MISSION*Makers*

National Aeronautics and Space Administration

Investigating Mission Design, Engineering and Space Exploration through Art

Investigate NASA mission design, engineering and space exploration through art and maker-based action! Creative, hands-on, gamer-inspired teams have a blast discovering and creating together...

Become a MISSIONMaker!

MISSION*Makers* Leader Guide

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PROGRAM OVERVIEW

Since the middle of the 20th century, NASA has investigated the deepest reaches of our solar system with robotic explorers. These spacecraft have unveiled the mysteries of our celestial neighborhood while pioneering invention and technology on an awe-inspiring scale. From the craft exploring our Moon, to roving robotic geologists on Mars, to the satellite communication that powers our smart-phones—and talks to space probes millions of miles from Earth, NASA's brilliant designers and engineers have propelled discovery and innovation that has impacted all of humanity.

MISSIONMakers is a robust learning package that invites learners to investigate the remarkable design and engineering behind the many fascinating NASA missions and their discoveries. Imaginations are ignited through this action-packed STEAM program that uses art and hands-on making as a vehicle for deep and lasting STEM learning. Exciting, Maker-based activities engage students in the engineering process in memorable and tactile ways. The program is scaffolded in phases to build both student knowledge and mechanical skills as they progress through the program.

Learners begin with a Guided Engineering Project inspired by OSIRIS-REx, a new sample return mission to asteroid Bennu. They engage in game-based activities to deepen their engineering awareness and critical thinking. Finally, they apply new knowledge as they tackle an Open Design Challenge to create a new NASA Discovery or New Frontiers Program mission. Throughout, engineering concepts are presented with a humanistic perspective to make technical concepts relatable. Teamwork is emphasized as it relates to the legacy and practice of invention, design and engineering.

CONTENTS (Click for Hyperlinks)

AGES

4th-6th Grades, Scalable For All Ages!

CURRICULAR TOPICS

Science, Technology, Engineering, Art, Mathematics, Design & Literacy

PROGRAM HIGHLIGHTS

- **Arts-integrated, maker-based introduction to space mission engineering & design**
- **Progress from guided engineering project to an open design challenge**
- **Build background knowledge and hands-on mechanical skills**
- **Learning reinforced by relating robotic craft to human systems**
- **Easy-to-implement lessons, teaching tools and art activities**
- **Suited to formal and informal learning environments**
- **Aligned to NGSS & CC Standards**
- **Scalable for all ages**

PROGRAM PHASES

MISSION*Makers* is offered in 4 phases, student knowledge is built through a sequence of experiences.

1) INTRODUCTORY POWERPOINT

(will be added after workshop)

- We are all engineers!
- Brief history of invention and engineering
- Brief history of space exploration
- Space exploration is a team effort - Mission Teams
- Mission spotlight - OSIRIS-REx [other missions to be added later]
- Engineering related to human attributes, systems and endeavors

2) GUIDED ENGINEERING PROJECT

- Guided engineering activity inspired by the OSIRIS-REX Mission (and other missions TBD)
- Team members take on roles that parallel real mission planning and management
- Easy-to-use templates create movable scale model of OSIRIS-REx spacecraft using craft supplies
- Includes kinetic elements utilizing basic mechanics and simple machines
- Builds student design and engineering knowledge while honing maker skills

3) MISSION*Makers* GAME SHOW

- Students explore engineering and instrumentation through a fun, game-based activity
- Space engineering technology relates robotic craft to human systems for accessibility
- Encourages critical thinking through Q&A format

5) OPEN DESIGN CHALLENGE

- Project-based opportunity to synthesize and apply new design and engineering knowledge
- “New Mission Planner” handout aids students in the design of a new mission
- Grounded in science goals and instrument knowledge - making with a purpose
- Incorporate an engineering solution for the new mission

PROGRAM IMPLEMENTATION

1) INTRODUCTORY POWERPOINT

Found on NASA Discovery Program Design of Discovery Educator Workshop archive website

Download the Design of Discovery Introductory PowerPoint* from the NASA Discovery Program website. The presentation includes Discussion Notes to foster discussion exploring engineering, history of invention, space exploration and the OSIRIS-REx mission. The discussion also introduces the team-aspect of mission design and relates engineering technology to human activities to help make technical topics relatable. The Power Point will have links to science resources for deeper investigation in the Notes section.

** A MISSIONMakers introductory PowerPoint will be available in April on the archive site*

2) GUIDED ENGINEERING PROJECT

Found in this Leader Guide - Pages 5 - 40

Advanced prep:

- Copy the OSIRIS-REx Maker Model Handout: one/team of four
- Collect and prepare supplies for the OSIRIS-REx art project as outlined on page 6.
- Copy or print the OSIRIS-REx model templates on colored or white card stock (pages 37-39).
- Make a sample model as outlined in the Instructables found on pages 6-36: key to implementation!

Maker Day:

- Divide students into teams of four. Give each team a copy of the Maker Model Teams Handout. Assign roles or offer schema to help them decide.
- Implement the art/maker activity by following the detailed step-by-step instructions in the Instructable on pages 6-36.

