10 Sept 69

Col Ford -

As per our telecon, enclosed herein is the briefing (A) gave to NASA which you attended last week.

I suggest we come up with a study number(s) for studies of possible use of DORIAN technology/hardware, etc. by NASA rather than proliferate DORIAN clearance and documentation.

I would be happy to work on such a plan.

Harvey Cohen
APPLICATIONS OF THE MOL

ACQUISITION AND TRACKING SCOPE (ATS)

TO NASA SPACE MISSIONS
BRIEFING PURPOSE

- DESCRIBE POTENTIAL UTILIZATION OF MOL ACQUISITION AND TRACKING SCOPE SYSTEM IN APOLLO LUNAR EXPLORATION AND APOLLO APPLICATIONS PROGRAMS
BRIEFING CONTENT

- MOL ATS DESCRIPTION AND STATUS
- POTENTIAL ATS APPLICATIONS TO NASA MISSIONS
  ✓ VIEWING DEVICE
  ✓ OPTICAL SENSOR
- PROPOSED STUDY BY THE AEROSPACE CORPORATION
MOL ATS DESCRIPTION AND STATUS

1. PHYSICAL AND OPTICAL CHARACTERISTICS

2. MOL ATS INSTALLATION

3. MOL ATS OPERATIONS

4. CURRENT ATS STATUS
A.T.S. PHYSICAL CHARACTERISTICS

FOLDING MIRROR

CONTROL

187 Lb.
105 Lb.

TOTAL
292 Lb.

HANDLE VIA BYE MAN
CONTROL SYSTEM
SECRET DORIAN

DORIAN/ITS PI-11 15ICAL CHARACTERS.
## MOLATS WEIGHTS

### OPTICS
- **TRACKING MIRROR ASSEMBLY**: 65 LBS
- **TELESCOPE**: 78
- **FIXED FOLD MIRROR ASSEMBLY**: 20
- **SHROUD**: 15
- **WINDOW AND BEZEL**: 9

187 LBS

### CONTROLS
- **GYRO AND GYRO ELECTRONICS**: 8 LBS
- **CONTROL STICKS**: 4
- **SUPPORT STRUCTURE**: 8
- **HARNESS**: 25
- **DRIVE ELECTRONICS**: 60

105

292 LBS
ATS OPTICAL CHARACTERISTICS

- **APERTURE**: 10 INCH UNOBSCURED DIAMETER
- **FOCAL LENGTH**: [Redacted]
- **MAGNIFICATION**:
  - **LOW POWER**: 16 X TO 32 X, ZOOM CONTROL
  - **HIGH POWER**: 63.5 X TO 127 X, ZOOM CONTROL
- **APPARENT FIELD OF VIEW**: 60°
- **REAL FIELD OF VIEW**
  - **LOW POWER**: 2° (AT 32X) TO 4° (AT 16X)
  - **HIGH POWER**: 0.5° (AT 127X) TO 1° (AT 63.5X)
- **RESOLUTION**: ≈ 3 FT/LINE-PAIR FROM 80 N. MI.
ATS SYSTEM CHARACTERISTICS

- POINTING ACCURACY: 0.1° (.95 p)
- LOS VIBRATION: ≤ 0.5 sec (peak to peak) above 6 Hz (.95 p)
- IMAGE MOTION RATES: ≤ 48 μrad/sec below 6 Hz (.95 p)
- LOS SLEW CAPABILITY: ≥ 30°/sec
VISUAL DISPLAY PROJECTOR CHARACTERISTICS

MISSION FUNCTION: PROVIDE VISUAL CUES TO ASSIST CREW IN IDENTIFICATION OF TARGET AND/OR TARGET ACTIVITY

SCREEN: BACK-LIGHTED, 6 1/2 INCHES IN DIAMETER

SCREEN BRIGHTNESS: 0 TO 25 FOOT-LAMBERTS, ADJUSTABLE

SELECTION CAPABILITY: COMPUTER OR CREW COMMANDS CAUSE ANY ONE OF UP TO 32,752 FRAMES TO BE PRESENTED

CUE CASSETTES: EACH CASSETTE CONTAINS 4094 - 16 MK FRAMES, ON REELS

RETRIEVAL TIME: 0.45 + N/100 SECONDS, IF CASSETTE INTELLIGENCE NOT REQUIRED
N = NUMBER OF FRAMES FROM PREVIOUS TO NEXT CUE

