there is motion involved so obviously we would need a camera that could record thse dynamic events and a still camera can't hack it. A still camera can give you a sequence ~~ofx~~ every few seconds, so steps were taken to develop a motion picture type camera. As far as a still camera is concerned we reevaluated the entire field and decided ~~dixxided~~ the Haselblad is still our best bet and we made arrangements to have the camera modified in a more formal fasion. We wouldn't individually hobby shop each camera to modify it, but we would strive to obtain a modification contract which was done and was met with success.

The original contract with Cinimechanics on the West Coast.

Back to the motion picture camera, since this is really the new system for the Gemini vehicles. The original on the 16mm camera was started by McDonnell Acft Corp who ~~be-~~ was the prime contractor on the space vehicle and this program was kicked off by the program office. We did not get thoroughly involved in this camera program until the camera was almost ready for use on the vehicles. The original camera was a very compact 16mm camera with limited film capacity, with battery driven, single speed, 6 frames/second and a semi-mode camera. I don't recall the entire evolution of that camera but I will say one of the first things we did when we took over the program - first - the fact that it was battery operated made it very limited life and it was a rather unreliable camera also. I think that McDonnell Acft Corp being a very excellent air-frame and spacecraft manufacturer did not really have the capability to build the camera. To build the camera, I think you have to go to a camera house which knows the ins and outs of what you can get into in building a mechanism of the type required in cameras. However, we did obtain useful pictures, on Gemini III, we obtained photography of the earth with the camera and activity inside the spacecraft as I recall.

Gemini IV - in Gemini IV the original camera was fitted out only with a 25mm and a 5mm lens. The 5 mm lens a very wide angle bug eye used in photography. The 25mm lens is more or less a normal focal lens for a 16mm camera and was used for earth strip photography. The quality of the photography was fairly good. On Gemini IV, we had a EVA exercise which was fairly well documented bytthis 16mm camera. We had a wider lens selection we had 5, 18, 25, and 75mm lens. The 5mm is for photography and the longer focal lens so you can get two objects farther away, with the 75mm being approximately 3 times the magnification for that camera being used for the longrange maneuvers which were coming up in rendezvous and docking. As far as the Haselblad goes or the 70mm camera, the program of terrain and weather was continued. We have obtained in Gemini a stereoscopic strips which greatly aided the terrain ~~evaluations-~~ evaluators. The 70mm camera is a still camera which was bracket mounted and sequentially shot to obtain strip along the earth's surface and with enough overllap to get a scopic tear. One other thing we started to run i nto was the fact we were encountering some unusual lighting situations in places. To return to the operational aspects, we did develop a family of exposures nominal photographic exposures to be used, and these were generally broken down to account for such things as the front angle of being photographed and categorically the type of terrain - like ~~desea-~~ desert, sea and vegetated areas. This turned out to be a successful way of doing things. We didn't depend on a crew to make all these judgments though they could do it very well but from the ground we knew by the location of the spacecraft what the ~~front~~ sun angle was at the area where they would take photography and we had a good feel and the help us on what the terrain looked like from below and from these two things, we would go to our tables and give them a recommended exposure setting which worked very successfully. There were cases particularly with photography and type photography which we were encountering in Gemini where we could not really predict what the exposures would be. For instance in air to air photography, ~~thx~~ photographing another vehicle in close proximity to your own, one part of the vehicle is usually brightly illuminated by the sun and we could predict what that ~~px~~ exposure would be, the other part would be in total shadow ~~ah~~ however, total shadow really wasn't total in that there would be reflections from the earth which would illuminate the so-called dark side of the vehicle. This illumination could vary grossly depending on whether you were over a cloud deck. If you are over a cloud deck you get a fairly bright reflection back to the spacecraft. This can be observed in many of the photographs taken during Gemini and there are examples in this report of this type of photography. If you wanted to photography detail in the shaded areas, it was difficult to determine what was required and consequently we introduced a spot meter. The spot meter is a photographic light meter however, it senses light in a very small area of the ~~fxxx~~ format. 1° in this case. This was required in some of our photography long range. If we took a general spot meter we used for family portraits we'd have too wide an angle and we could not do with an average exposure setting, we needed a definite exposure setting for the one area we were interested in. This proved very helpful in Gemini in the air-to-air photography.

