



# **BEHAVIORAL HEALTH AND PERFORMANCE**

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## **LESSONS FROM MOL: CREW AUTONOMY, PERFORMANCE, AND PSYCHOLOGICAL DEMANDS**

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# DISCLAIMER

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**The views expressed are those of the authors and do not necessarily reflect the official policy or position of NASA or the U.S. Government.**



# Disclosure Information

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We have no financial relationships to disclose.

We will not discuss off-label use and/or investigational use in this presentation.



# WHAT WAS MOL?

**Piloted reconnaissance platform in low Earth orbit**

- 5 missions
- 30 days
- 2 men per mission
- Sun-synchronous polar orbit: 98.6° inclination
- Low altitude: 80 x 186 NM (148 x 344 km)
- Initiated in December 1963 as “manned orbiting laboratory” to demonstrate general military value of man in space
- Authorized in August 1965 to demonstrate manned high-resolution reconnaissance
- Cancelled in June 1969 because of expense, redundancy





# THE DORIAN FILES REVEALED

OCTOBER 22, 2015, THE NATIONAL MUSEUM OF THE U.S. AIR FORCE



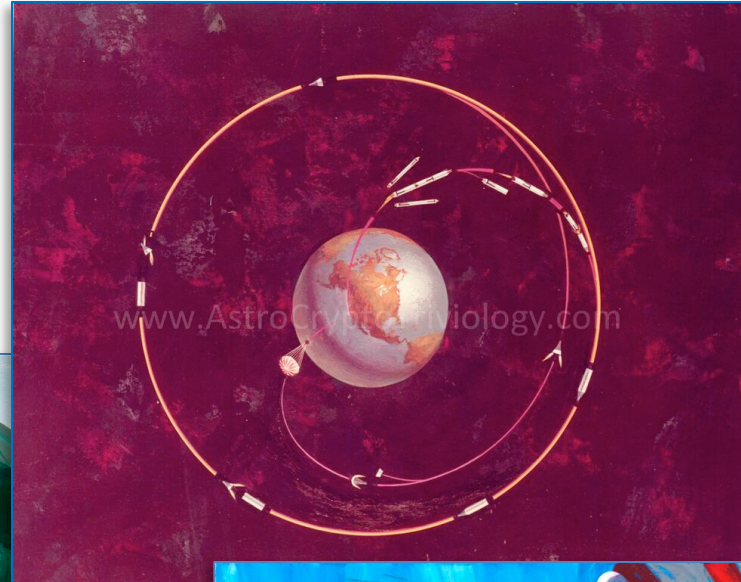
[www.nro.gov/history/programs/docs/MOL\\_Compndium\\_August\\_2015.pdf](http://www.nro.gov/history/programs/docs/MOL_Compndium_August_2015.pdf)

[www.nro.gov/foia/declass/MOL.html](http://www.nro.gov/foia/declass/MOL.html): 825 documents, 282 photographs, 1 movie

## NRO declassified 1 July 2015



# MOL MISSION PROFILE





# **MOL Primary Objectives**

(DoD Press release 25 Aug 1965)

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- **Learn more about what man is able to do in space and how that ability can be used for military purposes**
- **Develop technology and equipment which will help advance manned and unmanned spaced flight**
- **Experiment with this technology and equipment.**



# MOL “classified” Objectives

(15 April 1965)

- **General (in order of priority):**
  - Tech Dev improved mil obs capability (manned or unmanned)
  - Dev and Demo manned assembly & svc large structures in orbit
  - Other manned mil experimentation
  - Addition national objectives
- **Specific (in order of priority):**
  - Demo manned ops & svc of high-res photo reconn
  - Dev elements & tech required optical cam systems
  - Demo assem, svc, & manned ops high gain COMINT
  - Demo manned ops & svc multi-sensor payload
  - Demo and measure biological responses > 30 days orbit
  - Demo in-space maintenance capability
  - Demo extended EVA (assem & adjust equip in space)
  - Provide manned orbital vehicle add-on mil & non-mil payloads





