Artemis

Artemis

A Common Lunar Lander
for the
Space Exploration Initiative

Presentation to Aaron Cohen

September 17, 1991

Stephen Bailey/IE3/283-5411

Summary of Past & Future Events

Artemis

June 13	• Initial Common Lunar Lander Presentation, Authorization to proceed with In-house study
July 1	• Workshop held at JSC
July 17	• Kickoff meeting of EA spacecraft design study team
August 23	• EA Senior Board Review
Sept 17	• Design team results presentation, distribution to payload developers, sponsors and industry
Oct 11	• External concept assessment complete
Oct 21	• Presentation of program strategy and recommendations Procurement, Management structure, cost estimates, etc.

Artemis Program Rationale

Artemis

- Correctly anticipates the strategy that Mike Griffin as the new AA for Exploration brings to SEI
  - Build Congressional trust by starting small and meeting cost and schedule objectives
  - Sell SEI in bite size chunks - "Buy it by the yard..."
  - Start with Robotic Missions
  - Start early with missions that are:
    - Small
    - Simple
    - Cheap
    - Quick
    - Contribute to SEI goals

Artemis Program Rationale (Cont)

Artemis

- Analysis Stafford Synthesis Group Architecture Themes

    - Architecture 1, Mars Exploration - Meets the criteria of establishing a permanent presence of the moon, without committing to manned landings if Mars beckons irresistibly or if funding constrained

    - Architecture 2, Science Emphasis - Establishes "Lunar Network", also emplaces optical and radio observatories

    - Architecture 3, Moon to Stay... - Delivers rover for in-situ resource characterization and subsurface analysis prior to base selection

    - Architecture 4, Space Resource Utilization - Meets requirements to locate resource concentrations, map them and to test pilot processes, technologies, and equipment

Artemis Concept is Architecture independent - value varies with theme

Artemis Program Rationale (Cont)

Artemis

- Compelling scientific rationale exist for further exploring the surface of the Moon, and for using the Moon as a platform for Space and Astrophysics observatories
- Equally compelling is the need for engineering information
  - Base-site survey
  - Resource characterization
  - Hardware test or demonstration, and technology development
- Infrastructure emplacement
  - Navigation aids
  - Caches for long traverses
  - Emergency resupply
  - Remote equipment delivery

To safely extend the reach of humans to areas on the moon that are otherwise inaccessible due to cost or risk

Artemis

Summary of Potential Payloads

Sample Collection
- Sample

Geophysical Station
- Geophysical Station
- Central Station
- RTG
- Broad Band Seismometer
- Heat Flow Probe
- Long Period Seismometer
- Solar Wind Experiment
- Charged Particle Experiment
- Cosmic-Ray Experiment
- Micro-Meteorite Experiment
- Mass Spectrometer
- Suprathermal Ion Detector
- Cold Cathode Pressure Gage
- UV Spectrometer
- Alpha Particle Spectrometer
- Low Frequency Magnetometer
- Tidal Gravimeter

Rover
- Rover
- XRD/XRF
- LIBS
- Magnetometer
- Gamma-Ray Spectrometer
- Neutron Spectrometer
- Stereo-Imager
- Mass Spectrometer
- Visual and Near-IR Spectrometer

Telescopes
- 1 m APT/UV-IR Survey/UV Spec.
- UV Ast./Atm.
- Lunar Transit Telescope
- Lunar Hubble Telescope
- Moon-Earth VLBI
- VLF Interferometer

ISRU
- Cast Basalt
- O2 Extraction
- Thermal Processing
- Magnetic Separation
- Gas Analysis

Engineering
- Melt Drill

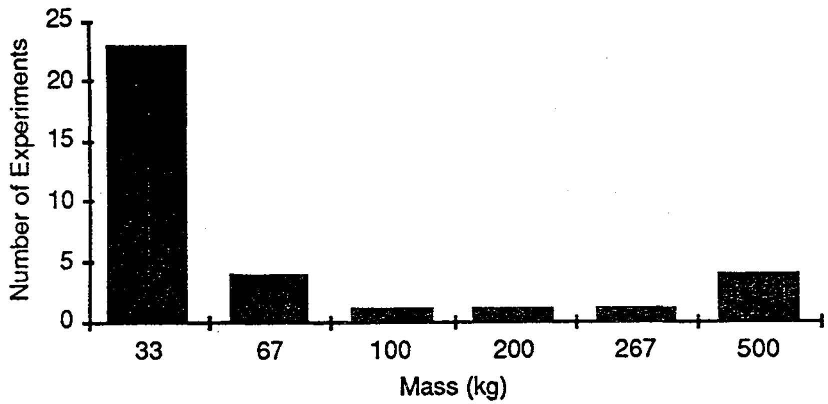
Biology
- Soil Solution
- Cell Development