Going into Gemini V. Gemini V was the first mission we introduced the spot meter. Back to Mercury. We did try at one time, I think it was Wally Schirra tried to use a commercial off the shelf wide angle light meter to take light readings of the earth and expose his camera by these readings and all the pictures turned out to be grossly over exposed. That was a bad move and that was what led us down the spot meter path. We needed not an average reading but a definite reading.

Gemini V - we still retained the 70mm equipment, the 60mm equipment however by this time we were getting concerned about the 60mm equipment. There was a limited supply of these things and they were getting fairly well worn out so we embarked upon a program to develop a new 60mm camera which would have added capabilities. We also were getting concerned about the quality of the 70mm camera which we thought should be better and we started to take steps to have the modification done by the camera manufacturer at his factory rather than by an ~~ide~~ independent outfit. Through the rest of the Gemini Program - This didn't change too much until we got to Gemini VII. Gemini VII which was out first rendezvous flight and then the photographic equipment changed somewhat. By this time we had a new sequence camera which was a substitute for the motion picture camera we talked about previously. The difference being the new sequence camera as the name implies, did not operate at a semi-mode. It took a series of individual pictures at selectable frame rates of 1, 6, and 16. There may have been another frame rate in there which I will have to check to see. This gave us more lattitude in photographing with a 16mm camera. We retained about the same lens complement we had earlier except we deleted the 25mm lens, so we had 5mm, 18mm, 75mm lens which became through the rest of the Gemini Program and would also be continued through the Apollo Program. The camera had interchangeable magazines and unlimited quantities as opposed to the previous movie type camera which had a limited quantity of magazines. This camera ~~wsa~~ was operated off spacecraft power which gave us longer life in flight. We didn't have to worry about the small batteries operating the camera and we had better camera stability. Our frame rates were more constant because we didn't have to change battery voltages and the system worked more reliably even though we did have some problems which were primarily in the magazine. From here on through the rest of the Gemini Program we had a standard camera package. More or less standard with some additions on later flights. There was the 70mm Haselblad cameras, the16mm sequence cameras built by J. A. , and the spot meter built by Honeywell.

In later Gemini missions one other camera was brought into the picture and that was a 70mm camera - actually a 70mm scientific camera. It had a complement of special lens for low light level photography and for UV photography, experiments in both of these areas were conducted on Gemini IX, X, ~~and~~-XI, and XII. Through the rest of the Gemini flights we did conduct experiments in UV photography, UV astronomical photography, the general dimlight phenomena photography, we continued the terrain and weather photography. Of ourse, we continued our air to air dynamic photography which was primarily for engineering documentation-giving us a tool to evaluate each rendezvous and we were in our infancy in rendezvous at this time and the tool turned out to be a very helpful one, showing just how well the pilots performed in their docking maneuvers, what some of the dynamics were between the two vehicles, once they were docked.

A new camera was introduced - a scientific camera was introduced to take care of the new group of experimental photography. Also another version of a Haselblad camera was introduced, commercially called the super wide angle camera, 70mm film format with a 38mm lens. The purpose for this photography was to (1) give us wide angle terrain in weather photography which was beocming of extreme interest to the weather and terrain investigators and also (2) to give us better still documentation of vehicles in close by space. We were getting close enough that we needed a little wider angle photography. I think the photography from these cameras is still shown in many placed today. Samples are shown in the back part of this report.

I don't think I need to go into details of the photography done in Gemini 10 through 12. I would like to say that as we progressed the photographic load became heavier with each mission, new experiments were introduced which in turn required the development of the new camera systems andmuch valuable photographiyc data was obtained. This is recorded in the various mission documents.

We can go on to Apollo, But before going on with the Apollo missions I will attempt to talk organizationally as to how this all came about. I would like to put a note of caution ~~xx~~ in here - there are probably many names I have forgotten. Primarily, the camera ~~assist~~ systems development was the responsibility of the Flight Crew Support Division and the Spacecraft Operations Branch, which later became the Missions Operation Branch and the particular section within that branch called the Flight Eqpt Section. ~~We-~~ There is an exception to this - one, as I mentioned before the first 16mm camera initial development was started by the Gemini program office on a contract to MacDac. About half way through the development we were charged with this responsibility and we modified that camera somewhat and carried it on from there. The 70mm scientific camera I mentioned had a long history. The Flt Crew Support Div was not directly responsible for its development and I believe the camera started out in the Engineering and Development Directorate and it had 2 project engineers and one technical monitor from Photographiyc Technology Laboratory. ~~Other~~