# Seeing “behind” the *Iron Curtain*

**“...the crew will have every point on the earth's surface within view at least twice a day....A telescope with the magnification of a million times at a distance of 37,500 kms (23,250 miles) on the so-called stationary orbit space station...would make the earth appear to be only 37 M (120 ft) from the observer. This is an almost terrifying power of observation which would make any kind of "Iron Curtain" completely senseless.”**



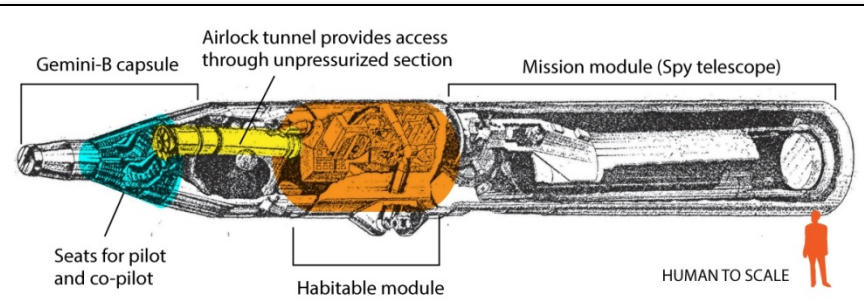
# KH-10 DORIAN

72-inch movable-mirror reflecting telescope for reconnaissance of “denied” territories (i.e., USSR, PRC)

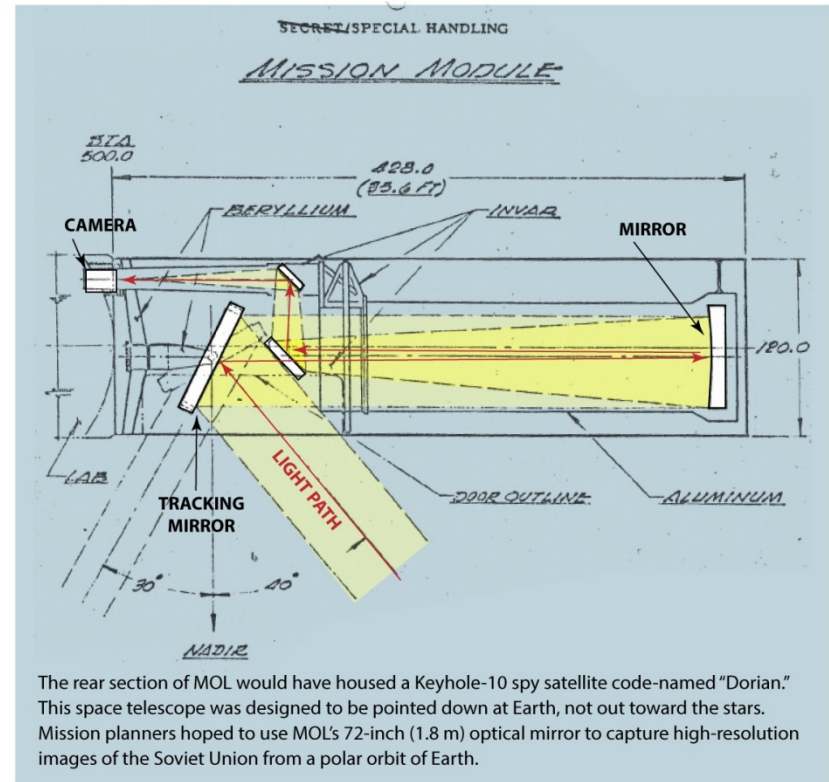


Waltrap-Catching the End of an Era-June2014.pdf

Studies in Intelligence Vol 58, No. 2 (Extracts, June 2014)



MOL was to be 71.9 feet (21.9 meters) from the nose of its Gemini-B command module to the tail of its spy satellite cargo. The craft was to be 10 feet (3.0 m) in diameter and would have weighed 31,910 lbs. (14,470 kilograms).



The rear section of MOL would have housed a Keyhole-10 spy satellite code-named “Dorian.” This space telescope was designed to be pointed down at Earth, not out toward the stars. Mission planners hoped to use MOL’s 72-inch (1.8 m) optical mirror to capture high-resolution images of the Soviet Union from a polar orbit of Earth.

