The Space Shuttle

OBJECTIVES:

Mission Team members will understand the major components and capabilities of the Space Shuttle.

Benchmarks:
Knows that women and men of diverse interests, talents, qualities and motivations and of various social and ethnic backgrounds, engage in the activities of science, engineering and related fields; some scientists work in teams, some work alone, but all communicate with others.

DISCUSSION:

Hello, my name is *fill in blank*. Today we are going to talk about and build a **Space Shuttle**. After the Apollo program the United States began concentrating on the development of a reusable launch system, the **Space Shuttle**. The Space Shuttle is a reusable spacecraft, called an orbiter, which can land like an airplane. Each shuttle mission is given an STS number. STS stands for Space Transportation System. So, for example, STS-95 is the 95th mission scheduled. Sometimes the missions fly out of order (e.g. 95 flies after 96) but they still keep their assigned number. America has four space shuttles. They are Atlantis, Discovery, Endeavor, and Columbia. Each shuttle can fly over 100 times with proper care and maintenance. As of 2002, each has flown approximately 25 times.

The shuttle's main parts are the flight deck, the mid-deck, and the cargo bay. The commander and pilot operate the spacecraft from the flight deck, the upper level of the cabin. The crew lives in the mid-deck area, where the galley, sleeping area, and toilet are located. An air lock leads to the center of the fuselage, the cargo bay, where payloads are stored in an area large enough to hold one and half school buses.

Two solid rocket boosters and three main engines on the orbiter launch the Space Shuttle. The reusable boosters jettison little more than 2 minutes into the flight, their fuel expended. Parachutes deploy to decelerate the solid rocket boosters for a safe splashdown in the Atlantic Ocean, where two ships recover them. The orbiter and external tank continue to ascend. When the main engines shut down, the external tank jettisons from the orbiter, eventually disintegrating in the atmosphere. A brief firing of the spacecraft's two orbital maneuvering system thrusters changes the trajectory to achieve orbit at a range of 185-402 kilometers above Earth's surface. The Space Shuttle orbiter can carry approximately 25,000 kilograms of payload into orbit so crewmembers can conduct experiments in a microgravity environment. The orbital maneuvering

system thrusters fire to slow the spacecraft for reentry into Earth's atmosphere. The reentry thru Earth's atmosphere heats the orbiter's thermal protection shield up to 3000 degrees. On the Shuttle's final descent, it returns to Earth gliding like an airplane.

The crew keeps the cargo bay doors open while the shuttle orbits. This prevents excessive heat build up and destruction of the spacecraft. They maneuver the ship, operate its manipulator arm, and monitor payloads from the back of the flight deck. They eat, sleep, relax, and take care of their personal needs in the mid-deck area.

The food for the astronauts must be lightweight, nutritious, convenient, and require as little storage space as possible. It also must not need refrigeration. Over half of their food is dehydrated, so astronauts have to add water to prepare it. Because of the weightlessness in space, scientists had to design special eating utensils, a portable modular galley, and safe, compact packaging.

Everything must be kept sanitary to keep the crew healthy. The eating equipment, dining area, toilet, and sleeping facilities in an orbiter are regularly cleaned to prevent the spread of germs. Astronauts have to take sponge baths rather than showers, because water droplets float in space and can damage equipment. Dirty water is suctioned off to a waste collection tank.

Most everyone's curious about how astronauts go to the bathroom. Since microgravity affects the use of the toilet, crewmembers must use foot restraints, a seat belt, and handholds to remain seated. The toilet uses a fan to draw solid wastes to a compartment where they are dried and disinfected.

Clothes can't be washed aboard the spacecraft, so astronauts change their trousers just once a week, and their socks, shirts, and underwear every other day. They store their dirty clothes in tight plastic bags. Garbage and trash are also stored this way.

Shuttle crewmembers sometimes sleep in their seats, in sleeping bags, in bunks, or by tethering themselves to the orbiter walls. Because there's no "up" or "down" in microgravity, they can sleep comfortably in any position. While sleeping, a person's arms naturally float up in a near horizontal position. Bunks have lights, communication stations, fans, sound suppression blankets, and sheets with microgravity restraints and pillows. Turning over in one's bunk is as easy as pushing off a wall (bulkhead) with one finger.

