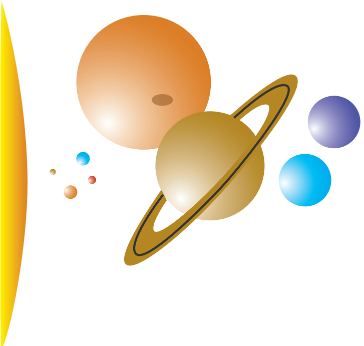
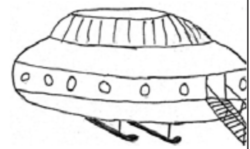


Activity 5
My Spacecraft to Saturn

Overview

During this activity, your youth:

- Can connect with the Cassini spacecraft and the designers who built it — by thinking like engineers.
- Follow the engineering process of building a spacecraft through team discussion, design drawing, model construction, and peer presentation — which emulates steps taken by the Cassini team in designing a spacecraft to travel to Saturn.
- Create and present their design drawing and their model spacecraft.
- Work as an engineering team to make changes, as in the engineering design process.
- Make and Take: A model of a spacecraft to go to Saturn, working together as a team.

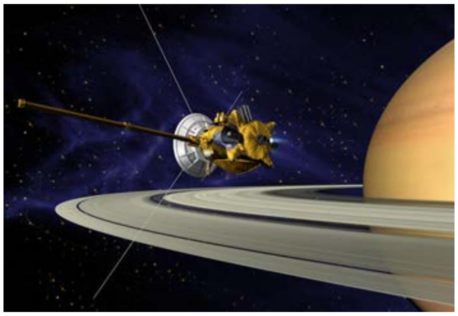


Time/number of sessions	Activity Type	Space Needed
Four 40-minute sessions	Hands-on construction	Classroom or cafeteria, space with tables and chairs

Activity Goals

Students will:

- Learn the way in which the requirements of space travel impact design of a spacecraft.
- Learn the value of "peer review" and revision as a normal part of the engineering design process — they learn to compare and contrast their solutions with the solutions of others.
- Learn to use illustrations with text to communicate their ideas to peers.



Where's the Science and Engineering?

- This activity presents an engineering challenge based on the science information students now have on Saturn and Cassini.
- Robotic exploration spacecraft are "built-to-order" to achieve specific science goals — they aren't typically "off-the-shelf." For the Cassini mission, the spacecraft was specifically designed for its destination, the distance, the risk and challenges of space, and the requirements of the science team's experiments to answer questions. It's the job of an engineering team to translate the goals of the scientists' experiments into the design and construction of a spacecraft.
- A robotic spacecraft has to be able to do many of the things we do as humans, but without our presence:
  - — "See" to navigate and send back pictures
  - — "Touch" with special instruments that can take samples
  - — "Hear" from and "speak" to engineers on Earth, through the use of communication antennas
  - — "Think" with computers and instruments that make measurements

National Science Education Standards

K–4

Technology
- Abilities of technological design
- Understandings about science and technology

Science in Personal and Social Perspectives
- Personal health

5–8

Physical Science
- Properties and changes of properties in matter
- Motions and forces

Science and Technology
- Understandings about science and technology

Science in Personal and Social Perspectives
- Populations, resources, and environments
- Natural hazards
- Risks and benefits

The National Science Education Standards state that students should be able to design solutions to problems. Drawing illustrations with accompanying text is a powerful way for students to organize and express their thinking.

Equity/Leveling the Playing Field

- In this activity, students are asked to brainstorm ideas. It is important to create an environment where all ideas are valued so that students will be more likely to share their ideas safely.
- Occasionally other students will laugh or ridicule ideas (or performance). Set the stage early — remind students to be courteous, that everyone's ideas are important, and that things we thought silly at one time are fact now (people have walked on the Moon, we've taken a peek at another world, we have evidence of planets around other stars!).

Materials

From Your Supply Closet

Session	For Students	
1 & 2	• Pencils and paper	
3	• Clean recyclable items (for example, empty cereal or pasta boxes, paper towel tubes, plastic bottles, etc.) • Pipe cleaners • Tape • Paper fasteners	• String • Paper • Aluminum foil • Glue

From a Photocopier/Printer

Session	For Leader	For Students
1	• *Designing a Spacecraft Script*	• *Design Questions* student handout

Getting Ready

- Read and review the activity step-by-step instructions in the "Do It!" section.
- Ask students to bring clean recyclable materials (cereal boxes, paper towel tubes, empty plastic bottles, etc.) from home to be used as building materials for the model.
- Gather recyclable materials from your site to have available as building materials.