SOURCES: NATIONAL RECONNAISSANCE OFFICE, NASA

KARL TATE / © Space.com





# Man's MOL Role

**MOL can be launched in such a manner and its orbit adjusted so as to pass over any geographic area once each day during sunlit conditions, permitting acquisition of very high resolution photographs. Man's role in a crisis management situation would be to relay near-real-time intelligence information-to the U.S., based on his ability to observe targets in the crisis area visually, to develop and interpret photographs on board, and to report all pertinent information to the ground by encrypted voice when within range of ground stations.**

**Crisis Management: Orbit adjusted to any geographic area once each day**

**Relay near-real-time intelligence information-to the U.S.**

- Based on ability to observe targets in the crisis area visually**
- Crew participation in target selection could yield almost three times as many photographs of high-intelligence-value targets**
- Develop & interpret photographs on board**
- Report all pertinent information to the ground by encrypted voice**

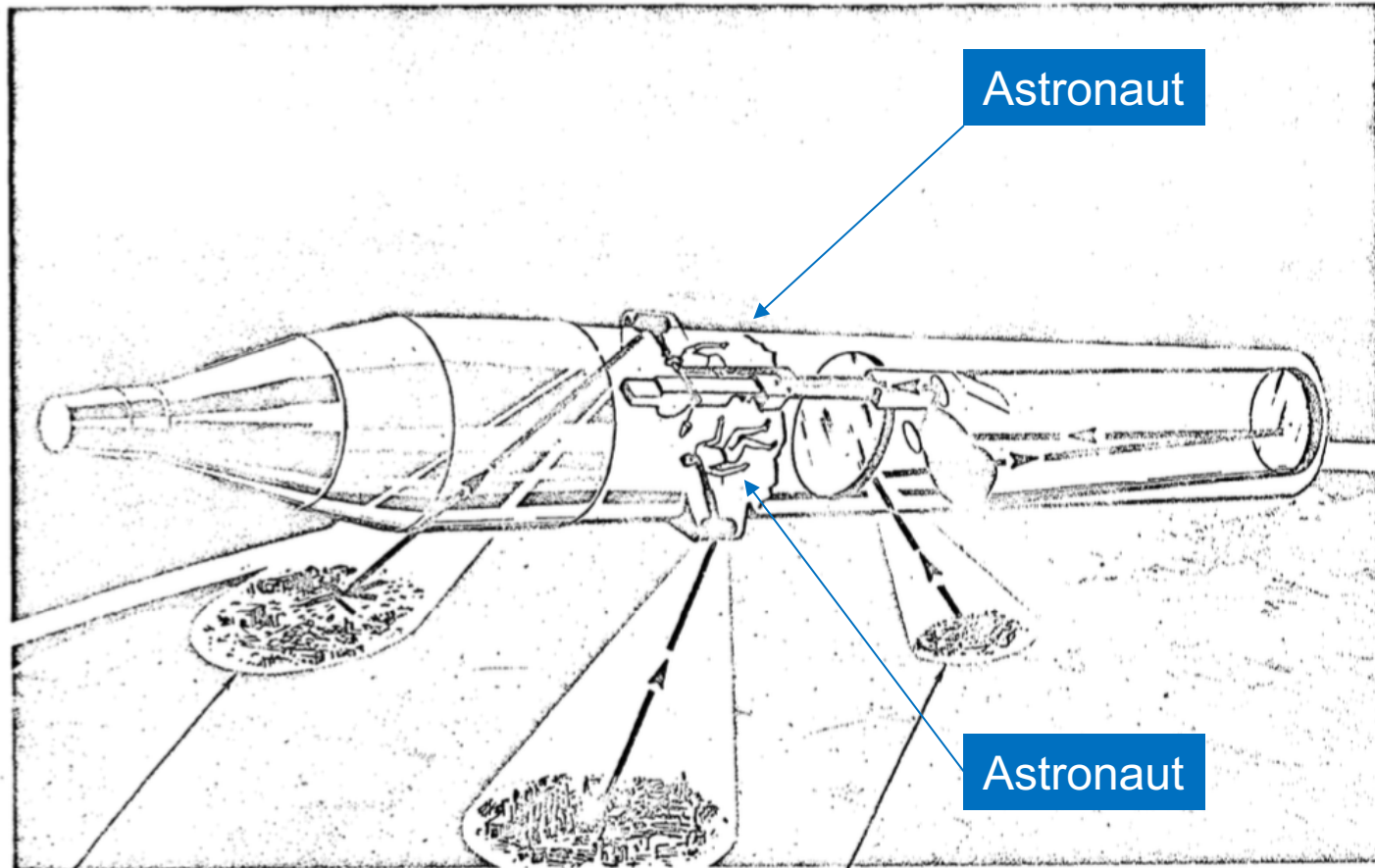


# MOL Operational Mode

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HANDLE VIA  
BYEMAN/TALE -KEYHOLE  
CONTROL SYSTEMS JOINTLY  
DORIAN



ASTRONAUTS INSPECTING TARGETS IN NEXT  
CLUSTER, FOR CLOUD COVER AND "ACTIVITY"

WHILE TARGET FROM PREVIOUS CLUSTER  
IS BEING PHOTOGRAPHED