Stephen Bailey/IE3/283-5411

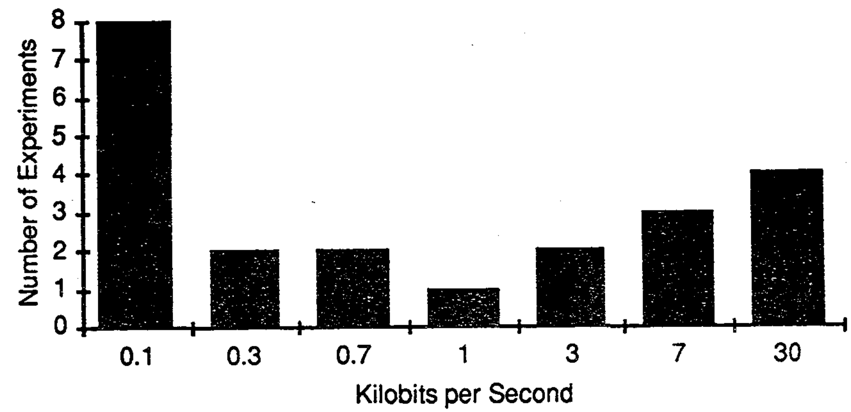
Artemis

Physical Characteristics of Experiments

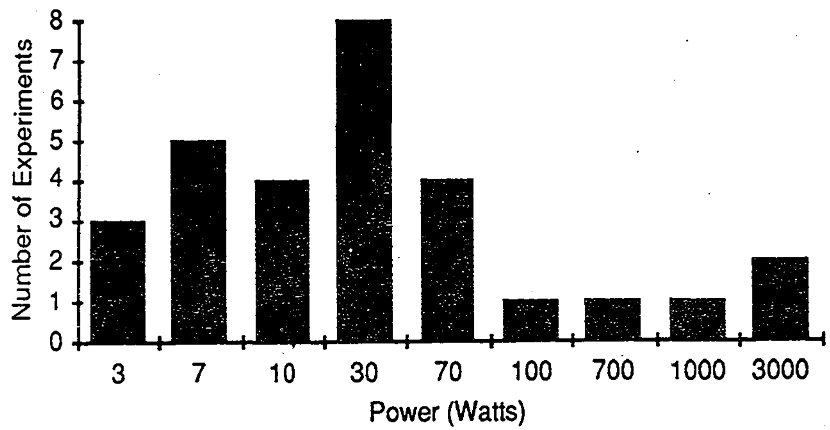
Mass of Individual Experiments



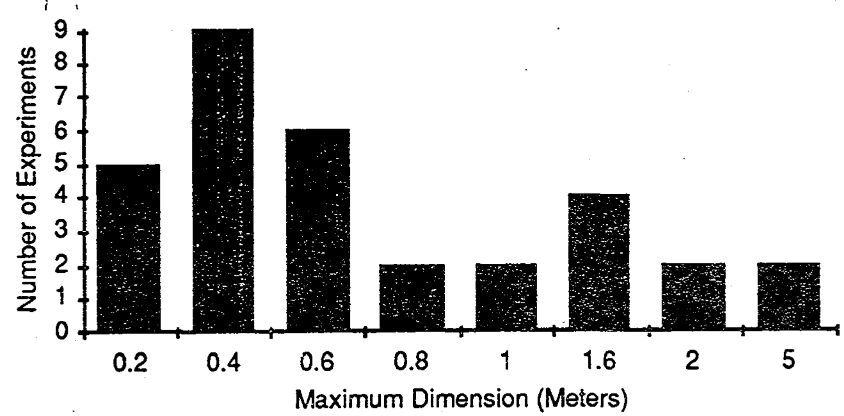