In the area of types of film available, film preparation, film loading of cameras in the area of advice and consultation, on exposure the photographic tech lab played a very prominent part. Some of the people I recall particularly were Dick Underwood who had a long experience in cartographic photography, Tom Br   Tom Guynes, and Bobby Gray. These people supported us during the Gemini Program not only i n the areas mentioned, in the direct film area, but they worked here with our people to help us in the contractor acceptance of cameras, and monitoring contractor efforts on the cameras, and preparation of cameras for flight and assisted us in supporting some spacecraft milestones with photographic equipment.

~~In Apollo~~ The project engineers on the various camera systems from our own group. The 70mm camera systems were handled pri arily by Jeff Bremmer and Richard Thompson. The 16mm camera systems were originall handled by Ken Glover who is not with us any and then Ron Gurlock took it over and has been the most prominent player in that area now. The all work in the Flt Eqpt Section which is headed by Jim Taylor.

So far I've been talking about equipment and how it all came about. One other very significant part of the program is using the equipment which means training the crews in the use of photographic equipment and training the crews to recognize the objects they are to photography. The training was primarily conducted by the same organization that developed the camera, the Mission Operations Branch, with assistance from the Photographic Technology in the areas of film lattitude ~~and~~ how much we can play with being off exposure and still being able to get good results. GSFC in some of their particular experiments, Paul Lowman, was a tremendous help in briefing crews on terrain formations. At that time he worked for GSFC however, he is no longer with them. Dr. Duncleman was very prominent in assisting the crews on the astronomical photography and the low-light photography. Normally what we had attempted to do - we would set up a training program and ~~traintghe~~ train the crew in the use of photographic equipment, how to troubleshoot the equipment if there was any inflight trouble, and we would brief them on the general photographic requirements of the mission. However, when we got into specific scientific photography we have attempted to bring the principal investigator into talk with the crew so the crew can hear directly what the scientist is really interested in and the scientist can relate how best to recognize some of the targets that he is to photograph, which aren't always obvious. For instance the dim-light phenomena is something the crewman usually cannot see and this photography is taken by determining ~~the~~ where the pheonomena should be located in the heavens at the time we take the picture and normally ground update is required for the astronaut to point in that direction and take the photography. The exposures are long and hav to be worked out by the principal investigator.

Starting with Apollo as we look at the Apollo Missions while we ar still flying Gemini. We saw we had another group of mission rquirements which always mean new photographic requirements. We had rendezvous and docking as we did in Gemini, but more of it which meant we again needed good sequence type photographic equipment. We had the terrain and synoptic weather photography was still carried along even though not formally. The primary purpose of Apollo was to land on the moon and obtain scientific information and bring it back to earth. Which meant we needed photographic equipment for lunar surface work. Part of the documentation and sampling of the moon was not only picking up the rocks and various samples, but to document where the samples were picked up from and what they looked like in their virgin state before being p8cked up. Every sample that is picked up has a group of 4-5 photographs to get a serial of the area and a picture of the sample with respect to the immediate terrain and with respect to the distant terrain. so we could locate later on by analysis, reconstruct where all these samples were picked up. We also had another dynamic situation in Apollo which is the LM landing and we had to photographically document this for future scientific analysis of the entire landing dynamics. Actually we learned some interesting things. We learned a lot about the lunar dust primarily from the 16mm photographs that were taken during descent and the effect this dust had on the crewman's visibility since the last few feet of landing were actually under direct Apollo control.

Apollo 7 which was an earth orbital mission. As I mentioned earlier, we had concern about the quality we were getting from the Haselblad photography and by the time Apollo came around we had taken some steps to get the very best out of the 70 mm eqpt and we had ~~negetai~~ negotiated a contract with Pallaird who is the US distributor for Haselblad eqpt and the contract was effectively for having cameras for Apollo spaceflight modified at the factory - they would have a separate assembly line for production of Apollo 70mm cameras. Effectively we used the same parts of the commercial cameras but they went through an extra step of inspection, we did use special lubricants to have them space compatible, we had much more severe environments on these cameras since they were to be used on the lunar surface, which meant we had to pay a lot more attention to the vacuum and thermal environments. Later on to find out more about dust environments. Also we introduced a new group of lens to be used with the 70mm camera. We introduced the 250mm and 500mm focal lens cameras primarily for the purpose of lunar photography of areas os scientific interest. We ~~interud~~ introduced a somewhat grossly modified 70mm camera system which we called a 70mm Haselblad data camera which was fitted out with a 60mm lens of extreme high revolution and color correctness. This camera is also fitted with a re   grid to allow us to do photogrametric analysis of this photography. This effectively was the lunar surface camera system.