FIGURE

DORIAN  
HANDLE VIA  
BYEMAN/TALE -KEYHOLE  
CONTROL SYSTEMS JOINTLY

ACQUISITION TELESCOPE SYSTEM OPERATING CONCEPT

PAGE OF PAGES



# Why "man" in MOL?

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## MAN IN MOL

- VERIFY, ADJUST, OR MANUALLY CONTROL CAMERA:
  - \* POINTING...
  - \* TRACKING...
  - \* ALIGNMENT...
  - \* FOCUS...
  - \* EXPOSURE...
- BACK-UP OTHER SPACECRAFT SUBSYSTEMS...
- ASSIST DIAGNOSTICS PROCESS...
- INCREASE RECONNAISSANCE VALUE/QUANTITY...

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BYEMAN/TALENT-KEYHOLE

Reverse Remarks on Vertical Mount

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## Mission Enhancement By Man

- TARGET COVERAGE VERIFICATION...
- CLOUD-FREE TARGET SELECTION...
- HIGH-VALUE TARGET SELECTION...
- ALTERNATE FILM CAPABILITY...
- ON-BOARD INTERPRETATION...
- VISUAL RECONNAISSANCE...
- [REDACTED]

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BYEMAN/ DORIAN

Reverse Remarks on Vertical Mount



# MOL Justification: Manned or Unmanned

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## *Why Manned & Unmanned Systems?*

### \* MANNED SYSTEM FIRST TO:

- ASSURE CAMERA PERFORMANCE...
- REALIZE EARLY USEFUL PRODUCT...
- MATURE UNMANNED SYSTEM SOONER...

### \* ALSO UNMANNED SYSTEM IF:

- THREAT/OBJECTIONS TO MANNED OPERATIONS...
- UNKNOWN PHYSIOLOGICAL LIMITATIONS...
- MANNED SYSTEM NOT COST-COMPETITIVE...