Experiment Downlink Data Rates

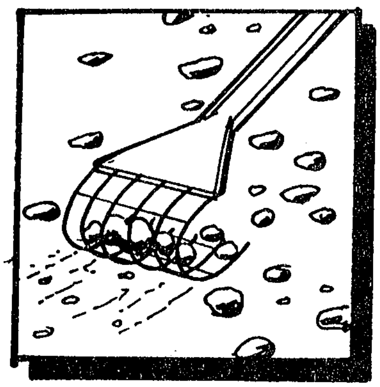


Power Requirements for Experiments

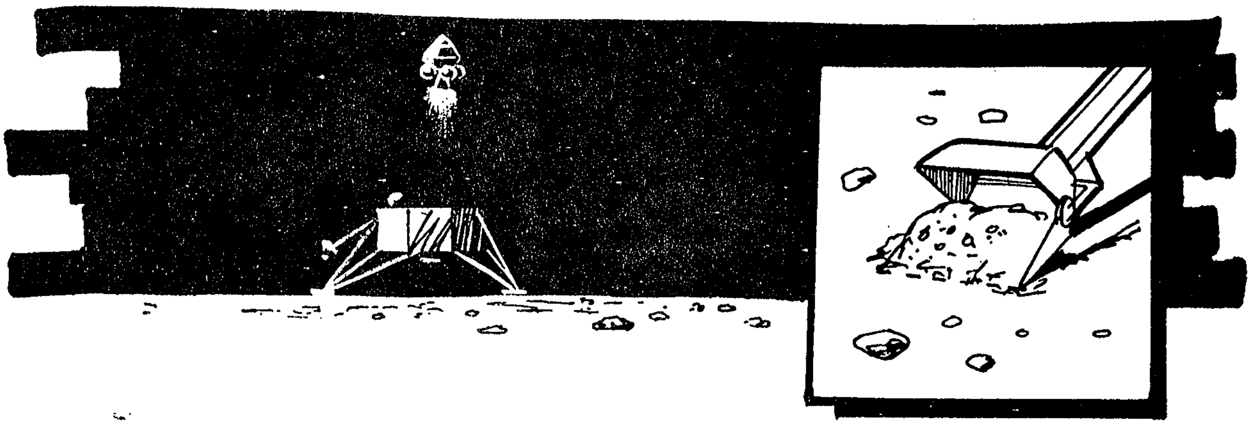


Maximum Dimension of Experiments

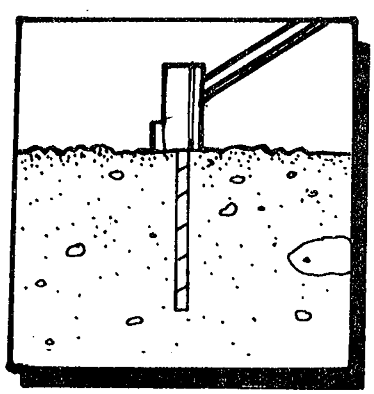