WEIGHT: PROJECTION - 23 LBS, CASSETTE 1.2 LBS
ATS/MAN'S ROLE (MOL MISSION)

1. INCREASE QUALITY OF TECHNICAL INTELLIGENCE BY REAL-TIME EVALUATION OF TARGETS

2. EACH CREWMAN WITH ATS VIEWS UP TO FOUR ALTERNATE TARGETS AND "VOTES" AS FOLLOWS

- REJECT (PROBABLY CLOUD COVERED)
- INACTIVE (TARGET CLEAR BUT NO TI FEATURES OF INTEREST)
- ACTIVE (TI INTEREST)
- OVER-RIDE (INTERUPT PROGRAMMED MAIN OPTICS)
CONCEPT OF MANNED EXAMINATION
FOR
TECHNICAL INTELLIGENCE INDICATORS/WEATHER

- IF EITHER ALTERNATE HAS ACTIVE INDICATORS, TAKE IT
- IF PRIMARY COVERED AND ALTERNATE CLEAR, SWITCH TO ALTERNATE
ACTIVE INDICATOR EXAMINATION AND SPECIAL PHOTOGRAPHY SEQUENCE

TIMES (SEC.)
- 10 - 2.5 - 3 - 5.2 -

DISTANCE (N. ML.)
- 42 - 10.5 - 12.5 - 22 -

ACQUIRE

START STEREO

END STEREO

START SETTLE

DECIDE

+36°

+11.5°

+4°

-20°

-5°

80 N. ML.
ATS PROGRAM STATUS, JUNE 1969

- OPTICAL DESIGN COMPLETE
- OPTICAL TESTS ON BENCH UNIT COMPLETE
  ✓ DESIGN PREDICTIONS VERIFIED
- FABRICATION OF OPTICAL ELEMENTS FOR TWO ENGINEERING UNITS: 95% COMPLETE
- MECHANICAL DESIGN: 75% COMPLETE
- ENGINEERING MODEL COMPLETION SCHEDULED AUGUST 1969
POTENTIAL ATS APPLICATIONS TO NASA MISSIONS

- APOLLO APPLICATIONS PROGRAM
- LUNAR EXPLORATION PROGRAM
POTENTIAL ATS RELATION TO APOLLO APPLICATIONS PROGRAM

- TASKS ASSIGNED TO ATS ABOARD AAP SIMILAR TO ATS FUNCTIONS ABOARD MOL:
  - VIEW EARTH (OR SPACE) FEATURES AND RECORD DATA
  - DIRECT OTHER SENSORS TO TARGETS ACQUIRED BY ATS

- ATS CAN BE USED AS A VIEWING DEVICE BY THE CREW, AND AS A PHOTO-OPTICAL AND/OR ELECTRO-OPTICAL SENSOR

- ATS OF PARTICULAR VALUE TO EARTH SURVEY TASKS (EG: AGRICULTURAL, GEOGRAPHICAL, GEOLOGICAL, OCEANOGRAPHIC) REQUIRING LESS THAN 50 FT. GROUND RESOLUTIONS

- ATS RECORDED DATA CAN BE RETURNED TO EARTH VIA WIDE-BAND TRANSMISSION LINKS OR DIRECT RECOVERY
## TYPICAL EARTH SURVEY TASKS REQUIRING LESS THAN 50 FT GROUND RESOLUTION