Leader Tips

- While there are some interesting similarities in the functions of a spacecraft and those of humans, watch your students for signs of misconceptions that robotic spacecraft work just like a human body; for example, that spacecraft breathe or speak a human language.

My Spacecraft to Saturn

Student Activity

Session 1 • Brainstorming

1. Tell your group that they are going to be working today to design a spacecraft to go to Saturn. Read *Designing a Spacecraft Script* aloud to the group.
2. Organize the students into teams of three or four. Ask them to spend a few minutes brainstorming a way to protect their spacecraft in the space environment. Bring the group back and ask students to share their ideas.
3. Tell your students that they will work as design teams and record their ideas. Give each team a copy of the *Design Questions* student handout.
4. Ask the design teams to proceed in designing and sketching their spacecraft.
5. Circulate throughout the room to assist the students as they complete their designs.

Session 2 • Revising the Plans

1. Have each team share their spacecraft designs with the larger group.
2. Encourage the large group to offer a friendly critique of the designs as they are presented.
3. Ask the teams to revisit their designs to fine tune them and incorporate their peers' suggestions if they feel the suggestions are appropriate.

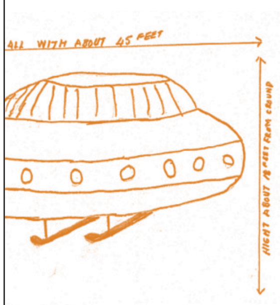
Session 3 • Building the Models

1. Have the students join their original teams.
2. Ask the students if they are satisfied with their designs. If not, allow them time to revisit and refine their designs. If so, tell them that they are going to build a model of the spacecraft based on their drawings.
3. Put all of the building materials out and ask the teams to think about how they can be used to make a model of the spacecraft in their sketches.
4. Remind the students to work together as a team. Ask students to make a "materials" list for their model and, when the group agrees on the list, take the materials back to their table.
5. Give students time to complete the model.
6. After they have completed building the model, ask them if they made changes to the design as they worked. If so, ask them to reflect those changes on their drawing.

Session 4 • Presentations

Ask each team to present their drawing and model. Ask them to:

1. Talk about their design process and the decisions they made in selecting that design.
2. Show their drawing and describe it.
3. Show their model and describe how they took a 2-dimensional drawing and created a 3-dimensional structure.



Questions for the Youth (Informal Assessment)

- What kind of changes happened when you translated the 2-dimensional design into a 3-dimensional structure?
- Did your design change as you started building? Discuss why or why not.

Sharing the Findings (Informal Assessment)

Have the class share things they like about each other's work, questions they have, and suggestions for the presented designs.

Leader Reflection/Assessment

Between sessions, ask yourself the following questions:

1. Are the students able to meet challenges or brainstorm successfully?
2. Did everyone participate? Did everyone feel comfortable sharing his or her ideas?
3. Were the students able to devise creative solutions to design challenges?

Encourage your students to visit the Cassini–Huygens website to see where Cassini is now, find more images of Cassini, and learn more about the spacecraft and the mission — saturn.jpl.nasa.gov/

Information for Families

Cassini on parade! A 50-foot tall robot featuring a "Family of Explorers" skated down Colorado Blvd. in Pasadena, California, during the Tournament of Roses Parade on New Year's Day 2005. Ten NASA spacecraft were featured in this float, made with 500 pounds of seed and 750,000 flowers! The crown jewel at the top of the robot's head was the Cassini spacecraft, sent to study Saturn. See the back of this page for a picture of the float that you can send home for families to enjoy, or view it at: spaceplace.nasa.gov/robot-float

Get fun facts about the Cassini spacecraft at: saturn.jpl.nasa.gov/kids/fun-facts-spacecraft.cfm

The Space Place offers simulations and space technology games for young children spaceplace.nasa.gov/menu/people-and-technology

NASA Resources

Careers at NASA

Hear NASA/JPL mechanical engineer and mentor Kobie Boykins explain that curiosity and a variety of interests make for a great work intern. They are also creative, innovative, good organizers, big thinkers, and detail-oriented; they write well, and they can be influencers, competitors, and collaborators. www.jpl.nasa.gov/education/videos/playVideo.cfm?videoID=2

Role Model Resource

Shonte Tucker is a thermal engineer at JPL, ensuring that items on a spacecraft are within flight temperature limits while making minimal use of spacecraft resources. Her job is critical to missions, because if an instrument's temperature range is not properly controlled, it may be unable to perform the task for which it was intended. Shonte advises students to "stay in school and have dreams, take as many math and science classes as possible, and don't give up your options. The skills acquired to fulfill a dream in one career direction could be used for a career in a completely different direction."

