Mission 5 Logbook
Initial Spacecraft and Lander Design

Tools of Comparative Planetology and Exobiology

Designing a Spacecraft and Lander -Optional Directions

A spacecraft and lander are of vital importance for the comparative planetologist and the exobiologist who cannot leave Earth! A spacecraft never lands on a planet, but it may orbit a planet and do remote sensing. Only a lander actually sets down on the surface of a planet.

A spacecraft must be able to travel through space undamaged, reach the target planet, deliver the lander, and send data back to Earth. A lander must be able to perform experiments designed to detect life (or the environmental conditions necessary for life) and send data back to Earth.

In this mission, you should be more concerned with the search for life than with spacecraft and lander design. It will be sufficient for you to simplify complex parts of your spacecraft and lander. For example, you might use a black box to provide the navigation without explaining how a black box works. For the purposes of this mission, it is not necessary to know how such complex devices work. However, the life detection mechanisms of your spacecraft and lander should be explained in as much detail as possible.

Your task is to design a spacecraft-lander system for use at your specific landing site (each site is different). There are four major facets of this design.

1. The exterior of your system must be able to withstand the conditions during travel and the conditions at your landing site.

2. Your system should include mechanisms for the purposes of propulsion and navigation.

3. Your system should include instruments that gather information about the conditions and the existence of life at your landing site and send that information back to Earth.

4. Your system should give some consideration to ways of avoiding contamination of the landing site with life-forms accidentally brought from Earth.

   First you will work individually, considering the solutions to the specific challenges imposed by your landing site, such as extra parachutes because of thin atmosphere, or broad-based feet to prevent a lander from toppling over in soft soil. Later you will work in teams to refine your spacecraft-lander design.

Make a simple drawing of your design. A good drawing is nice, but labeling and describing the function of all the parts is more important. Include everything you would need for a successful mission. In real missions, payload and overall cost are major considerations, but at this point you can create a plan unhindered by such constraints. Your final spaceship design (in mission 14) will include these factors.

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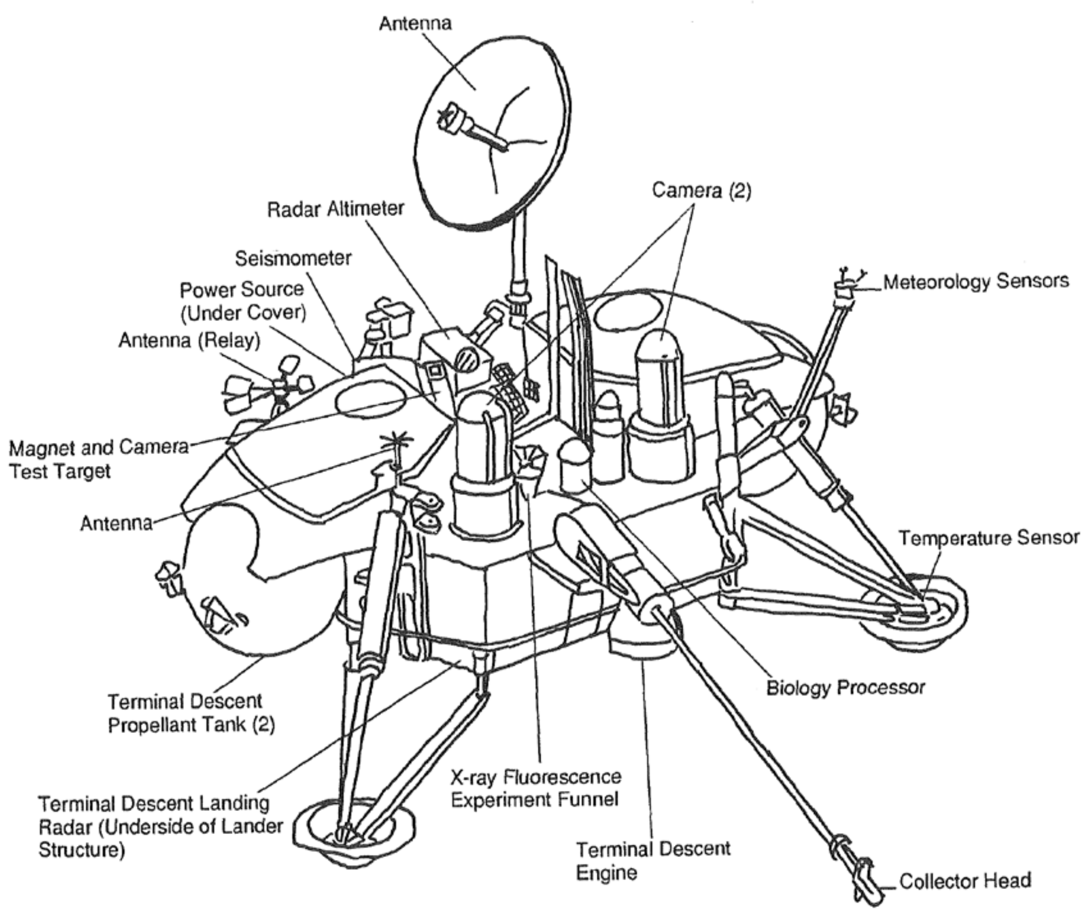
The Viking Lander—Image

Figure 5.1—*Viking* Lander.



The *Viking* landers packed an incredible ability to analyze the Martian atmosphere and surface into a small volume, which included an extendable boom with a scoop that could bring soil samples into the laboratory on board.

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Initial Spacecraft Design - Worksheet

Name: ______________________________ Date: ____________________________

Assigned Landing Site:

1. List the design considerations specific to your assigned landing site. What would your spacecraft need to arrive safely? What would your lander need to function?