ROCK SAMPLES

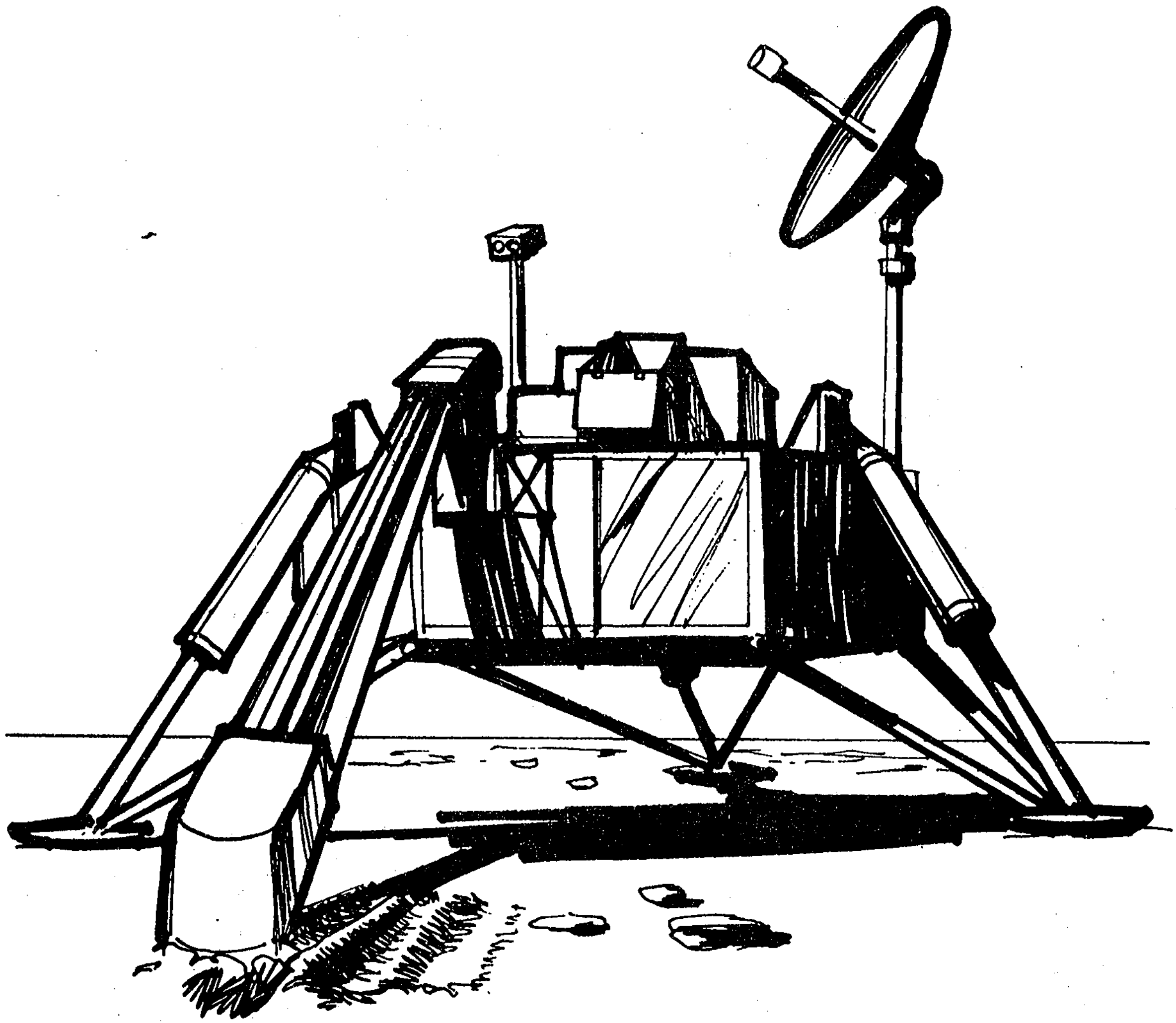


SOIL SAMPLES



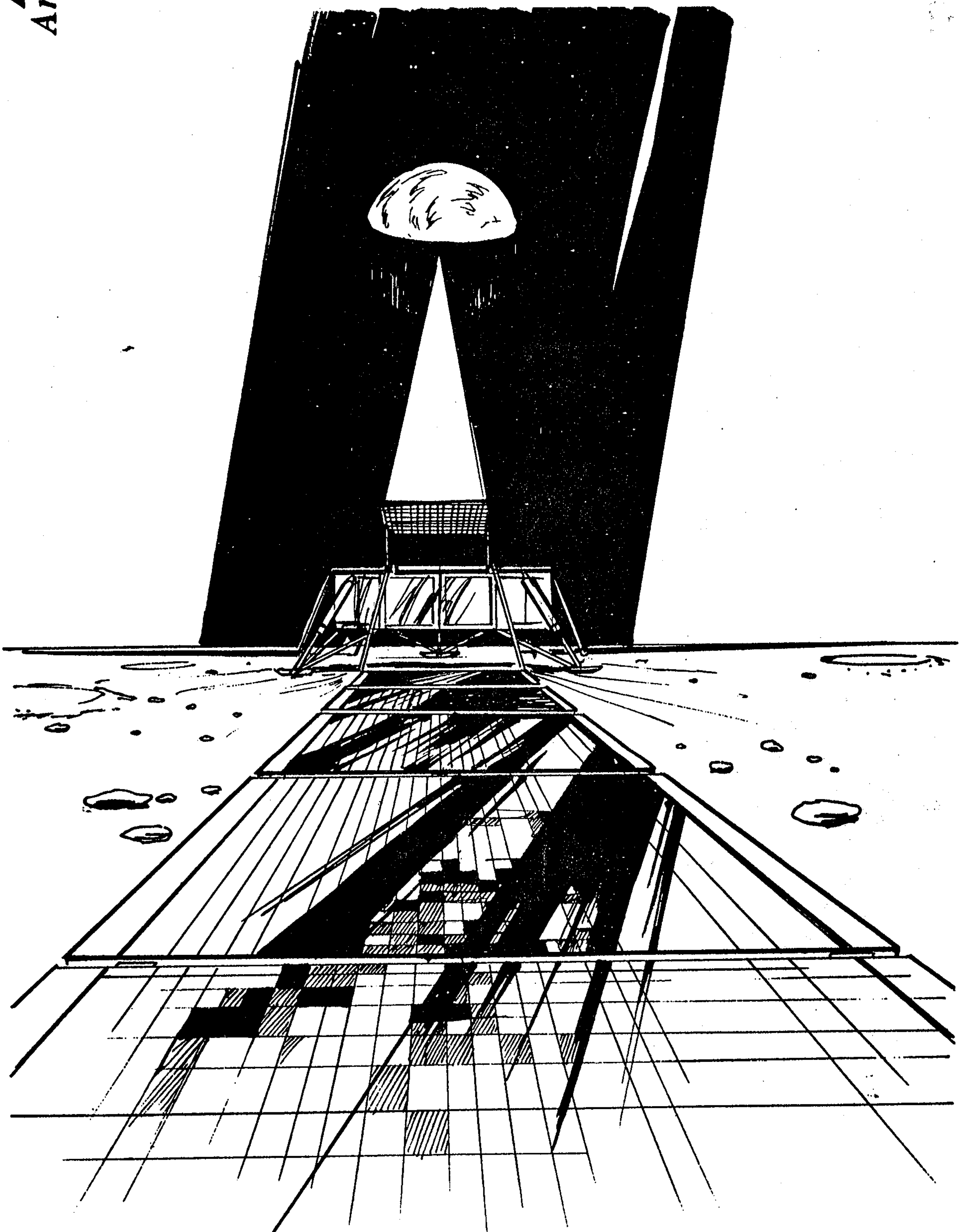
CORE DRILLING

SAMPLE RETURN MISSION



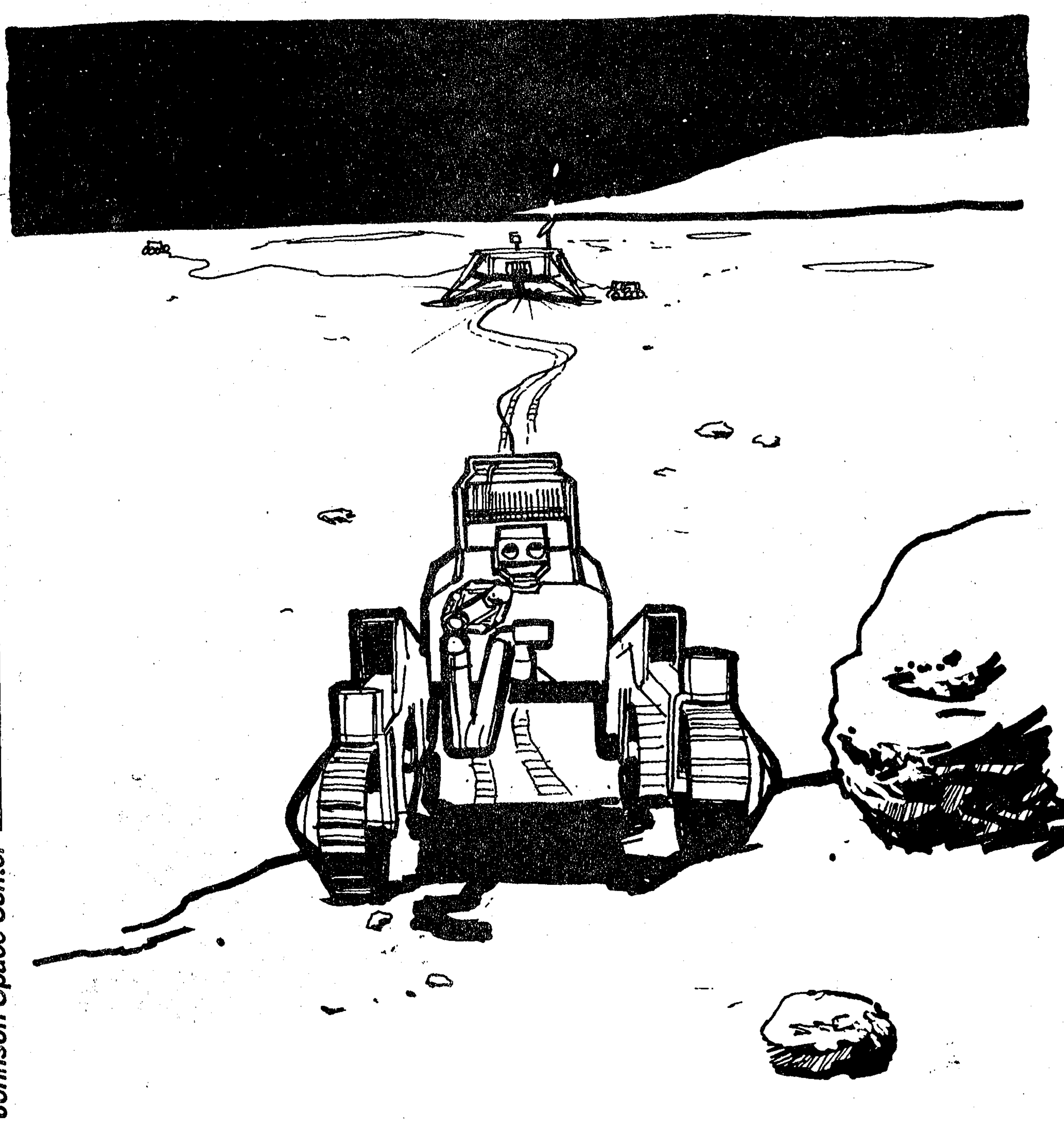
ISMU PILOT PLANT
ON UNMANNED
LUNAR LANDER