Read more about Shonte Tucker at: solarsystem.nasa.gov/people/profile.cfm?Code=TuckerS

Resources

Where Is Cassini Now? Visit the Cassini website at saturn.jpl.nasa.gov for more information on Saturn and to view "Cassini Status."

See the Cassini spacecraft's "almost human" features at: saturn.jpl.nasa.gov/spacecraft/overview/

Taking the Science to the Next Step

Have the students write a paragraph describing everything about their spacecraft. For an extra challenge, you can hang the sketches of spacecraft around the room, and have the class members work in pairs to match descriptive paragraphs to the actual sketches.

Build a paper model of the Cassini spacecraft (or others): solarsystem.nasa.gov/kids/papermodels.cfm

Spacecraft Design Research: After students finish their designs, you can encourage them to go to the NASA solar system website at solarsystem.nasa.gov/missions to look at other spacecraft and think about how the designs are the same or different from Cassini.

There are two NASA student-friendly interactive websites to see spacecraft and to virtually design and build a spacecraft of your own:
virtualfieldtrip.jpl.nasa.gov
www.jpl.nasa.gov/education/BuildMissionGame.cfm

Learn how robotic spacecraft communicate with people on Earth (requires free Adobe Flash™ download): spaceplace.nasa.gov/dsn-game

Literacy

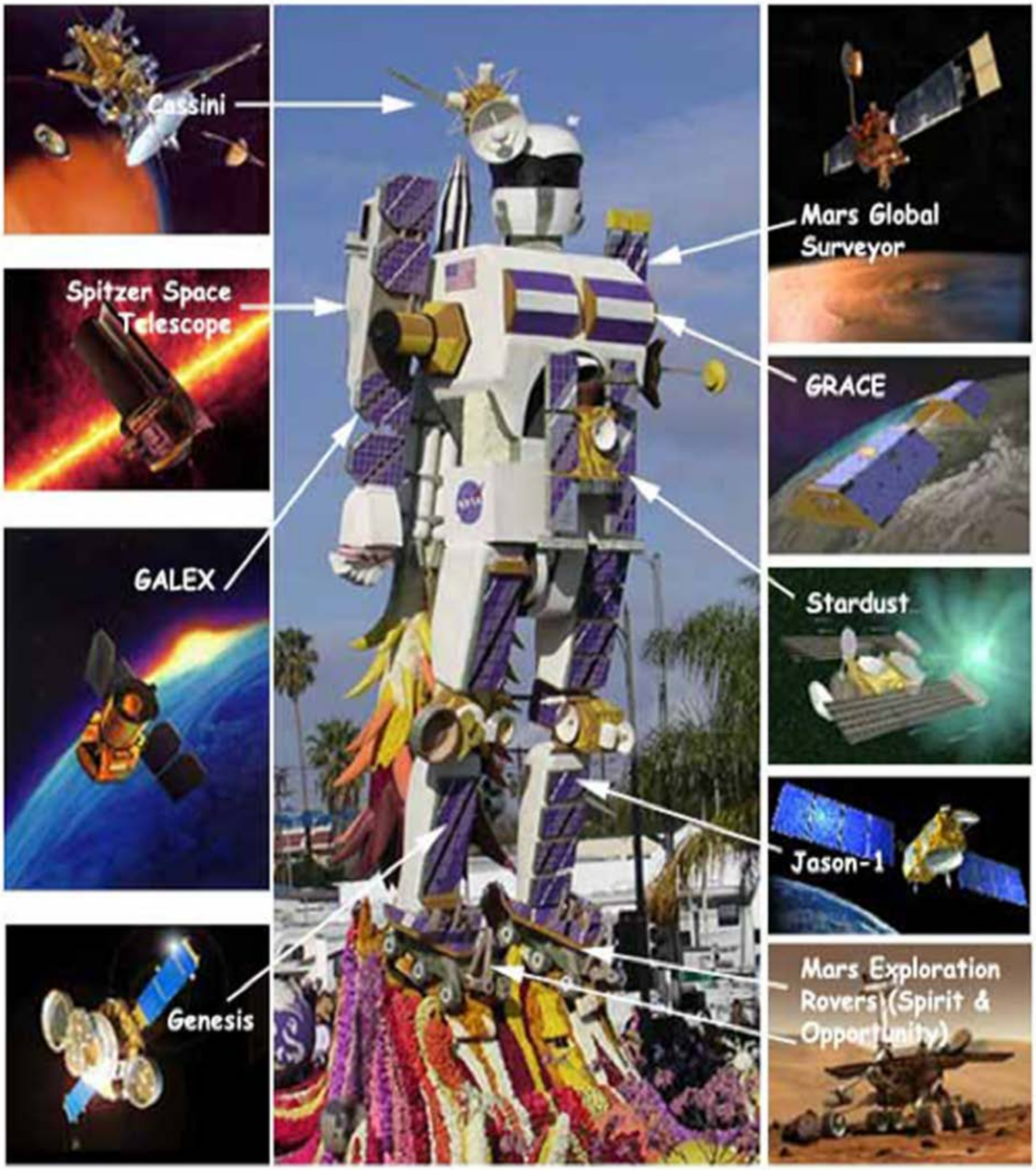
Ask students to write a paragraph comparing a human to a Cassini spacecraft. Have students write one paragraph about how they are the same and another paragraph about how they are different.