2. Brainstorm on major spacecraft and lander components. Draw the design for your spacecraft and lander on another sheet of paper, labeling all components. Describe how the following components work.

- Propulsion system:
- Fuel or energy source:
- Landing gear:
- Mission control instruments:
- Communication devices:
- Data collection devices:
- Life detection devices:
- Other devices or capabilities your spacecraft or lander has:

3. Provide a sample of the data your spacecraft would send back.

4. Provide a sample of the data your lander would send back.

5. How will this information help you to decide if life is present at the landing site?

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Landing Site Environment—Data Sheets

Landing Site # I--- Mars, Utopia Planitia Desert

Planet Size: Mars is 52% the size of Earth.
Coordinates: 84 North Latitude, 250º longitude.
Gravity: .38 G (Earth gravities).
Temperature: -58 C.
Atmospheric Pressure: .006 ATM (Earth atmospheres).
Topology: Flat, open area with gentle slopes. Surface strewn with rocks 10-20 centimeters in diameter. A few larger boulders here and there.
Soil Composition: 21% Silicon, 13% Iron, 3% Aluminum, 5% Magnesium, 4% Calcium, 3% Sulfur. The soil is soft. Great wind storms kick up dust that poses a hazard to a lander.
Atmospheric Composition: 95% carbon dioxide; 2% nitrogen; 1.5% argon; 0.1% oxygen; trace amounts of water vapor, carbon monoxide, neon, krypton, and xenon.

Landing Site # *2*- Mars, Olympus Mons Volcano

Planet Size: Mars is 52% the size of Earth.
Coordinates: 18º North Latitude, 133º Longitude.
Gravity: .38 G (Earth gravities).
Temperature: Thin atmosphere due to the great altitude allows for temperatures ranges on Mars from -92º C to 26º C.
Atmospheric Pressure: .006 ATM (Earth atmospheres).
Topology: On the edge, very fine dirt and not many boulders. A sheer cliff skirts the mountain, but this should not present a problem to the landing site because it is well marked on maps of Mars.
Soil Composition: Igneous, crusted, basaltic lava rich in magnesium and iron.
Atmospheric Composition: 95% carbon dioxide; 2% nitrogen; 1.5% argon; 0.1% oxygen; trace amounts of water vapor, carbon monoxide, neon, krypton, and xenon.

Landing Site # 3- Mars, Northern Pole

Planet Size: Mars is 52% the size of Earth.
Coordinates: 90º North Latitude, 0º Longitude.

Gravity: .38 G (Earth gravities).
Temperature: -67º C.
Atmospheric Pressure: .006 ATM (Earth atmospheres).
Topology: Like the surface of dry ice.
Soil Composition: Frozen carbon dioxide, with possible frozen water underneath. Some soil is mixed in the patches of carbon dioxide.
Atmospheric Composition: 95% carbon dioxide; 2% nitrogen; 1.5% argon; 0.1% oxygen; trace amounts of water vapor, carbon monoxide, neon, krypton, and xenon.

Landing Site # 4-Venus, Aphrodite Terra Continental Plate

Planet Size: Venus is 95% the size of Earth.
Coordinates: 0 Latitude, 90º Longitude.
Gravity: .91 G (Earth gravities).
Temperature: 460º C.
Atmospheric Pressure: 90 ATM (Earth atmospheres).
Atmospheric Composition: 96% carbon dioxide; 4% nitrogen; trace amounts of oxygen, water vapor, and argon.
Topology: Unknown.
Soil Composition: Unknown.

Landing Site # 5--- Atmosphere of Venus

Planet Size: Venus is 95% the size of Earth.
Coordinates: An orbit 30,000 feet above the surface.
Gravity: .91 G (Earth gravities).
Temperature: 460º C.
Atmospheric Pressure: 90 ATM (Earth atmospheres).
Atmospheric Composition: 96% carbon dioxide; 4% nitrogen; trace amounts of oxygen, water vapor, and argon.
Topology: Does not apply.
Soil Composition: Does not apply.

Landing Site # 6----Venus, Rhea Mons Volcano

Planet Size: Venus is 95% the size of Earth.
Coordinates: 30º North Latitude, 285º Longitude.
Gravity: .91 G (Earth gravities).
Temperature: 460º C.
Atmospheric Pressure: 90 ATM (Earth atmospheres).
Atmospheric Composition: 96% carbon dioxide; 4% nitrogen; trace amounts of oxygen,
water vapor, and argon.
Topology: Unknown.
Soil Composition: Unknown.

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Design Conference—Worksheet

Name: ________________________________ Date: ___________________________

Assigned Landing Site:

1. Your team is composed of all students who share your assigned landing site. Observe the design of each team member's spacecraft-lander system. What are its unique and outstanding qualities? How is it designed for the specific conditions at your landing site?

Designer's Name Unique and Outstanding Qualities of the Spacecraft-Lander

2. As a team, design a spacecraft and lander for the conditions at your landing site, using the best aspects of each design. Draw your design for this spacecraft-lander system on another sheet of paper, labeling all components.

3. Describe how the following components work.
   - Propulsion system:
   - Fuel or energy source:
   - Landing gear:
   - Mission control instruments:
   - Communication devices:
   - Data collection devices:
   - Life detection devices:

4. Provide a sample of the data your spacecraft would send back.

5. Provide a sample of the data your lander would send back.

6. How will this information help you to decide if life is present at the landing site?

7. After you have observed the spacecraft-lander designs of other teams, describe the differences in lander design that were necessary for the different landing sites.

Site # 1: Mars, Utopia Planitia Desert

Site # 2: Mars, Olympus Mons Volcano

Site # 3: Mars, North Pole

Site # 4: Venus, AphroditeTerra Continental Plate

Site # 5: Atmosphere of Venus

Site # 6: Venus, Rhea Mons Volcano