Mission 5
Initial Spacecraft and Lander Design Tools of Comparative Planetology and Exobiology

Overview

In mission 5.1, each student designs, diagrams, and describes a spacecraft-lander system to explore one of six specific sites on Mars or Venus. In mission 5.2, students form teams based on common landing sites and design a composite spacecraft-lander system. Each team presents its ideas to the class, summarizing the conditions at their landing site and the components of their spacecraft- lander system and how they are suited to the landing site.

Notes

In mission 4, students journeyed to Mars and Venus. In the real world, comparative planetologists and exobiologists send spacecraft and landers to other planets to discover the characteristics of an alien environment or to search for signs of life. Today's missions are robotic solely because of cost; technically, manned missions are feasible. All successful missions are the products of creative ideas, careful planning, and team work.

Mission 5.1
Materials

For a *Class of* 30

- Transparency of Viking Lander

For Each Student

- Drawing paper
- Drawing and coloring tools (rulers, markers, etc.)
- Landing Site Environment data sheet
- Initial Spacecraft Design worksheet
- Designing a Spacecraft and Lander optional directions
- Pencil

Getting Ready

1. Assemble drawing materials.

2. Make five copies of each Landing Site Environment data sheet. Cut the sheets in half so each student receives only one landing site. (Students who receive the same landing site will work together as a team in mission 5.2.)

3. Copy the Initial Spacecraft Design worksheet and the Designing a Spacecraft and Lander optional directions for each student.

4. Make a transparency of *Viking* Lander.

Classroom Action

1. Preliminary. Hand out the Initial Spacecraft Design worksheets and the Landing Site Environment data sheets. There are six landing sites; each student should get one of these. Distribute all six sites randomly. Be aware that the Atmosphere of Venus site is more challenging than the other sites. (In mission 14, Final Spacecraft and Lander Design, students' landers will set down on these sites. Student teams will be given simulated data to analyze. Students teams in mission 14 will be the same teams formed in mission 5.2, so be sure to record teams and save all completed student pages.)

2. **Discussion.** Explain that 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. Discuss with students the importance of spacecraft and landers to the comparative planetologist and the exobiologist. Ask students to name what they think are the major components of a spacecraft. Make sure students conclude that a spacecraft must be able to travel through space undamaged, reach the landing site, deliver the lander, and send data back to Earth. Ask students what can be learned from a spacecraft. How does a spacecraft gather its information? What cannot be learned from a spacecraft? Why not?

   Teacher's Note: *On Mars, the prime meridian is defined relative to a tiny crater in the Sinus Maridiani region of Mars. This entire region was used as the meridian until the Mariner mission (which had the first orbiter), when the position was redefined as the center of this crater.*

   For Venus, before the Russian Venera *missions, there were several definitions for the meridian because each observing group could define its own. The* Pioneer, *the Arecibo Earth-based, and the* Magellan *radar mapping of Venus have led to a consensus-the meridian is now defined as the centralpeak of the Ariadne crater: This peak was chosen because it was present in all three mapping projects and because it is particularly easy to see with radar. The International Astronomical Union (IAU) has a committee in charge of the cartographic coordinates of planets and satellites. It meets every third year.*

   Ask students to name what they think are the major components of a lander. Make sure students conclude that 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. Landers can assess the local planetary conditions: geology, chemistry, or meteorology. Ask students what can be learned from a lander? How does a lander gather its information? What cannot be learned from a lander? Why not?

Put the transparency of the *Viking* Lander on the overhead projector. Have students identify on the *Viking* the major components of a spacecraft they mentioned in their previous discussion. Then have them point out the data collection devices on the *Viking.*

Tell students that there are four major facets of designing a spacecraft-lander system. One, the exterior of the system must be able to withstand the conditions during travel and the conditions at the landing site. Two, the system should include mechanisms for the purposes of propulsion and navigation. Three, the system should include instruments that gather information about the conditions and the existence of life at the landing site and send that information back to Earth. Four, the system should not contaminate the site with life-forms brought from Earth.