Singing Activity

Just for fun, the Cassini Virtual Singers at the Jet Propulsion Laboratory get together occasionally and perform songs they have developed.

The singers are scientists, engineers, and others who support the mission. They have a repertoire of about 50 songs, based on familiar melodies but with lyrics about the Cassini mission. As a group, ask students to write a song about Saturn to the tune of Old MacDonald.

Family of Explorers



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Designing a Spacecraft Script (For Leader)

Today you are going to think like an engineer. Many of the people who work at NASA are engineers. It's the job of an engineering team to design and build a spacecraft to help answer the questions that scientists have.

Cassini is a one-of-a-kind spacecraft that was specifically designed to go to Saturn, to be able to travel the distance, to survive the risk and challenges of space, and to learn about Saturn, its rings, and its moons.

Here is your design challenge for today. How can you design your team's spacecraft to fly all the way to Saturn — about 800 million miles away from Earth? (Engineers often work in metric units — so Saturn is about 1,300 million kilometers away from Earth.)

A robotic spacecraft has to be able to do many of the same things we do as humans, while it is far away from our control:

- "See" to navigate and send back pictures
- "Touch" with special instruments that can take samples
- "Hear" from and "speak" to engineers on Earth, through the use of an antenna to communicate back and forth
- "Think" with computers that keep the spacecraft safe and take care of all the data from the instruments

To design your spacecraft, you and your design team are going to work together and make decisions about the following things.

- How will you protect the spacecraft in the icy cold temperature of deep space?
- How will you control and keep in touch with your spacecraft?
- How will you keep the spacecraft safe if it is hit by a space particle (a dust particle or ring particle)?

- What science question do you want the spacecraft to explore when it gets to Saturn?
- Do you think you should send humans on the spacecraft? If you think you should send humans, how will they survive? [Prompts: Food and water for 7 years? Bathroom/waste? Air?]

- What are some challenges that might be encountered with the spacecraft on the journey to Saturn?
- What will you name your spacecraft?
- Why did you choose that name?

It's the job of an engineering team to design and make a "built-to-order" spacecraft to help answer the questions that scientists have. Once you think of possible solutions to these design challenges, your design team will draw a sketch of your Saturn spacecraft. Remember to include everyone's ideas!

Design Questions (For Students)

Here is your design challenge for today. How can you design a spacecraft that will make it all the way to Saturn — about 800 million miles away from Earth? To design your spacecraft, you and your design team are going to work together and make decisions about the following things.

- How will you protect the spacecraft in the icy cold temperature of deep space?

- How will you control and keep in touch with your spacecraft?

- How will you keep the spacecraft safe if it is hit by a space particle (a dust particle or ring particle)?

- What science question do you want the spacecraft to explore when it gets to Saturn?

- Do you think you should send humans on the spacecraft? If you think you should send humans, how will they survive?

- What are some challenges that might be encountered with the spacecraft on the journey to Saturn?

- What will you name your spacecraft?

- Why did you choose that name?

Once you think of possible solutions to these design challenges, your design team will draw a sketch of your Saturn spacecraft. Remember to include everyone's ideas!