To move around to work in microgravity, astronauts have to use suction cups on their shoes, and Velcro strips and other straps and attachments so they can hang onto things.

The basic space shuttle crew has a commander, a pilot, and a mission specialist. The commander and pilot are in charge of the flight. The mission specialist coordinates payload operations and carries out the scientific objectives of the mission. The payload specialists are scientists, engineers, or physicians selected by the companies that build the payloads. The mission specialist and scientist payload specialist work together on different kinds of experiments and also place satellites in orbit.

To work outside the shuttle to service or retrieve free-flying satellites, astronauts use a **Manned Maneuvering Unit** that is propelled by nitrogen gas. They have many **Extravehicular Activities** such as inspecting and photographing payloads, inspecting modular instruments, performing experiments, doing repairs, and operating equipment and tools.

Most important for the success of missions is effective communication among astronauts and with flight control on the ground. Headsets, computers, and satellites are used to help personnel communicate.

ACTIVITY

NASA Space Shuttle Glider

DISCUSSION QUESTIONS:

1. The first landing of astronauts on the moon was a tremendous source of pride for Americans. Do you think that the country still has as much national pride in our space program as it did then? Why or why not?

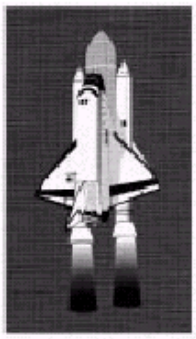
2. Discuss whether or not we should try to send humans to Mars—an expensive proposition, but one that might yield a great deal of scientific information. Consider whether we should more fully understand the Earth before moving on to another planet and whether we have a right to try to inhabit Mars just because we have the technology to do so.

3. Are we learning enough from the space shuttle missions to justify the billion-dollar price tag for each launch? Who should pay for these trips? Who benefits from them?

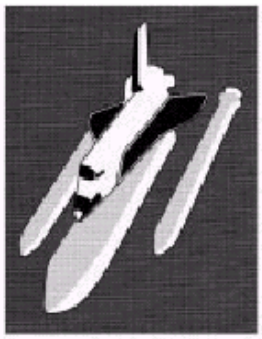
4. Discuss the importance of computer simulations to the space program. Could astronauts be trained properly without them? Can every dangerous situation be properly simulated? Why or why not?

5. The space shuttle program was designed with the building of an international space station as its final goal. This goal has yet to be reached. Do you think that different nations are capable of working together toward such an ambitious, costly goal? How should we decide which countries are allowed to be involved in building and using space stations?

Mission Team Leader's notes. Give Galaxy Explorers copies of the below Shuttle Glider activity to follow along during the presentation. You can additionally use a picture of the Space Shuttle or model to illustrate.



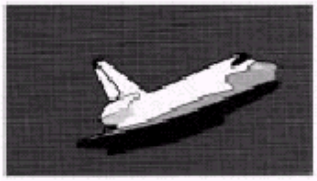
LAUNCH



BOOSTER SEPARATION

EXTERNAL TANK SEPARATION AND ORBIT INSERTION

ON-ORBIT OPERATIONS



RE-ENTRY

Space Shuttle Glider Assembly Instructions

AIRSTRIP LANDING

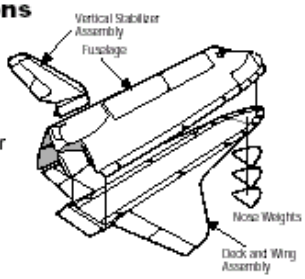
Assembly Instructions

Read carefully before assembly.

1. Cut out all parts using scissors.
2. Cut out V-shaped notches on Fuselage to create tabs along outside edge. Fold tabs out.
3. Glue or tape three Nose Weights to underside of glider nose. Use the fourth weight provided if needed for extra trim after assembly.
4. Fold Fuselage along middle line.
5. Starting at the nose, glue or tape fuselage to Deck and Wing Assembly. Match tabs on Fuselage exactly to those two halves together using tabs provided.
6. To close the nose, glue or tape the two halves together using tabs provided.
7. Fold Vertical Stabilizer Assembly. Fold out tabs A and B. Except for tabs A and B, glue or tape Vertical Stabilizer Assembly to make one solid piece.
8. Attach Vertical Stabilizer to Fuselage, matching tab A with point A and tab B with point B.