Apollo 7 was an earth orbital mission. We picked up terrain and weather photography we missed on Gemini and did it very successfully. We closed out the synoptic terrain and weather investigations. ~~Gem-~~ Apollo 7 being our first opportunity to be in a spacecraft of reasonable size, we did a fair amount of interior cockpit photography to try to document and better understand how a crewman can maneuver himself around in his vehicle and we got very valuable data here. We got good engineering data on the entire docking with the LM adapter and one other thing - a television camera was introduced in the Apollo Program. We were responsible for the operational requirements for TV as we are responsible for all the photographic operation. We are not responsible for that piece of equipment.

Apollo 8 was the first lunar orbit mission. One of the prime requirements was to get good photographic documentation of the moon and to look at the sites which we are to visit on lunar landings in later missions. There is scientific concern of looking at the earth and the moon at long distances. We did obtain mapping of the moon by taking stereoscopic strips along the moon. We introduced another piece of equipment this time which is called an intervelometer and is exactly what the name implies - it triggers the camera at intervals. On Apollo 8 we introduced an electric driven Haselblad camera so we could remotely trigger this thing and very accurately sequence the camera. We also took long high resolution photography with 250mm lens of specific targets on the lunar surface. We obtained 16mm sequential strip photography across the lunar surface to give folow-on crews an idea of how they would see things as they were approaching a landing site. We didn't make a low level pass but it was the best information we had at the time.

Going into Apollo 9 - The purpose of Apollo 9 was primarily to thoroughly check out the entire stack - the SIVB, the SLA and the LM and to practice the docking separation and redocking in earth orbit. This was done with a large amount of photographic documentation - both the sequence camera documentation - we also again used the wide angle 70mm camera for close-in inspection of the drogue, the impact points of drogue and any possible damage and we did EVA and LM we had the docked vehicles to check out the emergency docking procedure. The wider angle cameras helped here. Being earth orbital we did do some additional multi-spectral terrain photography even though I mentioned earlier that we stopped all that - we did do some on this mission primarily with black and white IR and color Ecktochrom film. Actually, this multispectral terrain photography and by that I mean there were 4 cameras - 4 70mm cameras ganged together and triggered simultaneously to take a picture of the same area at ~~3~~ 4 different spectrums ~~plus~~ at one time. This was primarily part of the Earth Resources program. I understand the results of that photography have been successful and have trigered the requirement for other multispectral photography of the moon later in Apollo and have given a lot of information for the Earth Resources program - the aircraft flight multispectral photography and the same thing is planned again for the Skylab missions.

Apollo 10 was another development mission - this time to evaluate the entire system at lunar distances - a lunar flight was made and the docking and undocking rendezvous, etc., was accomplished in lunar orbit, however, no landing was accomplished on this ~~misie-~~ mission. We did take landing point approach photography to be used for crew training of the later Apollo missions and again documented the docking, the LM extraction, did a photographic documentation of the entire LM. In all of these this photography was analyzed to assure ourselves that there was no problem showing up with the vehicles that was not obvious on the telemetry but would only be obvious by inspection. The analyses were negative.

Apollo 11 - This was our first lunar ~~surface~~ landing mission. The new thing photographically here is that we were going down for the moon which in Apollo 11 again being a lunar surface development mission was not very heavily scientifically oriented but was paving a path for later ambitious scientific missions. We investigated the lunar dust problem upon landing and it was observed and verified by the camera data that upon approaching a lunar surface we did generate a dust cloud which close into the spacecraft would obscure the surface and this was an area of great concern bucause the final toudhdown was done visually. We are touching down in an area of which we know very little about especially when we are talking about boulder sizes of up to 5-6 feet These do not show upon any of the orbital photography and we don't know about these kind of protrusions until we are close to the surface. However, these obstacles are big enough to cause us problems in trying to land a LM You havetto pick an area void ~~for~~ of the larger objects. Not only boulder type objects, but the small craters the 6-8-10' craters must be avoided. Especially if they are deep craters. As a result of what we learned on Apollo 11 we did modify our landing techniques somewhat to try to avoid the dust problem and it was primarily in the direction of landing to keep ~~the~~ from blowing the dust in front of us but rather blow it to the side or get it in back of us.