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BYEMAN/DORIAN

Reverse Remarks on Vertical Mount



# **MOL Astronaut: Assessment & Selection**

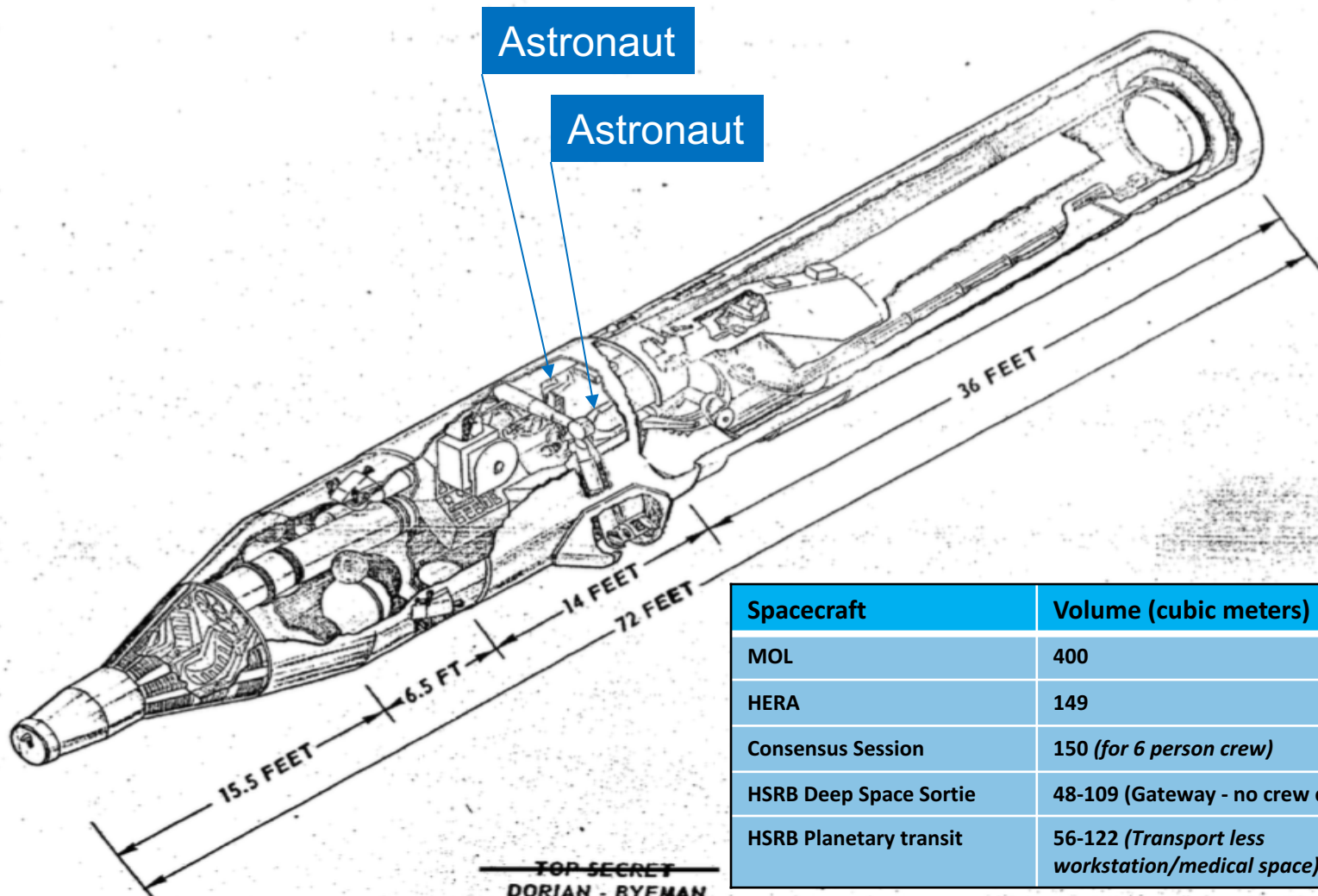
- **Test Pilots: USAF & USN**
  - **15 selected from 60 potential candidates**
  - **26-35 years of age**
  - **14/15 married & children**
  - **12/15 oldest child in family**
  - **Character strength achieved in spite of adversity**
    - **Experiences of immediate, life-threatening stress**
    - **Self-awareness of anxiety (never in presence of actual emergency)**
    - **Handled stress in cool detached manner**



# MOL Habitat

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## BASELINE MOL MANNED MODE

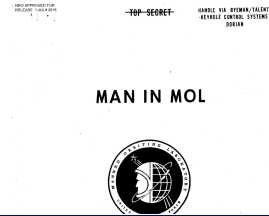


Spacecraft	Volume (cubic meters)
MOL	400
HERA	149
Consensus Session	150 (for 6 person crew)
HSRB Deep Space Sortie	48-109 (Gateway - no crew quarter)
HSRB Planetary transit	56-122 (Transport less workstation/medical space)





