CORNELL UNIVERSITY

Center for Radiophysics and Space Research

ITHACA, N. Y.

CENTER FOR RADIOPHYSICS AND SPACE RESEARCH
CORNELL UNIVERSITY
ITHACA, NEW YORK

July 30, 1969

CRSR 345

FINAL REPORT

to

NASA MANNED SPACECRAFT CENTER

for

LUNAR SURFACE CLOSE-UP PHOTOGRAPHY

CONTRACT NAS9-9017

Principal Investigator: Prof. Thomas Gold

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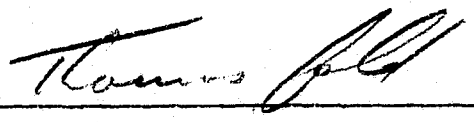
SIGNATURE PAGE

LUNAR CLOSE-UP PHOTOGRAPHY



Thomas Gold, Principal Investigator

FINAL REPORT

CONTRACT NAS9-9017

LUNAR CLOSE-UP PHOTOGRAPHY

The plan under this contract was to work together with the industrial contractor, Eastman Kodak, to produce a lunar close-up camera in time for the Apollo 11 flight. This has been achieved, and the camera appears to have worked satisfactorily. The pictures will be analyzed as soon as they are available for the information they contain concerning the nature of the various constituents of the lunar surface. Work at Cornell under this contract consisted in firstly specifying the optical, electrical and mechanical characteristics that were desirable. Various camera mock-ups were put together in order to test the results of a range of optical conditions and advise NASA and Kodak accordingly. A list of design parameters tested at Cornell and design points discussed with Kodak during development is included in Enclosure 1. Enclosure 2 includes photographs taken during design phase.

Co-Investigators on the camera contract with Prof. Gold included:

Dr. Edwin Land	Polaroid Corporation
Mr. Fred T. Pearce	Manned Spacecraft Center, NASA
Dr. Edward Purcell	Harvard University
Dr. Roderic Scott	Perkin Elmer Corporation

In the development phase constant contact was maintained with Kodak. NASA's decision to include the camera on the Apollo 11 flight so reduced the time available for development that the required coordination between Professor Gold and Kodak was on a more informal basis than normal, there being no time for the usual written progress reports. Professor Gold visited Rochester several times, and Kodak personnel visited with him at Cornell (see Enclosure 3). An early Kodak model of the camera was tried out at Cornell, found generally very satisfactory, and some minor changes were suggested. A version of the camera was also tested at Cornell for its resistance to mechanical impairment by the fine rock powder which is known to cover the lunar surface.

Preparations are being made for the scientific analysis of the lunar pictures. A stereo projector has been obtained, and methods of making models from stereo pictures are being investigated. Professor Gold is planning a visit to Houston in the near future for the first view of the lunar photography of Apollo 11, including that made with the stereo camera.

ENCLOSURE 1

Design parameters tested out at Cornell included:

1. Object-image ratio
2. Focal length
3. Aperture
4. Flash brightness
5. Stereo convergence angle

Further design points discussed with Kodak:

1. Re-cycling time
2. Number of frames
3. Type of film
4. Handle and trigger
5. Spring-loaded hood design
6. Cycling indicator

ENCLOSURE 2

PHOTOGRAPHS TAKEN DURING DESIGN PHASE

1. Modified speed graphic camera used in development phase of lunar close-up photography.

2. Mock-up device for camera handling purposes, lunar weight.

3. Lunar simulated soil - general picture.

4. & 5. Photographs of lunar simulated soil taken with early model of Kodak close-up camera.