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>TASK</th>
<th>COLOR DESIREABLE</th>
<th>TASK</th>
<th>COLOR DESIREABLE</th>
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<tr>
<td>AGRICULTURAL</td>
<td>Crop Identification</td>
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<td>GEOGRAPHICAL</td>
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<tr>
<td></td>
<td>Timber Inventory</td>
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<td>Transportation Survey</td>
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<td>Land Use Surveys</td>
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<td>Industrial Survey</td>
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<tr>
<td></td>
<td>Rangeland Surveys</td>
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<td>1:24,000 Scale Mapping</td>
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<td>1:62,500 Scale Mapping</td>
<td>X</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>1:250,000 Scale Mapping</td>
<td>X</td>
</tr>
<tr>
<td>GEOLOGICAL</td>
<td>Groundwater Survey</td>
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<td>OCEANOGRAPHIC</td>
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<tr>
<td></td>
<td>Volcanic Eruption Assessment</td>
<td></td>
<td>Commercial Fish Location</td>
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<tr>
<td></td>
<td>Mineral/Petroleum Survey</td>
<td></td>
<td>Sea State Survey</td>
<td>X</td>
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<tr>
<td></td>
<td>Heavy Metal Survey</td>
<td>X</td>
<td>Coastal Mapping</td>
<td>X</td>
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<tr>
<td></td>
<td>Earthquake Assessment</td>
<td></td>
<td>Coastal Engineering Survey</td>
<td></td>
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<tr>
<td></td>
<td>River Basin Mapping</td>
<td>X</td>
<td>Navigation Hazard Survey</td>
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<td></td>
<td>Water Pollution Survey</td>
<td>X</td>
<td>Marine Pollutant Survey</td>
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<tr>
<td></td>
<td>Sedimentation Survey</td>
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<tr>
<td></td>
<td>Erosion Survey</td>
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<tr>
<td></td>
<td>Flood Mapping</td>
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<tr>
<td></td>
<td>Geological Mapping, 1:250,000 Scale</td>
<td>x</td>
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</table>
## ATS Capability from 240 N. Mi. Earth Orbit

<table>
<thead>
<tr>
<th>F. O. V.</th>
<th>Magnification</th>
<th>Visual Ground Resolution (ft.)</th>
<th>Projected F. O. V. Diameter (n. mi.)</th>
<th>Photographic Ground Resolution (ft.)</th>
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<tbody>
<tr>
<td>4° ZOOM</td>
<td>16 x</td>
<td>57</td>
<td>18</td>
<td>31.0</td>
</tr>
<tr>
<td>2°</td>
<td>32 x</td>
<td>30</td>
<td>9</td>
<td>--</td>
</tr>
<tr>
<td>1° ZOOM</td>
<td>63.5 x</td>
<td>15</td>
<td>4.5</td>
<td>7.8</td>
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<tr>
<td>1/2°</td>
<td>127 x</td>
<td>9</td>
<td>2.3</td>
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</table>
Wide-band data transmission from low-earth orbit using data relay satellite

<table>
<thead>
<tr>
<th>Transmission Rate Data</th>
<th>Frame Resolution (LP/MM)</th>
<th>Frame Area Per Minute (IN²)</th>
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<tbody>
<tr>
<td>Analog</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 MHz</td>
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<td>108</td>
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<tr>
<td>25 MHz</td>
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<td>275</td>
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<tr>
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<td>27</td>
</tr>
<tr>
<td>25 MHz</td>
<td>100</td>
<td>67</td>
</tr>
<tr>
<td>Digital*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 MB/SEC</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>50 MB/SEC</td>
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<td>25</td>
</tr>
<tr>
<td>10 MB/SEC</td>
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<td>1.2</td>
</tr>
<tr>
<td>50 MB/SEC</td>
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</tbody>
</table>

* Digital based on 5 bit PCM, no compression
POTENTIAL ATS RELATION TO LUNAR EXPLORATION PROGRAM

- ATS can be used by the Apollo crew to make detailed visual surveys of the lunar surface and record selected objects, sites, and regions
  - Landing site evaluations
  - High resolution mapping
  - Location/identification of surface objects (vehicles, geological details)

- "Low light" electro-optical sensors would allow investigations of polar and terminator regions and crater shadows

