PHOTOGRAPHIC ASPECTS OF NASA MANNED SPACE FLIGHT MISSIONS

1. Background

The Project Mercury and Project Gemini manned flight programs were characterized by a large volume of significant space photography acquired for engineering, scientific, and public information purposes. Photographic subjects ranged from equipment functions to meteorological conditions, from astronaut activities to terrain, from astronomy to oceanography.

Terrain photography experiments have been particularly important in the Gemini series, identifying the potential values of small-scale color coverage of very large areas of the world for earth resources survey applications. While the hand-held cameras used by the Gemini astronauts were not highly sophisticated, these instruments had the advantages of light weight, flexibility, and low cost; their publicized use from orbit resulted in no unfavorable international reactions.

With Project Apollo now beginning its flight phase in earnest, it is timely to review the photographic elements of the upcoming missions.

2. Apollo

The flight program calls for several unmanned earth orbital test flights to qualify the flight systems, followed by manned earth orbital flights of increasing difficulty to qualify and train the flight crews and their ground support elements. The lunar mission attempts would then follow.

It is expected that, in Apollo as in the earlier missions, photography from space of the earth, moon, and stars will be continued, although at a lower level of activity commensurate with the lunar mission orientation of the program; the Mercury and Gemini projects were only earth orbital in capability.

Apollo 5

The first unmanned Apollo missions were reentry and guidance tests using "boiler-plate" spacecraft; the first of these to carry engineering photography equipment was the first Saturn V mission flown last year in a highly elliptical orbit. The unmanned Apollo 5 had on board a fixed, automatically operated Maurer multi-exposure camera focused through the spacecraft window. The camera was activated near apogee, at an altitude of some 10,000 nautical miles, and exposed its film during the entire terminal phase of the mission. The film was routinely recovered from the spacecraft after its parachute descent, sea landing, and subsequent pick-up by the aircraft carrier Bennington.

The purpose of the Maurer photography was to verify the actual response of the spacecraft to the pre-programmed altitude control ? commands by comparison of the film record with the theoretical performance.

The film records actual spacecraft attitude changes and rates from the fixed camera within the spacecraft in terms of angular motion of the imaged earth being photographed through the window.

Apollo 6

The unmanned Apollo 6 mission scheduled for March 21, 1968, will also carry a Maurer camera to record engineering data on spacecraft orientation. Apollo 6 will first fly two circular orbits at an altitude of 100 nautical miles and then begin the high altitude portion of the mission. The background of the spacecraft window through which the fixed camera is focused will be the earth sub-satellite track for the majority of one complete orbit. In order to make maximum use of the mission, it is expected that the engineering film data will also be used by the earth resources survey program participants to provide an insight into the value of this class of photography for each of their disciplines. It is expected that the more interesting photographs will have a significant public information value.

Apollo 6 Photography

The on-board Maurer camera timer is automatically activated by the acceleration of the spacecraft at launch. The interval between timer activation and first exposure is approximately 90 minutes, or at the beginning of the second orbit. The camera then operates automatically at the rate of one frame (or exposure) every 8.5 seconds until the full 180-foot film supply is exhausted, or about 2 hours.

The orbital inclination of 32.5° means that the spacecraft will encounter both day and night locally as it moves eastward around the earth. Because the camera operates continuously, some 50% of the photography will be of un-illuminated areas.

With an 8.5-second interval between exposures, there will be an overlap of approximately 55% between the individual frames; this will permit stereo analysis of the imagery. Each frame covers an area approximately 75 nautical miles on a side. Because of the overlap, each fram actually includes an advance of 34 nautical miles along the satellite's ground trace. A continuous strip 75 nautical miles wide can be photographed around the globe, but because of spacecraft attitude changes, only approximately 21,000 nautical miles of the earth trace will be covered.

The trace on the enclosed map indicates the nominal path of the spacecraft in the low-orbit phase. The trace is marked to indicate the initiation and termination of photography and the local day-night condition. The attached table provides the list of significant areas over which the spacecraft will pass while recording photography; the approximate times of passage are given in both Eastern Standard (EST) and Local Standard Times (LST), using the 24-hour notation.

In summary, the major photographic coverage of interest will be from the northwest to southeast swath across Africa, starting with Mauritania and ending with Malagasy.

The fine grain color film proposed for use is either S0121 (preferred) or S0368. The maximum angular resolution of the system is expected to be on the order 0.3 milliradians; under the best conditions of sun angle and atmospheric calm, an object on the order of 125 by 125 feet might be detected but could not be identified. Average ground resolution for detection is expected to be on the order of 150 to 200 feet; identification is limited to objects several times larger than the detection threshold. For earth resource survey experimentation, this photography should provide a first approximation of the data quality that future experimental satellites may provide on a systematic, longer duration basis.