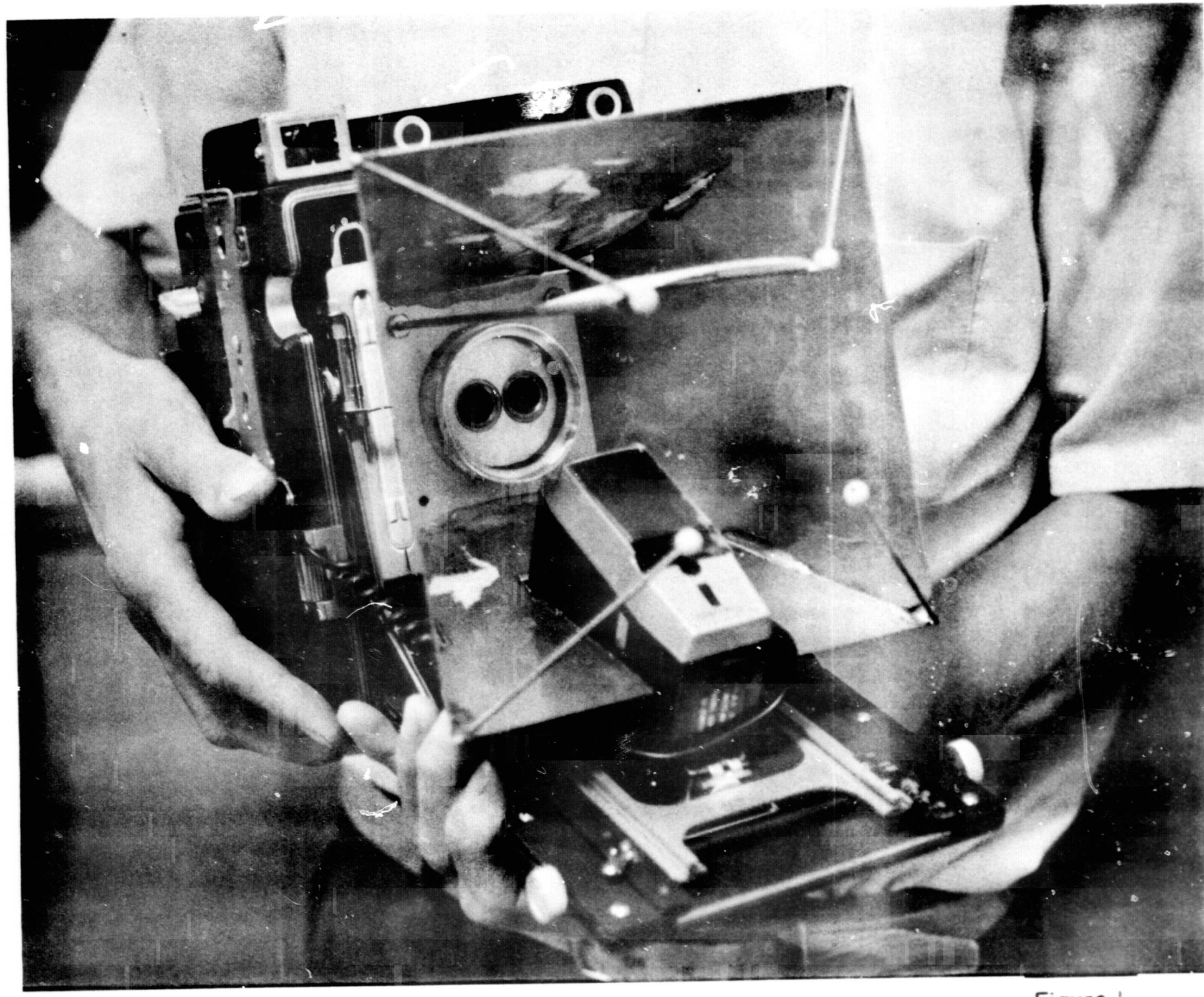


Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5

ENCLOSURE 3

PRIMARY COORDINATION CONTACTS DURING CAMERA DESIGN

December 14, 1968 - Meeting with Dr. George Mueller, NASA at MSC, Houston

January 7, 22, & 28, 1969 - Conference calls to Kodak and Co-Investigators

March 8, March 14, April 25, 1969 - Conferences with Kodak personnel in Rochester, NY

March 27, May 13, 1969 - Conferences with Kodak personnel at Cornell University, Ithaca, NY

ENCLOSURE 4

CORRESPONDENCE WITH NASA

Letters

1. March 24, 1969
2. May 29, 1969
3. July 24, 1969

C O P Y

March 24, 1969

Dr. George Mueller
Code M
NASA Headquarters
Washington, D. C. 20546

Dear George:

This is to tell you that I am satisfied with the progress made by Kodak in their design of the lunar close-up camera. While the urgency precludes the complete optimization of all parameters, I am satisfied that we have basically a very sensible design and that an excellent performance can be expected.

I will continue to be in close touch with Kodak and with MSC in this project, and I will inform you periodically of the progress in all areas--design, construction, training program and, we trust, results.

Yours sincerely,

T. Gold
Director

TG:cf

cc: E. Land
E. Purcell
J. Baker
R. Gilruth
F. Pearce
D. Hornig

Bcc: B. Elle
J. L. Boon
A. Simmons
H. Waggershauser

C O P Y

May 29, 1969

Dr. George E. Mueller
Office of Manned Space Flight
Code M
NASA Headquarters
Washington, D. C. 20546

Dear George:

I am sending you under separate cover a stereo viewer and ten slides taken with our moon camera. I thought you might like to have this around in your office as one glimpse is better than any amount of description of the nature of this instrument. We are well satisfied with the progress, and also the robustness of the instrument in quite adverse circumstances. I do hope it will be possible to have a half hour of the astronauts' time in order to show them how best to use the camera. I think it speaks well for the ease of operation that we will be satisfied with as little as half an hour, but that much would really help to get even better pictures. We are chiefly concerned with the quick and approximate judgment that one can make, and that is quite sufficient to get the essential part of the object into the plane of best focus when the surrounding surface is very convex or very concave. We are setting up a number of objects suitably marked and measured up so that we can tell an astronaut immediately as he is doing it whether he is right, too near or too far. As I have said, it is only a very crude judgment that is needed, and anyone can readily learn it in this way in a few minutes (it is no good trying to learn it by taking pictures and remembering afterwards what one has done. It will be far better for the instructor to be able to say on the spot what the error is).

I understand that the astronauts are very rushed at the moment, but I still hope we can get that little bit of attention. May I add my congratulations to an enormous list on the great success of Apollo 10.

Yours sincerely,

T. Gold
Director

C O P Y

July 25, 1969

Dr. George Mueller
Code M
NASA Headquarters
Washington, D. C. 20546

Dear George:

This is just to tell you how delighted I am that the close-up camera was used and seems to have functioned. I am sure we shall have very valuable information from it. I should like to thank you and the members of your staff who have made it possible to get the thing on board and deployed.

This is also an occasion to stress once more what a good job Kodak has done in producing a well-engineered object so quickly. I am sure that my colleagues on the PSAC Photographic Sub-committee who defined the basic nature of the instrument will be very pleased with our progress.

I will of course keep you closely informed of scientific results, both in the form of a first round after a quick look, and a second round after a careful analysis including the construction of models that closely duplicate the appearance.

Yours sincerely,

T. Gold
Director

TG:cf