- ATS recorded data can be returned to Earth via wide-band transmission links or direct recovery
TYPICAL CSM ATS INSTALLATION

COMBINED LUNAR LANDING/MAPPING MISSION

ELECTRO-OPTICAL DISPLAY

MAIN OPTICS AND CAMERA

EXPERIMENT SECTOR

SECTION A-A
TYPICAL ATS LUNAR OBSERVATION CAPABILITY
LUNAR LANDING SITE INSPECTION SCENARIO

- 10 N. M. ORBIT
- LOCATE LANDING ZONE WITH LOW POWER ATS
- DISPLAY IN CM AND MISSION CONTROL
  - 2400' FOV
- CENTER LANDING SITE SCENE ON DISPLAY
- SWITCH TO HIGH POWER ATS
  - 600' FOV
- CONFIRM LANDING SITE
  - MISSION CONTROL
  - APOLLO CREW
- LM DESCENT ON SUBSEQUENT ORBIT
  OR
- ALTERNATIVE LANDING ZONE/SITE EXAMINE
LUNAR SURFACE OPTICAL DATA ACQUISITION

- REAL TIME VIDEO INFORMATION
- STORED FILM RECORD

VIDEO DATA RESOLUTION
2.3 FT @ 20 N. MI.

VIDEO TRANSMISSION
ANTENNA

L. O. S. TRANSMISSION

EARTH

APOLLO CSM

OPTICAL FIELD
OF VIEW

AREA RECORDED

MOON

PHOTO DATA RES.

HANDLE VIA BYE MAN
CONTROL SYSTEM
TYPICAL LUNAR SURFACE OPTICAL DATA ACQUISITION SCENARIO

1. ACTIVATE SYSTEM FOR LUNAR OPERATIONS, I.E. EXPOSE OPTICAL HEAD, CHECKOUT MECHANISMS, VERIFY FILM AND ELECTRO-OPTICAL SYSTEMS OPERATION

2. IDENTIFY LUNAR GEOGRAPHICAL AREA OF INTEREST USING CUE DATA

3. POSITION OPTICAL SYSTEM TO PLACE AREA OF INTEREST IN OPTICAL FIELD OF VIEW

4. PERFORM IMAGE CENTERING OF TARGETS AS REQUIRED

5. INITIATE DATA ACQUISITION MODE(S) FOR ELECTRO-OPTICAL SCENE RECORDING OR FILM/CAMERA OPERATION

6. CONTROL QUANTITY OF DATA COLLECTED BASED ON VISUAL OBSERVATION OF CONDITIONS AFFECTING PHOTOGRAPHIC OPERATIONS

7. RETRIEVE FILM FOR RETURN TO EARTH IN COMMAND MODULE
CONCLUSIONS

- APPARENT NEED FOR AN A.T.S. ON NASA MANNED SPACE
  PROGRAMS HAS BEEN IDENTIFIED

- SYSTEM DESIGN ESSENTIALLY COMPLETED ON D.O.D. MOL
  PROGRAM

- ADAPTABILITY OF A.T.S. TO NASA MISSIONS APPEARS
  FEASIBLE BUT DETAILED STUDY NEEDED TO PROVIDE
  IMPLEMENTATION PLANS

- INTIMATE PARTICIPATION IN ATS CONCEPT AND DEVELOPMENT
  MAKES AEROSPACE CORPORATION LOGICAL CONTRACTOR TO
  PERFORM STUDY FOR NASA ON EFFECTIVE ATS UTILIZATION
PROPOSED STUDY BY THE AEROSPACE CORPORATION

- PHASE I - SYSTEM DEFINITION

- PHASE II - GSE/TD OF CONTRACTOR EFFORT
MANNED SPACE SYSTEM BACKGROUND

THE AEROSPACE CORPORATION, SINCE ITS FOUNDING, HAS BEEN ACTIVE IN MANNED SPACE SYSTEM ANALYSES.