Stephen Bailey/IE3/283-5411



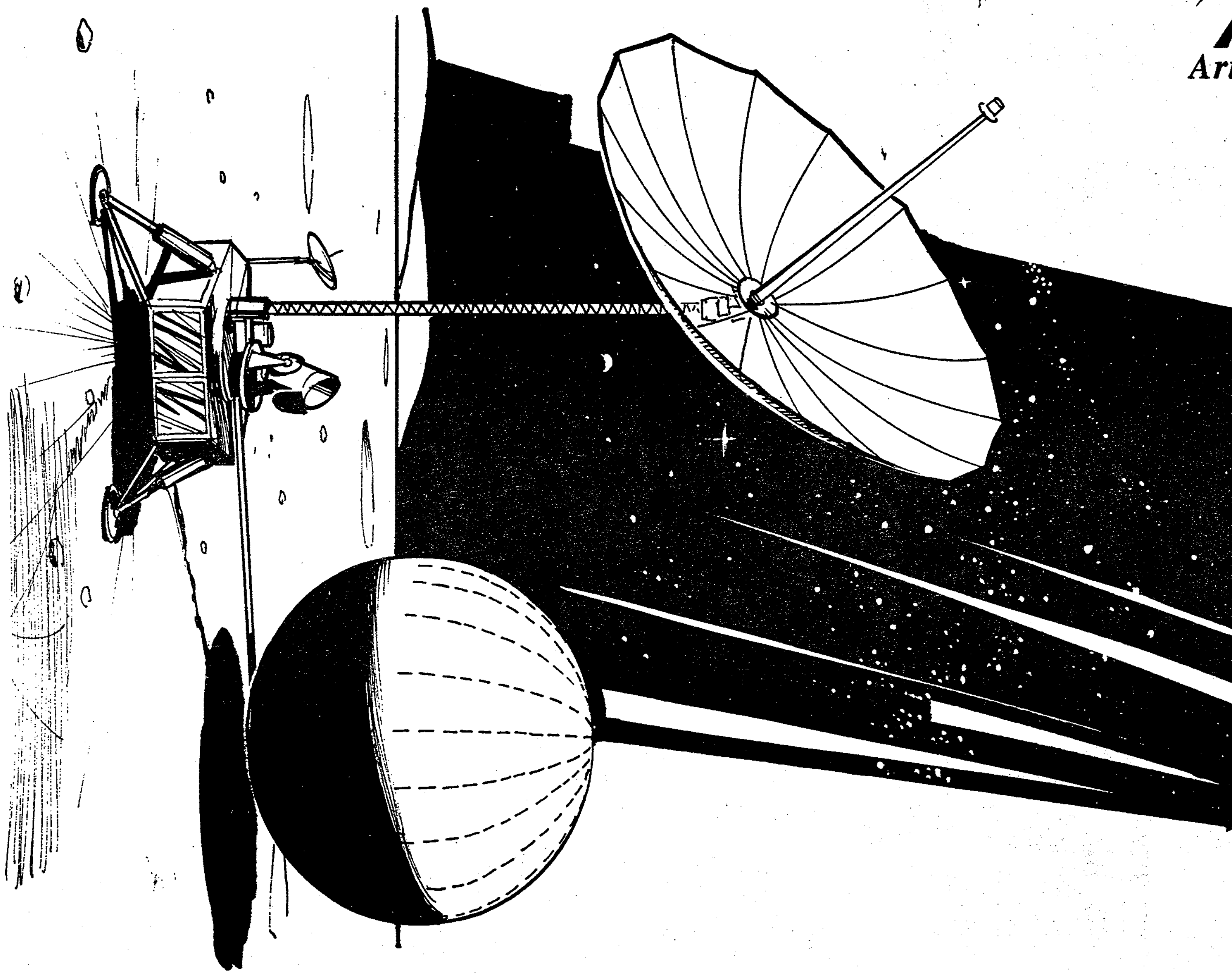
BEAMED POWER PROOF-OF-CONCEPT

Stephen Bailey/IE3/283-5411



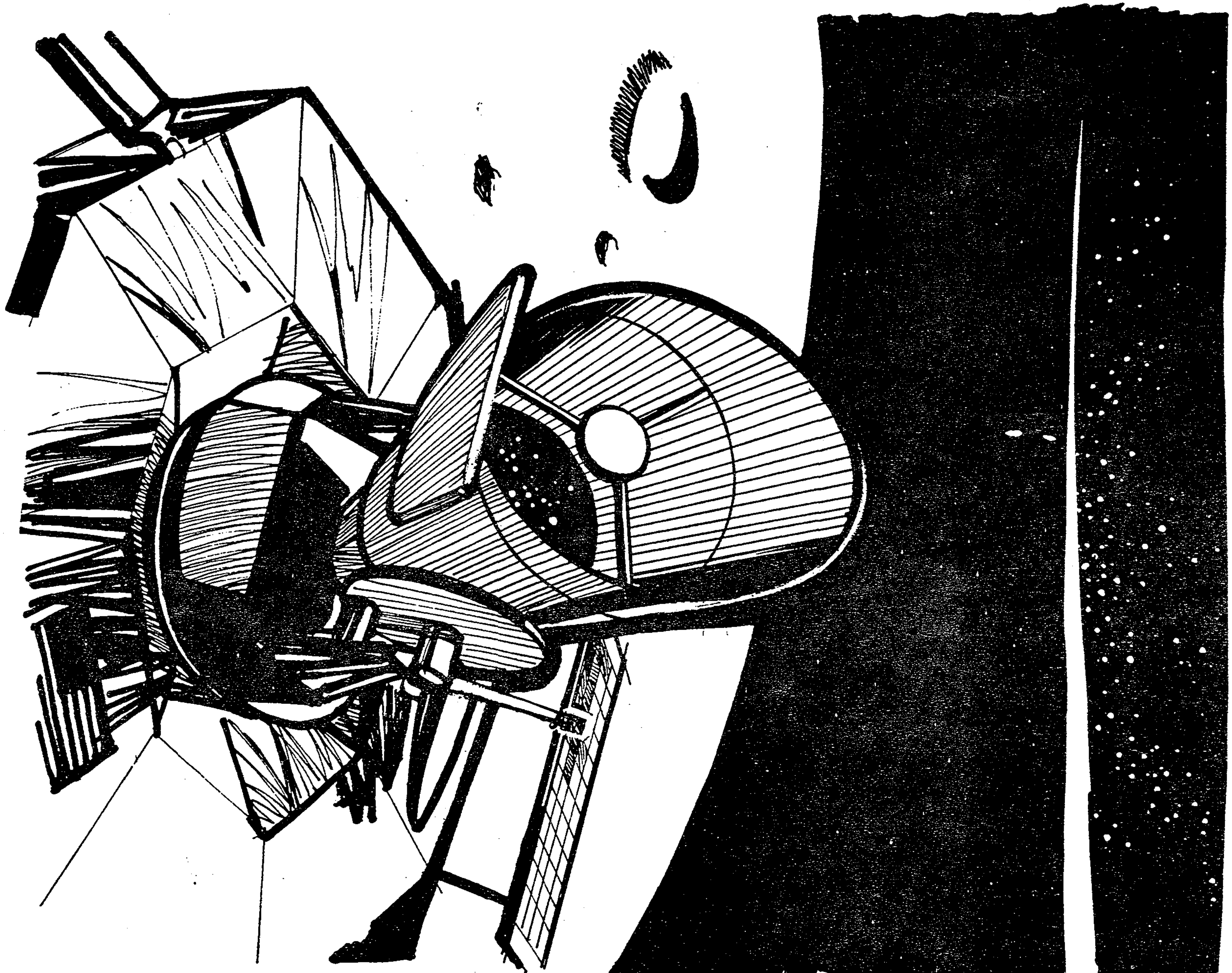
TETHERED MICRO-ROVERS

Artemis