Preflight Instructions

For the best results, launch your glider with a gentle level toss. Bend the Body Flap for slightly greater lift.



Space Shuttle Glider Challenges

Challenge #1—Determine the scale of the glider

Needed: Space Shuttle Glider, metric ruler, and calculator
What To Do: Measure the length of your glider in centimeters. Divide your answer into the length of the real Space Shuttle orbiter to determine your glider's scale.
Space Shuttle orbiter length: 3,724 centimeters.

Challenge #2—Glide ratio

Needed: Space Shuttle Glider and tape measure
What To Do: Gently launch the Space Shuttle Glider horizontally from a measured height above the floor. Measure how far across the floor the orbiter traveled from the launching point. Determine the glide ratio by dividing how far it traveled by the distance it dropped to the floor. Research the glide ratios of other aircraft such as commercial jets, small private planes, and sail planes.

Challenge #3—Fishing Line Guidance System

Needed: Space Shuttle Glider, paper clips, nylon fishing line, cellophane tape, and book
What To Do: Spread open two paper clips so that they become "S" hooks. Straighten out the lower end of the S for each hook and attach these straightened ends to the back of the glider with tape. One clip should be in the nose and the other in the tail. Tie one end of the fishing line around the book and set the book on the floor. Stand several meters from the book and hold the other end of the fishing line about one meter above the floor. Hook the glider onto the fishing line and let it go. Try to get the glider to land on the floor without running into the book.

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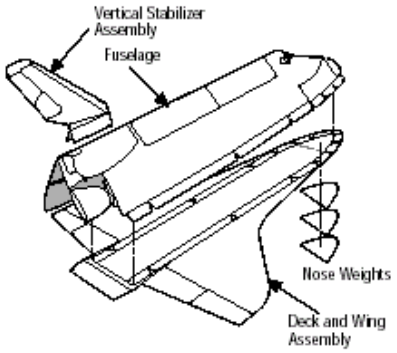

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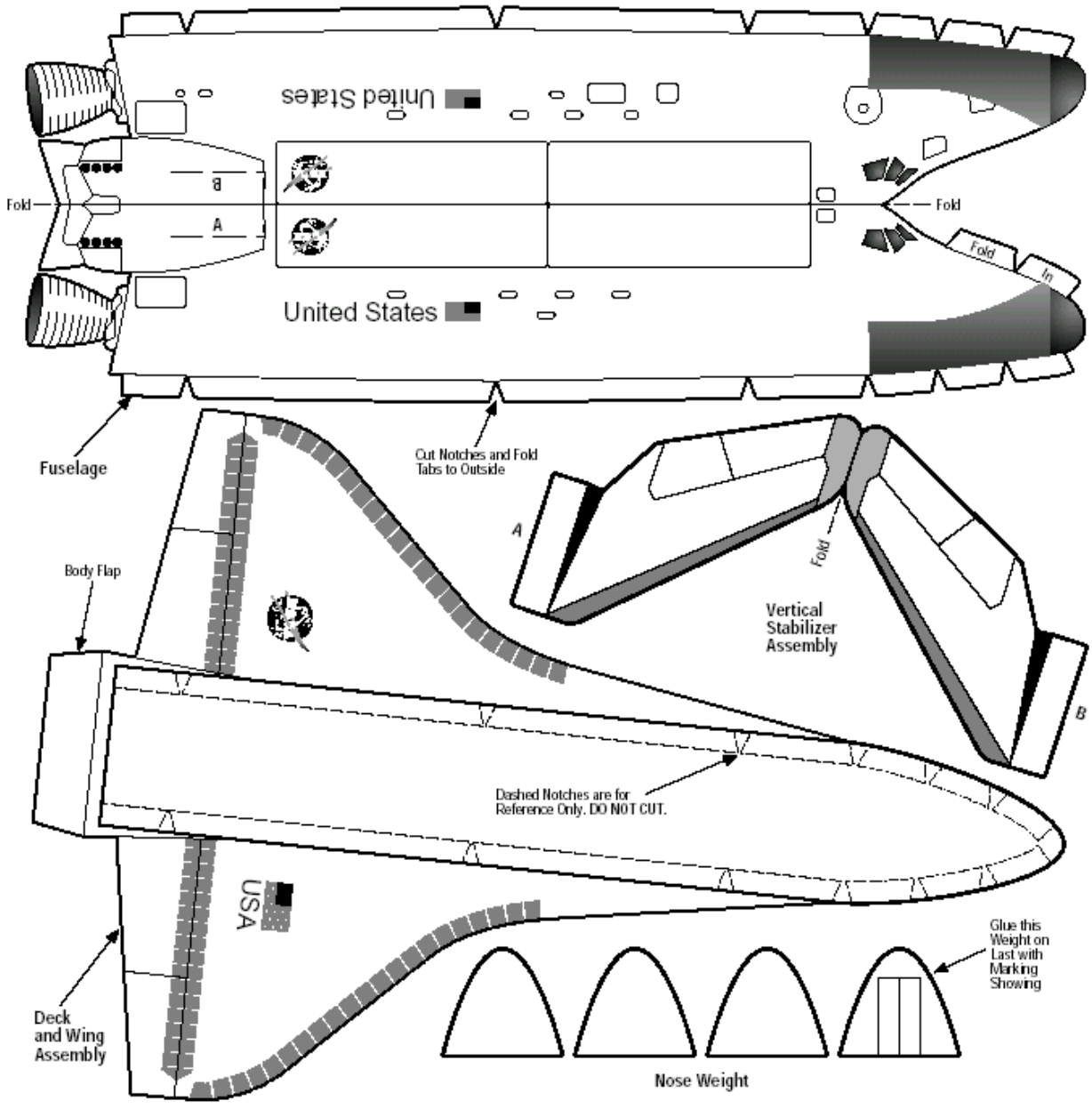