# Lesson's from MOL

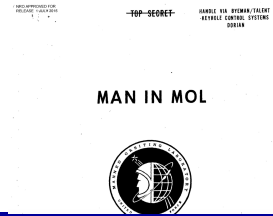


## ASSESSING MAN'S CAPABILITIES IN SPACE

- The MOL reconnaissance mission: quantitative data on man's capabilities in space.
  - Responsive to demands of President's Scientific Advisory Committee
  - Exercise maximally all of his physical and mental faculties, repetitively, and over a sufficiently long period to permit the establishment of statistical validity of the assessment.
  - Tasks in Typical mission pass over Russia
    - As a broad-band multiple sensor, information integrator, and decision maker.
    - Assessment of his abilities to continue to act in a coordinated psychomotor manner while performing tasks ranging from gross manipulation to those requiring fine finger dexterity.
    - Man's performance during flight compared to his baseline performance acquired during ground training and testing.



# Lesson's from MOL (cont'd)



## ASSESSING MAN'S CAPABILITIES IN SPACE

### • Mission requirements

- Vast amounts of data be recorded and transmitted to the ground
  - health status:
    - Vehicle & its systems
    - Man
  - Crew assessment of the last photographic payload sequence.
  - Information concerning their decisions:
    - On weather avoidance
    - Selection of targets of transient value
    - Crew inputs to pointing and tracking
    - Voice comments on the targets, etc.
    - Recorded and used as special value in assessing the crew's contribution to the mission during flight.
    - Crew comments, telemetry on mission equipment operation and the resulting photographic product would permit postflight reconstruction of mission events and the part that the equipment and the crew played during the mission event.



# MOL Autonomous Mission

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HANDLE VIA BYEMAN/TALENT  
KEYHOLE CONTROL SYSTEMS  
DDRIAN

MAN IN MOL



- **Operation of MOL mission equipment:**
  - **Automatic**
  - **Manual**
  - **Various combinations of automatic/manual modes**
- **Mission results due to man's performance and contributions were planned for comparison to those achieved by the completely automatic system.**
- **MOL high-resolution photography reconnaissance mission**
  - **Offered a unique opportunity to evaluate man's utility, capability and contributions to a demanding military mission.**
  - **Complemented other crew performance data being accumulated by the NASA manned space program.**
  - **Duration and magnitude would have made a major contribution to the scientific data base needed to extrapolate and project man's capabilities in extended space flights of increased duration.**



# Crew Flexibility

**“The Secretary further stated that the MOL laboratory module possessed sufficient flexibility to support other missions besides high resolution reconnaissance, such as communication intelligence or ocean surveillance, should they**

MOL Crew flexibility to support other missions (besides high resolution reconn):

- COMINT
- Ocean Surveillance
- Unique laboratory environment for scientific experiments
  - 1,000 cubic feet of pressurized volume
  - 3,000 cubic feet of unpressurized experiment space

MANNED  
ORBITING  
LABORATORY  
PROGRAM  
(MOL)

By Carl Berger

MOL PROGRAM OFFICE  
Department of the Air Force  
Washington, D.C.



# Crew Versatility

In the long run, it is believed that man's ability to enhance the quantity and intelligence value of the photography will prove to be his more important contribution, particularly as the automatic devices mature, permitting

## Value of MOL Crew:

- Man's ability to enhance quality & intelligence value of the photography
- Target coverage verification & cloud-avoidance
- Inspecting alternate targets for activity
- Using special films
- Very sophisticated intelligence collection

gence collection capability, not previously available to the intelligence community.

DORIAN  
HANDLE VIA  
BYEMAN/TALENT-KEYHOLE  
CONTROL SYSTEMS JOINTLY

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# Inherent Attributes: Performance in Space

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BYEMAN/TALENT-KEYHOLE  
CONTROL SYSTEMS JOINTLY

Maximum operational capability by exploiting inherent attributes of man

A final, significant product of manned MOL reconnaissance operations will be the acquisition of valid, statistically reliable data on man's performance in a demanding operation, which will be uniform military and scientific communities.

Valid, Statistical Data Performance Data  
-In space  
-Operating complex equipment

The MOL manned system has been designed for maximum operational capability through exploitation of the inherent attributes of man. Program provides the potential envisioned when man was originally incorporated into the basic system.