Stephen Bailey/IE3/283-5411

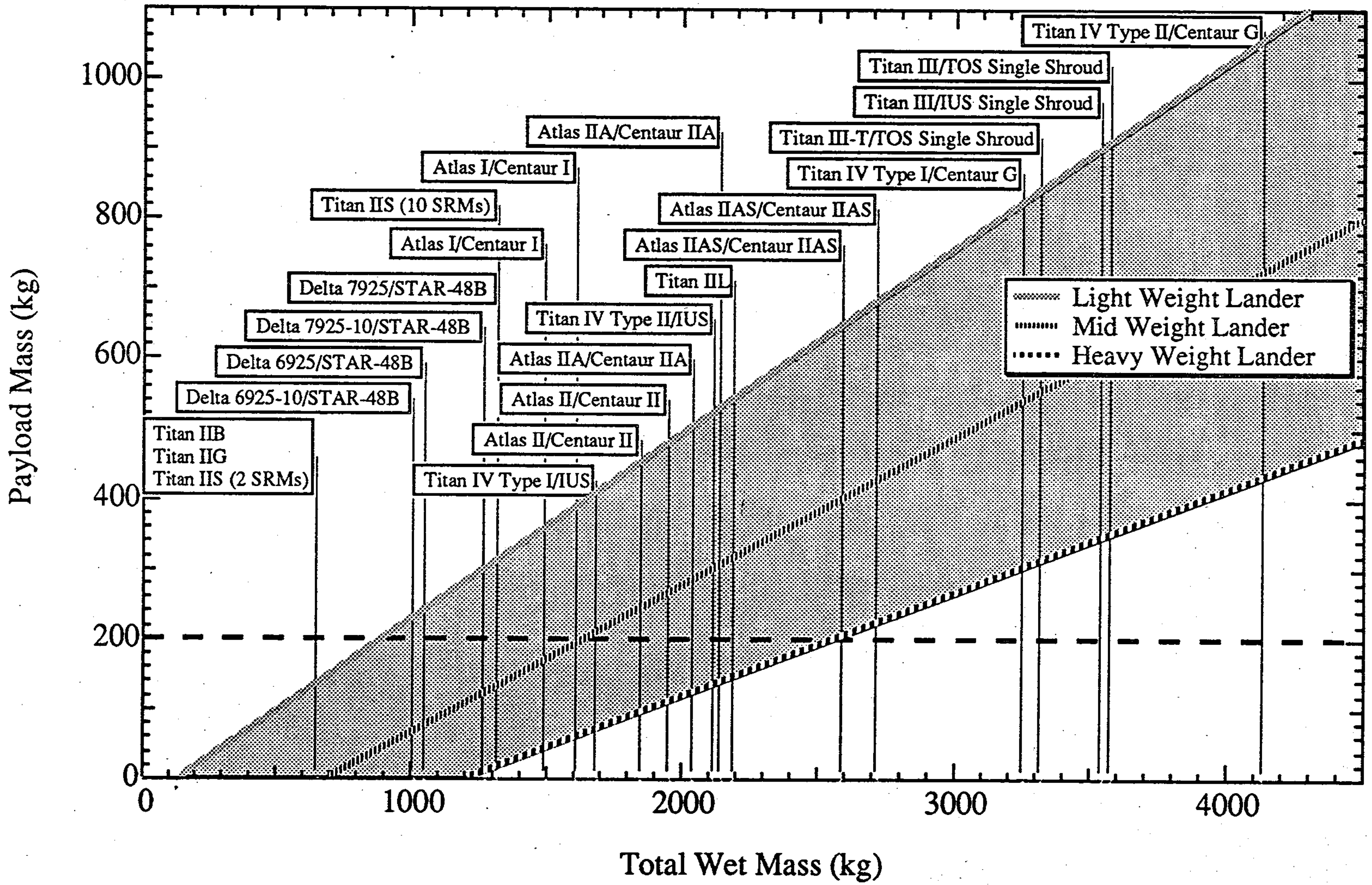
U.S. Gov't



Stephen Bailey/IE3/283-5411

TransLunar Injection Capability of US Launchers as a Function of Payload Delivered to the Surface

