OBSERVING PICTURES FROM SPACE: MAKING STEREO 3-D IMAGES

Developed for the Stardust-NExT Mission
by Dee McLellan

TEACHER NOTES AND LESSON PLAN:

PURPOSE:

As a result of this activity, a student will have an understanding of how to use 2-D images to create 3-D images. Students will gain a better understanding of visible images retrieved from distant spacecrafts. Students will be able to use this technique to study images taken of comet Tempel 1 in 2005 and compare those pictures to new images that will be taken by the STARDUST spacecraft camera in 2011. Not only that, they can better appreciate the latest NASA images from all missions as they are published (terrific resource is NASA's Image of the Day: http://www.nasa.gov/multimedia/imagegallery/).

The process parallels that of the scientists and engineers as they work to make sense of new imagery from space missions. Often taken from very far away and while moving fast, images are of varying resolution and quality. Scientists pour over the images, create composites (for example, the image of Tempel 1 the students work with is actually a composite of 16 images), and make educated hypotheses about what it is they are viewing.

Utilizing stereoscopic pairs adds depth and dimension not only to our vision, but our understanding. With such skills, we can help our students join scientists in the thrill of authentic exploration from afar.

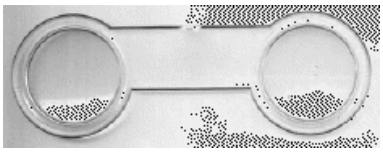
NATIONAL SCIENCE STANDARDS:

A. Science as Inquiry
A.1.c Use appropriate tools and techniques to gather, analyze and interpret data.
A.2.g. Scientific investigations sometimes result in new ideas and phenomena for study, generate new methods or procedures for an investigation, or develop new technologies to improve the collection of data
D. Earth and Space Science
D.3.a.The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets
D.3.b.Most objects in the solar system are in regular and predictable motion
E. Science and Technology
E.1. Abilities of technological design
E.1.b. Design a solution or product
E.1.c. Implement a proposed design

MATERIALS:

- *Observing Pictures from Space: Making Stereo 3-D Images* student pages
- *Observing Pictures from Space: Making Stereo 3-D Images* PowerPoint
- Background materials (optional)
    - Images of comets close up and from afar
- Access to a computer and internet
- Pictures of comets or have students find some (http://stardustnext.jpl.nasa.gov/multimedia/comets.html)
- Several cubic dice or other cubes

- A few toilet paper rolls
- Digital camera (to take your own pictures) or pictures from the internet
- Stereoscopic Viewer Pattern Parts 1 and 2 on cardstock for each student
- Scissors
- Glue
- Magnifying Glasses or Stereo lens for 4 inch focal point (http://www.the3-Dmarket.com/Plastioc/3fcallengths.asp or http://www.berezin.com/3-D/vieweracces.htm)



LESSON PLAN:

Teacher Background

Please read the student sheet thoroughly for general background information as well as a sense of the trajectory of the lesson. The PowerPoint offers a great deal of additional information as well.

- Tip! Review the PowerPoint, **starring those aspects of the notes you would like to emphasize.

Student Background knowledge/motivational activity options –

- *Comet on a Stick!* http://stardustnext.jpl.nasa.gov/education/index.html Learn comet anatomy and characteristics while engaging in a fun activity.
- Have students read *The Comet Chronicle's* "Is It a Comet… or a Cow?" in small groups.
    - Hang several large pictures of comets around the classroom – both close-up and distant images, for example Tempel 1's nucleus and Hale-Bopp in the night sky. In a class discussion, debrief from the reading by having the class identify features and characteristics of comets by looking at these images.
- *Comet Fun Facts*:
    - Tip! With either activity, start a class vocabulary list posted on large paper as you go. Use for on-going reference.

Pre-lesson preparation –

Students read the *Observing Pictures from Space: Making Stereo 3-D Images* introduction on pages one and two.

- This could be done as a class, in small groups, or for homework
- Next, you may want to divide students into groups and have each group read some of the optional materials about comet anatomy and/or the STARDUST NExT mission.
    - Print this material for each student or visit the website (http://stardustnext.jpl.nasa.gov/index.html) and have the students read and explore the website.
    - Have each group report to the rest of the class on what they have learned about the mission.

Lesson –

Now have the students return to the second page of *Observing Pictures from Space by Making Stereo 3-D Images* student page two: *2-D Pictures Vs Stereo 3-D Pictures*. Use the PowerPoint to guide students through this lesson. Students should read along with the PowerPoint. Have them do the activities that go with the pictures. Have the students follow the directions to try to see the stereo pair of Tempel 1 in 3-D.

- If possible, have dice available for students to handle and observe. Have the students continue to read and look at the pictures of Tempel 1.
- Have toilet paper rolls, tape, scissors, etc. available if students want to try using them. As they discover new details about the comet, Tempel 1, after looking at it in 3-D, add that to your list.

Have the students follow the directions to try to create their own stereo pairs. They can also build the viewer.