Significant Information to both scientific & military communities



# Crew Performance Challenges

In either case, he said that the absence of man increased the development risk. Citing the various new features which were planned for automatic operation during both manned and unmanned flights, he noted that man would be able to override or compensate for most of the failure modes envisioned for this equipment. However, any "out-of-specification performance" in automatic functions could defeat the resolution objective, whereas retaining man during the orbital development period "not only will enable *us* to increase the output and quality of reconnaissance data acquired in this period but will assist in identification and correction of equipment deficiencies.

Automatic Operation during manned and unmanned flights

- Man could override or compensate for most failure modes
- Increase output and quality of reconn data
- Identification & correction of equipment deficiencies



# Demands on Crew

- **Physiological Demands:**
  - **Polar orbits**
    - Unprecedented inflight radiation (200-500 mrem over 30 days~half the dose of abnominal x-ray)
    - Low inclination orbits (trapped protons & smaller particles)
    - Galactic cosmic radiation increases by 40%
  - **Circadian Dysregulation (orbit every ~81 mins)**
    - Launch day: est awake nearly 17 hours
    - Duty day: est 16 hours
    - Separate shifts likely (mission overwatch)
  - **Autonomy (10 mins or less of comms, 80 mins of radio silence:**
    - On-board planning
    - Real-time target selection for high-res photo reconn





# Human Factors Demands

operations are lost. In MOL, man will be on board the vehicle and will have the capability to diagnose the operation of various systems, subsystems, and components. This capability will permit rapid assessment of many malfunctions and out-of-tolerance conditions, leading quickly either to restoration to normal operating conditions or to manual operation, if necessary.

The manned version of MOL incorporates a malfunction alarm system which monitors approximately 100 laboratory and 100 mission-payload segment parameters, providing aural and visual warning signals and displays which contain information concerning out-of-tolerance conditions. In the event of a malfunction, the alarm system also immediately initiates automatic recording of data from several hundred instrumentation points for later transmission to the ground or call-up by the crew. In many instances, the

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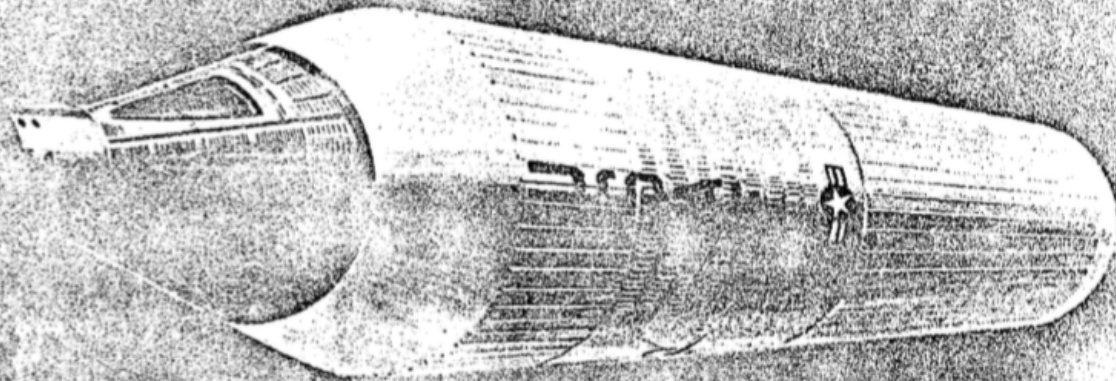


# MOL Crew “Disciplined Initiative”

- **Flexibility in selecting targets**
  - **Avoided wasting of photo capacity (cloud cover)**
    - 20-25% more cloud-free pictures daily
    - Selection of alternate targets on separate passes
    - Certainty specific targets photographed
  - **Opportunities to observe transient situations**
    - Take advantage of momentarily increased intelligence
    - Primary target plus average of 3 alternates (each pass)
    - Double or triple rate of acquisition
  - **Quality enhanced (insert color, infra-red, etc.)**
  - **Real-time or near real-time on image interpretation**
- **Overall confidence in system reliability**
  - **Adjust, diagnose, evaluate, work around system**



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## MANNED ORBITING LABORATORY

# Questions?