Artemis



Stephen Bailey/IE3/283-5411

Study Objectives

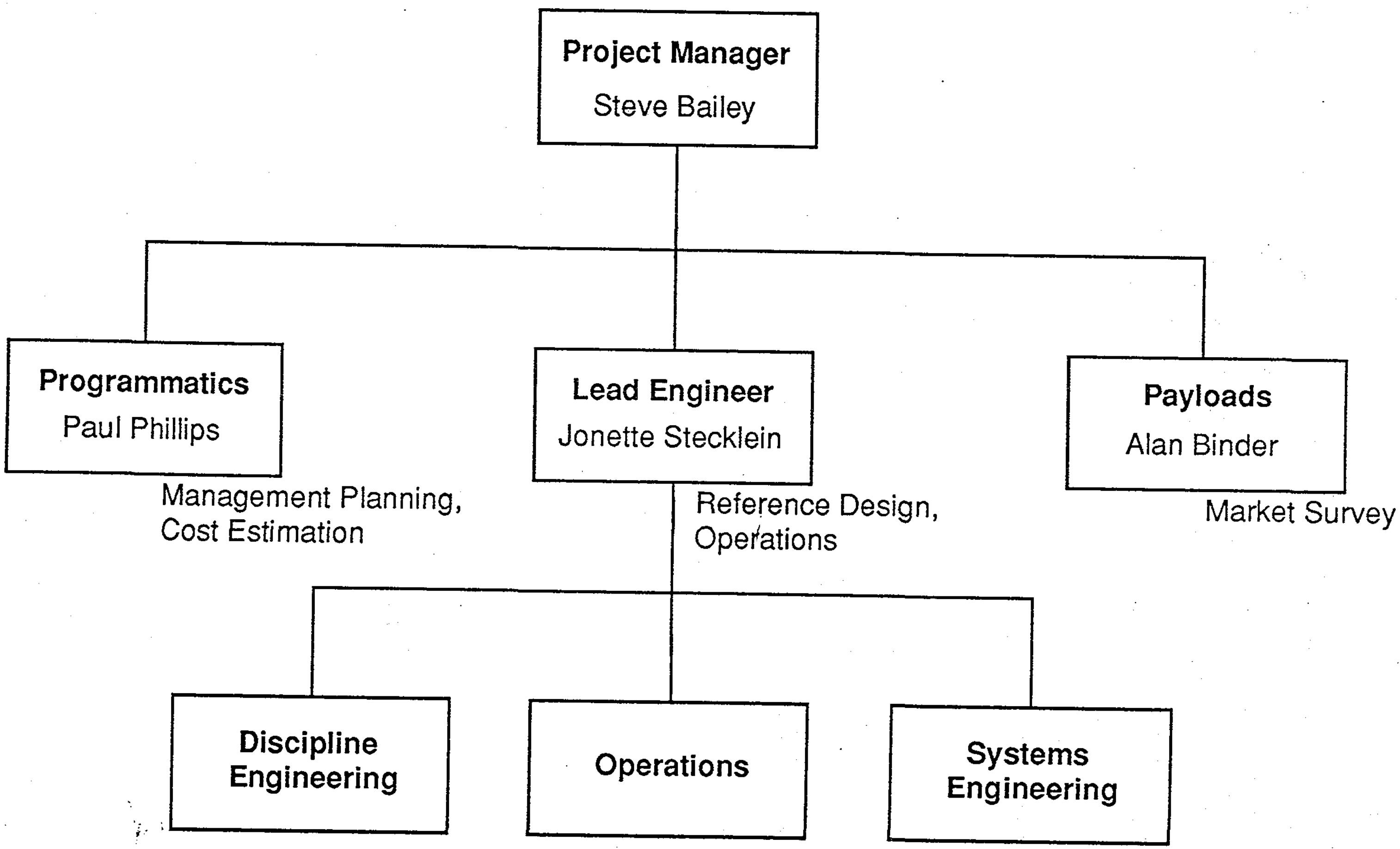
- The purpose of the design study is to define what the attributes of a lander would be that rank priorities as:
    - Cost (as low as possible)
    - Schedule (1996 launch date)
    - Performance (within reason for a potentially long lived system)
    - Risk (acceptable for this mission type)

- Provide crisp definition of lander concept for critical review by:
    - Payload Developers
    - Payload Sponsors (Codes M, R, SL, SS, SZ, SB, XE, ...)
    - Industry and other Government agencies (particularly SDIO)

- Demonstrate the ability of the center to quickly mobilize, with NIO leadership, and to efficiently produce quality study products

Artemis

Study Team Organization



Stephen Bailey/IE3/283-5411

Artemis

Study Products

(Complete)

- Payloads Assessment
  - Market Definition
  - Interface Requirements
- Payload Integration Analysis
- Requirements
  - Lander mission and system
  - Payload Interfaces
  - Operations
- Launch Vehicle Analysis
- Subsystem Design Concepts
- System Trade Studies

(In Work)

- Cost Analysis
  - System-level Up
  - Top Down
- Ground Operations Overview
- Mission Planning/Ops. Overview
- Program Management Plan
- Procurement Plan
- Facilities Assessment
- Development/Certification/ Test Plan

Stephen Bailey/IE3/283-5411

Conclusions

Artemis

- Excellent support from the Center resulted in a well executed study
- In many ways a prototype for how similar preliminary concept studies can be performed
  - Fast paced, fixed schedule
  - NIO in project management role, ET in Systems Engineering role, EA providing discipline engineering
- Concept study will be finished by mid October
  - EA's work is finished
- Study objectives met
- Next phase of requirements assessment set to begin
- Accolades all around

Recommendations

- Return in mid October with Programmatics assessment
  - Strategic options and recommendations
    - Program Implementation Plan
    - Procurement Strategies
    - Project Management Strategies
    - Facilities and resource assessment