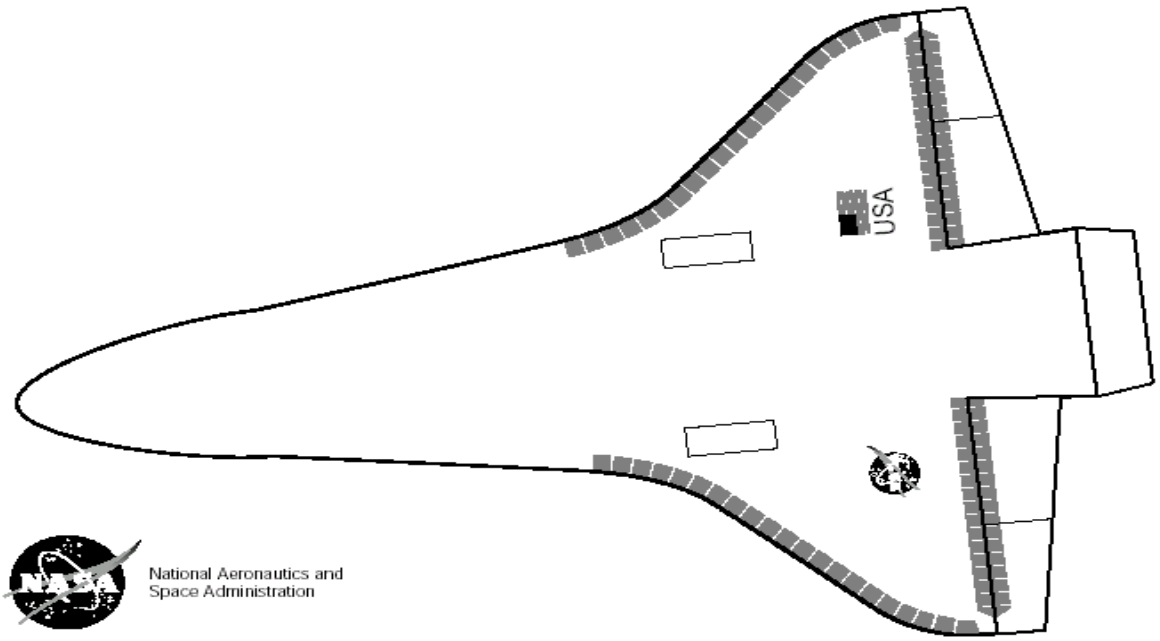

National Aeronautics and
Space Administration