Teacher's Note: *The focus of this mission is more the search for life than it is spacecraft and lander design per se. It will be sufficient for students to simplify complex aspects of their spacecraft and landers. For example, they might include black boxes 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 the spacecraft and landers should be explained in as much detail as possible. The spacecraft-lander systems shouldbe designed uniquely for use at specific landing sites.*

Teacher's Note: *It is vastly more exciting for students to consider manned missions to Mars or Venus, and such missions are feasible. However, they are not very likely in the foreseeable future because they are very expensive compared to robotic missions. Discuss the cold realities of finance with students, but do not kill their dreams.*

3. **Activity.** Have students brainstorm for 10 minutes on what to include in their spacecraft lander system. Each student should consider the solutions to the specific challenges imposed by the landing site (e.g., extra parachutes because of thin atmosphere, or broad based feet to prevent a lander from toppling over in soft soil). After 10 minutes, hand out drawing materials. Have students complete their Initial Spacecraft Design worksheets. (Note that there is no teacher's key for this worksheet because student answers to the questions will vary; all reasonable attempts should be accepted.) Explain that a good drawing is nice, but that labeling and describing the function of the parts is more important. Encourage students to include everything they would need for a successful mission.

   Teacher's Note: *Students will tend to plan for a manned flight unless instructed otherwise. At this point, let them use their imagination to think about how exciting it would be to travel to other planets and to create a plan unhindered by such constraints. In real missions, payload and overall cost are major considerations. Students' final spacecraft-lander designs(mission 14) will include these factors.*

Mission 5.2
Materials

For Each Student

- Design Conference worksheet
- Pencil

Getting Ready

1. Copy the Design Conference worksheet for each student.

Classroom Action

1. **Activity.** Hand out the Design Conference worksheet to each student. (Note that there is no teacher's key for this worksheet because student answers to the questions will vary; all reasonable attempts should be accepted.) Divide the class into teams of students who share the same landing site. Each team should have about five students. Tell students that they will be holding conferences to discuss their spacecraft-lander system designs. Have them use their worksheets to review each spacecraft-lander system and record its unique and outstanding qualities. Tell each team to design a composite spacecraft-lander system based on the best aspects of each individual design. A team might start with one person's design and add to it, or begin anew.

2. **Oral Presentation.** Invite teams to present their work to the class. They are responsible for educating the class about the conditions at their landing site and for presenting and explaining their proposed spacecraft and lander. Hold a Press Conference in which teams tell the public what they intend to do; have the press in the audience take notes and publish a newsletter on the expected launches. Or, have a science fair poster session in which one member from each team stands by the team's drawing while the remaining team members observe the plans of other teams. Have teams draw pictures of their landing sites as well. After all presentations, have teams meet again to rethink some of their ideas and refine their spaceship and lander designs.

3. **Conclusion.** Collect all the designs from each team and save them for mission 14, Final Spacecraft and Lander Design. Display the composite design from each team on a bulletin board.

Going Further

Activity: Do-It-Yourself Spaceship Models

Ask students to bring in various doodads (anything from paper clips to bottle caps and different sized boxes and pieces of cardboard). Have students use these items (and glue, tape, and pins) to construct models of their spacecraft and landers. Have students try to make each component as descriptive as possible while maintaining a low overall weight. This activity can be done by individual students or by the conference teams. Have a show or competition with categories such as best spacecraft, most original lander, most functional spacecraft-lander system, and so on.

Research: American and Russian Spaceships

Ask students to research the design of real spacecraft and share their findings with the class. Did the Americans and the Russians use the same designs? How were they different? Assign each team a specific spacecraft. Have students bring in pictures or drawings of their assigned spacecraft.

Research: The Starship *Enterprise*

The Starship *Enterprise* (in its many manifestations of *Star Trek* fame) was thought out by spacecraft designers. There are also schematics and technical manuals for the *Enterprise.* Ask students to find these schematics and manuals in a library and evaluate the designs. Are they realistic? Functional? Which aspects were put in just for Hollywood? Why doesn't the *Enterprise* ever land on a planet?