- COMPARATIVE STUDIES OF GEMINI, APOLLO AND DYNASOAR
- DOD/NASA GEMINI EXPERIMENTS PROGRAM
- ATLAS, GLV, TITAN III LAUNCH VEHICLES
- CONCEPTUALIZATION, GENERAL SYSTEMS ENGINEERING AND TECHNICAL DIRECTION OF USAF MANNED SPACE PROGRAMS
- MANNED ORBITAL LABORATORY

THE CORPORATION HAS BEEN ENGAGED IN THE DESIGN AND SIMULATION OF CREW VIEWING SYSTEMS SINCE 1964.

- POINTING AND TRACKING SCOPE (MOL EXPERIMENTS)
- ACQUISITION AND TRACKING SCOPE (MOL PROGRAM)
STUDY SCOPE

- Investigate the application of the ATS to NASA space missions and vehicles
  - APOLLO APPLICATIONS PROGRAM
  - LUNAR EXPLORATION PROGRAM

- Develop multiple uses of the ATS
  - CREW VIEWING DEVICE
  - PHOTO AND ELECTRO-OPTICAL SENSOR (NORMAL AND "LOW-LIGHT" SCENES)
  - NEAR REAL TIME DATA TRANSFER

- Define NASA ATS configuration and operations
  - ATS DESIGN
  - VEHICLE INTEGRATION
  - CREW TRAINING
  - COST, SCHEDULES, AND SPECIFICATIONS
ATs APPLICATIONS

I STUDY TASK AREAS

- NASA PLANS AND HARDWARE (APOLLO AND AAP) REVIEW
  - OPERATION PLANS, TIMELINES, PERFORMANCE TRADES
  - VEHICLE SYSTEM DESIGN CHARACTERISTICS AND CONSTRAINTS

- MISSION APPLICATION AND PERFORMANCE ANALYSIS
  - MISSION OBJECTIVES
  - ORBIT SELECTION CRITERIA
  - OPERATING MODES
  - CREW TASK ANALYSIS
  - TOP TIME LINE DEFINITION
  - SIMULATION/TRAINING REQUIREMENTS
  - IMPACT OF ATS ON CURRENT MISSION PLANS

- FLIGHT VEHICLE INTEGRATION STUDIES
  - ATS CONFIGURATIONS ANALYSIS
  - INSTALLATIONS ANALYSIS AND LAYOUTS
  - VEHICLE SUBSYSTEM IMPACTS
  - SYSTEM COMPATIBILITY ANALYSIS/SUMMARY

- SPECIFICATION DEVELOPMENT
  - BASIC OPTICAL SYSTEM
  - PERIPHERAL RECORDING EQUIPMENT
  - INSTRUMENTATION
  - COMPUTER HARDWARE/SOFTWARE
  - POTENTIAL MODIFICATIONS
  - TEST REQUIREMENTS

- TRAINING PROGRAM AND EQUIPMENT REQUIREMENTS DEFINITION

- PROGRAM IMPLEMENTATION PLAN

- DEVELOPMENT AND ACQUISITION COST ESTIMATES
ATS APPLICATIONS

PHASE I STUDY PROGRAM PLAN

TASK AREAS

- NASA PLANS & HARDWARE (APOLLO & AAP) REVIEW
- MISSION APPLICATIONS & PERFORMANCE ANALYSIS
- FLIGHT VEHICLE INTEGRATION STUDIES
- SPECIFICATION DEVELOPMENT
- TRAINING PROGRAM & EQUIPMENT REQUIRED DEFINITION
- PROGRAM IMPLEMENTATION PLANS
- DEVELOPMENT & ACQUISITION COST ESTIMATES
- DOCUMENTATION
- REPORTS

1969 1970

S O N D J F

P.R. MID P.R. FINAL

SECRET DORIAN

HANDLE VIA BYEMAN CONTROL SYSTEM
## ATS APPLICATIONS
### PHASE I STUDY MANPOWER ESTIMATE

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<th>Task Areas</th>
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<td>NASA PLANS &amp; HARDWARE (APOLLO &amp; AAP) REVIEW</td>
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**TOTAL MAN MONTHS**

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<tr>
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