- Get a more definitive reading from our customer, Mike Griffin, on the Artemis Concept

- Conduct an assessment of where to go from here
  - Options:
    - Quit until serious indication of program interest
    - Study Common Mars Lander
    - Consider In-House skunkworks
    - Other

Stephen Bailey/IE3/283-5411

The Name and the Logo

- Should a project develop, we would like to suggest a name
  - Artemis
  - Reference from classical Greek mythology
  - Purposefully avoiding an acronym
- Artemis is the Greek Goddess often associated with the Moon
  - She is the twin sister of Apollo
  - The shining one, goddess of the golden arrows
  - The slender crescent of the Moon is her bow
- The logo represents the shaft of an arrow notched in the bow, with a "quiver" of payloads ready to loose

Appendix

Payload Descriptions

Payload: Sample Return

Vital Statistics
Mass: 200 kg
Power: TBD
Volume: 2m x 2m x 2m
Data Rate: TBD
No. of Missions: ~100 over 30 years
Mission Duration: Few hours on Lunar surface

Description: Collect 1 kg of 1 to 3 cm rock and soil samples. Deliver the samples to Earth via a return stage. Obtain representative samples from the numerous petrological units over the entire lunar surface.

Objective: Determine the composition, the age and developmental history of the lunar crust and mantle and the Moon itself. Find economically important resources for use on the Moon and for export to Earth.

Payload: Geophysical Station Network

Vital Statistics
Mass: 150 kg
Power: 45 w
Volume: 1.6m x 1.2m x 1.2m
Data Rate: 1.1 kbs
No. of Missions: >20
Mission Duration: >10 years

Description: Set up a global network of geophysical stations to obtain long term, seismic, heat flow, magnetic, exospheric, gravity, etc., data on the Moon.

Objective: Determine the internal structure, composition, energy budget, etc., of the Moon. Determine the composition and dynamics of the lunar atmosphere.

Stephen Bailey/IE3/283-5411

Payload: Teleoperated Rovers

Vital Statistics
Mass: 200 kg
Power: 300 w
Volume: 2m x 2m x 2m
Data Rate: 25 kbs
No of Missions: ~10
Mission Duration: ~1 year

Description: Obtain composition, gravity, magnetic, etc. profiling data along 100 to 1000 km traversers. Do detailed resource mapping of 1 to 10 km square areas.

Objective: Determine the variations in the composition and structure of the crust on the regional scale to determine its origin and evolution. Determine the extent and ore grade of lunar mining sites.

Stephen Bailey/IE3/283-5411

Payload: 1m Astronomical Telescopes

Vital Statistics
Mass: 200 kg
Power: TBD
Volume: 2m x 2m x 2m
Data Rate: TBD
No. of Missions: ~10
Mission Duration: >10 year

Description: Set up several 1m, automated telescopes. Obtain high quality, uninterrupted, long term, UV, visual and IR, photometric, spectral and sky survey data.

Objective: Determine the composition, structure and evolution of stars, galaxies and the universe as a whole.

Payload: Moon-Earth Radio Interferometer

Vital Statistics
Mass: 200 kg
Power: TBD
Volume: TBD
Data Rate: TBD
No. of Missions: 1
Mission Duration: > 10 years

Description: Set up a radio telescope on the Moon as part of a Moon-Earth interferometer with a 384,000 km baseline (30 x greater than possible on the Earth alone).

Objective: Obtain detailed astrometry with a resolution of 30 microarcsec (at 6 cm wavelength).

Payload: Very Low Frequency Radio Antennas

Vital Statistics
Mass: 20 kg
Power: 20 w
Volume: TBD
Data Rate: TBD
No. of Missions: > 20
Mission Duration: > 10 years

Description: Set up an array of 1 to 10 mHz antennas to obtain the low frequency radio spectra of galactic and extragalactic sources.

Objective: Determine the structure of galactic and extra-galactic objects. Map the distribution of interstellar matter out to several thousand parsecs.

Stephen Bailey/IE3/283-5411

Payload: Lunar Polar Crater Telescope

Vital Statistics
Mass: 200 kg
Power: TBD
Volume: 2 m x 2 m x 2 m
Data Rate: TBD
No. of Missions: 1
Mission Duration: > 10 years

Description: Set up a 1 m, automated, IR telescope in a permanently shadowed, polar crater where the temperature is always < 80k.

Objective: Obtain IR data on solar system, galactic and extra-galactic sources with a telescope and detector which are naturally cooled in the lunar polar environment.

Stephen Bailey/IE3/283-5411

Payload: Lunar Resource Utilization Experiments

Vital Statistics
Mass: 200 kg
Power: TBD
Volume: TBD
Data Rate: TBD
No. of Missions: > 10
Mission Duration: 1 year

Description: Set up laboratory scale experiments to make lunar oxygen, cast basalt, metals, ceramics, etc. from lunar resources.

Objective: Evaluate various processes proposed for obtaining useful products from lunar resources.

Stephen Bailey/IE3/283-5411

Artemis

Payload: SEI Engineering Experiments

Vital Statistics
Mass: 200 kg
Power: TBD
Volume: TBD
Data Rate: TBD
No. of Missions: > 10
Mission Duration: 1 year

Description: Conduct engineering tests of equipment in the lunar environment.

Objective: Determine the effects on SEI critical hardware of lunar dust, 1/6g, vacuum, etc.

Stephen Bailey/IE3/283-5411

Payload: Biological Experiments

Vital Statistics
Mass: < 200 kg
Power: TBD
Volume: TBD
Data Rate: TBD
No. of Missions: ~ 3
Mission Duration: 1 year

Description: Set up small, automated biological experiments in the lunar environment.

Objective: Determine the effects of 1/6g, cosmic radiation, etc. on the growth and health of simple plants and animals.

Stephen Bailey/IE3/283-5411