We did get good documentation of the lunar surface in the area of the Apollo 11 landing site, we investigated and documented such ~~pehon~~ phenomena as the zero phase affect which results from extreme poor visibility looking down sun. We also documented such affects as looking up-sun and with very bright sun conditions without atmospheric scattering and the other thing which plagued us photogrqphically but is a requirement for the mission is that we landed at very low sun angles which means that when you photograph anywhere near the quadrant of the sun you are most likely to get some sun impinging on the lens and causing some reflection. We   to have a high noon situation. The sun is always pretty much down on the horizon so it's   to what you would run into in photographing about 20-30 minutes before sunset on earth.

The photographic equipment for Apollo 11 was almost totally switched over to the electric cameras about this time. We used electric cameras on the surface and this was the main reason that electric camera was developed in that the crewman is restricted mobility wise very severely. in the lunar surface configuration, not only being pressurized but by thermal and meteoroid ~~domnance.~~ garments. The electric camera was the answer where you could just pull a trigger and take a picture advance the film, and be ready for the next picture.

Through Apollo 11 then, I will reiterate what the standard photographic complement was - It was 70mm Haselblad camera electric driven, with a 80mm lens for orbital use, a 250mm lens for orbital use, and a with the data camera with a 60mm lens for the surface use. A 16mm camera with lens of 5, 10, 18, and 75mm for a 16mm camera. The 10mm lens is news to the program at this time and is used primarily for the descent photography through the LM window from 60,000' to touchdown. It is also used for EVA activities outside the spacecraft and for photographing the ascent of the LM from the lunar surface back into lunar orbit.

Review - The Photographic Technology Lab continues to support in the area of film, film loading, and also in assistance in calibrating equipment accepting aquipment. Up ~~until Apollo, however, the~~ Starting with Apollo we had a new group which supports our photographic efforts which is primarily the Mapping Sciences Office of the S&AD. Our primary contact over there was Jim Sasser, head of the lab. We worked with such people as Lou Wade, Jim Drague, Geo Blackman, Ken Hancock, and many others. The S&AD, is primarily the user agancy of the lunar/mapping photography taken from orbit. They support this entire directorate in supplying mapping information to use in the simulators and to be used an onboard data, for crew maps. The surface geologists give support in determining what exposure they require to record the phenomena of multi through the lunar surface. USGS is the primary ggency there.

Re the entire development of the lunar program as it relates to the scientific aspects which are the ultimate objectives of the whole program. Up through Apollo 11 the science was rather minimum and the reason for that being was that it took through Apollo 11, the first lunar landing mission, to develop the operational techniques for getting to the moon, establishing proper orbits around the moon, establishing photographic procedures for photographing the moon, making a lunar landing, doing it successfully and feeling our way along to see what our capabilities on the lunar surface are, so that we would have developed a fully operational mission which could then devote its attention to doing lunar surface, lunar orbit, ~~atmosp-~~ selestial science, and science in all other disciplines without having to worry primarily about how we are going to get there and back. In other words, we were developing the station wagon that gets us out to the rock field where we can then go picking away at rocks. I think by Apollo 11 we had got to that stage. We had developed a successful system, which could get us to the moon, could get scientific equipment to the moon and set it up, activate it, do scientific sampling, document that sampling and bring the results back to earth. At the same time, we had spent a lot of effort in training the crews in geology and other scientific disciplines so they could be trained observers. So they could by having been briefed by the scientists beforehand, bring back the type of information required. ~~I think when~~ I feel very strongly that on Apollo 12 and 14 we have done significant scientific experiments and we are ready to do more as we go on with Apollo 15, 16, 17 where we hav the capability of going to rougher terrain areas and get into the highlands, amke longer excursions by the aid of the lunar roving vehicle, and we have further developed our scientific instrumentation, we know more of what we want to look at now based on what we've seen previously.