ASSESSMENT: FORMATIVE AND SUMMATIVE OPPORTUNITIES –

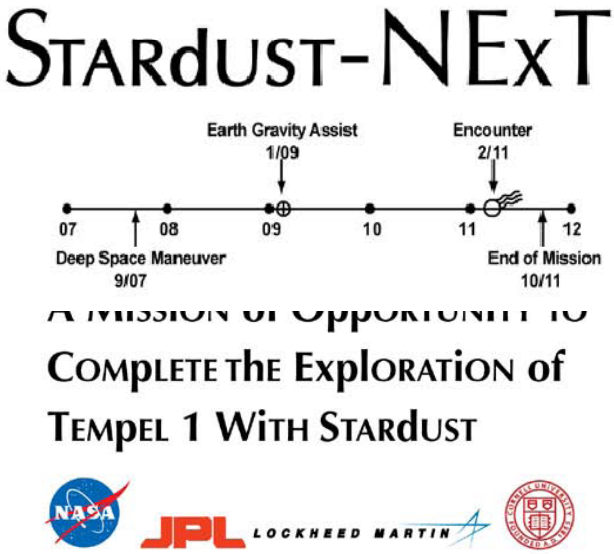
Have students answer the *Questions for Pondering and Assessment* in their journals or logs, individually or in teams.

- Tip! The essay question *Extra, Extra, Read All About It!* could be used for either formative or summative assessment.
- As an alternative to a written assessment, students could work in competing news teams, each team with a unique image, and bringing breaking space news to their rapt audiences world-wide!

February 14, 2011, STARDUST-NExT is projected to arrive at comet Tempel 1. How will new images captured by the spacecraft compare the ones that Deep Impact took in 2005? When the first images arrive on Earth, students can make those pictures into stereo pairs, working alongside the science team in its dynamic discoveries, participating in the real thrill of cutting edge science in action!

BACKGROUND MATERIALS:

About Stardust-NExT

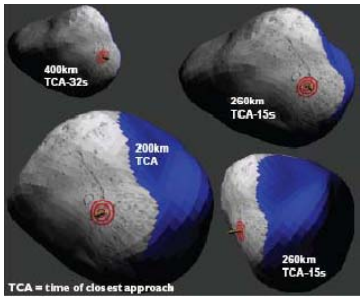


Stardust-New **Ex**ploration of comet **T**empel 1 is a low-cost, low-risk mission that reuses the Stardust spacecraft to fly within 200 km of Tempel 1, enhancing studies previously initiated by NASA's Deep Impact mission on July 4, 2005.

Read more: http://stardustnext.jpl.nasa.gov/mission/pdfs/SD_NEXT_Fctsht.pdf - fact sheet

Animation of the Tempel 1 flyby of Stardust NExT on February 14, 2011

View it: http://www.astro.cornell.edu/next/noannot.mov - animation of flyby



Welcome to the Stardust-NExT Mission

Need to go to a comet? Why not just reuse an existing spacecraft? A Discovery Mission of Opportunity, Stardust- NExT, short for "New Exploration of Tempel 1" is doing just that. A collaboration of NASA, industry and educational partners continuing the journey of exploring comets with the hopes of increasing our knowledge and understanding of what they are, how they compare to each other, and, whether they change during the life cycle of their journey through our solar system.

The Stardust-NExT mission will provide the unique opportunity to compare particles analyzed from two different comets, Wild 2 and Tempel 1, using the same instruments and to, proving scientists the opportunity to compare two individual observations of a single comet taken before and after its made one orbit around the Sun.
Read more: http://stardustnext.jpl.nasa.gov/mission/mission_history.html

Interview with Attitude Control Engineer, Kevin Gilliland

What is your role on the mission?
I'm responsible for the spacecraft's attitude, or its orientation in space. We are most often controlling to keep the antenna on Earth. Occasionally, we turn toward an imaging target or toward the Sun for more power. I'm also responsible for implementing the control for any required corrections to our trajectory.

The position of Attitude Control Engineer requires working very closely with the Navigation team. Every thruster pulse required for control makes a tiny change to the spacecraft's orbit. The Navigation Team's orbit determination task, then, requires a prediction of all of these thruster pulses.
Read more: http://stardustnext.jpl.nasa.gov/mission/interviews/KGilliland.html

Encountering a Comet
by Kevin Gilliland, Attitude Control Subsystems, LMSS
The year began with Stardust-NExT spacecraft flying by Earth in a maneuver called a "gravity assist." On January 15, the spacecraft came within 9,200 km (5,700 miles) of California as it flew by. Many interplanetary missions use an Earth gravity assist, or EGA, to change their orbit by using the Earth's gravity to accelerate the spacecraft. Our January flyby was designed to set Stardust-NExT on course to a Tempel-1 encounter in February 2011.
Read more: http://stardustnext.jpl.nasa.gov/mission/encounter_comet.html

ADDITIONAL RESOURCES –
Additional Website on 3-D:
How to Make Your Own Eye-Popping 3-D Pictures
http://www.jpl.nasa.gov/news/features.cfm?feature=528