3) MISSION*Makers* GAME SHOW

Found on NASA Discovery Program Design of Discovery Educator Workshop archive website

Download the MISSIONMakers Game Show from the website:

- Implement the Game Show based on the instructions found in the Notes section of the Power Point which includes both detailed instructions and Q&A prompts to guide the Game Show.

5) OPEN DESIGN CHALLENGE

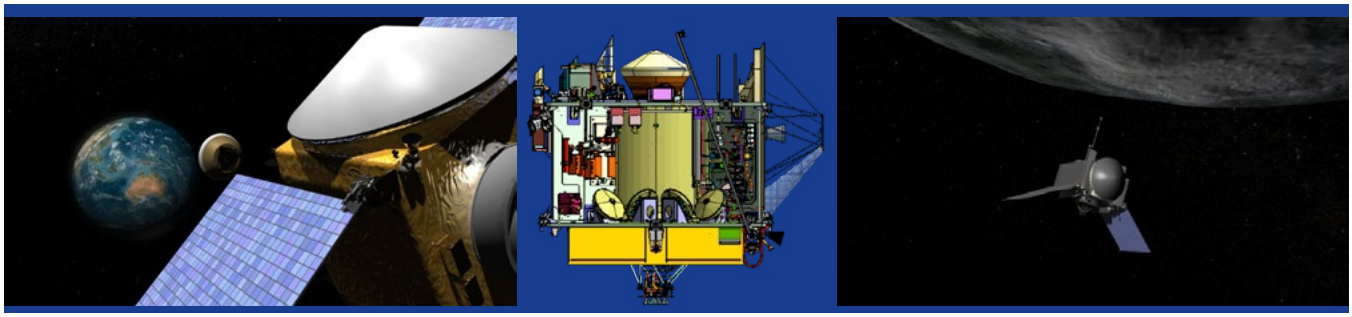
Found in this Leader Guide - Pages 40 - 44

- Implement the Open Design Challenge whereby students synthesize their knowledge to make a new mission based on instructions found on page 40.
- Print the New Mission Planner Handout to guide this process found on page 41 - 44.
- Make, show & share new missions!

LEARNING OBJECTIVES

- **Explore diverse NASA missions and the science questions that drive them**
- **Investigate innovative engineering solutions**
- **Build simple machines and moving models**
- **Experience the power of collaboration to achieve mission objectives**
- **Explore ways that data can be collected from distant worlds and the instruments that capture it**
- **Examine elements involved in engineering and the design process**
- **Discover the choices involved in mission planning and design**
- **Make with purpose**

MISSION SPOTLIGHT: OSIRIS-REx



For the Guided Engineering Project, learners experience what it means to be part of a NASA mission team through the process of building a scale model of the exciting new mission, OSIRIS-REx. Scheduled for launch in 2016, OSIRIS-REx will travel to the near-Earth asteroid Bennu, take a sample of its surface and return it home! In the Guided Engineering Project, teams make an OSIRIS-REx paper model, including a movable sampling arm, solar arrays and sample return capsule. Students model the special teaming involved in space mission design, planning and management as they make their spacecraft. Model parts and instruments are color coded to relate to mission teams to enhance learning through color association.

- **Spaceflight Engineers - Red**
- **Flight Teams - Yellow**
- **Science Teams - Blue**
- **Mission Managers - Green**

MORE ABOUT OSIRIS-REx

The Origins Spectral Interpretation Resource Identification and Security-Regolith Explorer (OSIRIS-REx) mission seeks answers to questions that are central to the human experience:

- Where did we come from?
- What is our destiny?

OSIRIS-REx is traveling to asteroid Bennu, a carbon-rich resident left from the earliest days of the solar system. OSIRIS-REx will chase Bennu down and carry samples of the asteroid back to Earth to help us understand the origins of oceans and life on Earth. Bennu is also one of the most potentially hazardous asteroids—it may impact the Earth late in the 22nd century (a long time from now)! OSIRIS-REx will determine Bennu's physical and chemical properties. This will be critical for future scientists developing a mission to minimize the effects of a potential impact.

In addition, asteroids like Bennu contain natural resources such as water, organics, and precious metals. Future space exploration and economic development will rely on asteroids for these precious materials. Asteroids may one day fuel the exploration of the solar system by robotic and manned spacecraft!

OSIRIS-REx MISSION GOALS

- **Return and analyze a sample of Bennu**
- **Document the topography, mineralogy, and chemistry of the sample site**
- **Map the topography, mineralogy, and chemistry of Bennu globally**
- **Measure the orbit variations caused by non-gravitational forces**
- **Compare observations made at the asteroid to Earth-based observations**

www.asteroidmission.org/

OSIRIS-REx MISSION

Traveling to Asteroid Bennu in 2016!

- **Learn about Near-Earth asteroids**
- **Collect samples and return them to Earth**
- **Take pictures & make maps of this unique small world**

OSIRIS-REx Maker Model Teams Handout:

Students break into the following teams to make their OSIRIS-REx Models

TEAM	INSTRUMENTS	JOB/PURPOSE
Spacecraft Engineers	**Responsible for the spacecraft body**	**The skeleton, skin and muscles**
1 student	Bus	Body that holds and carries equipment & instruments
	SRC: Sample Capsule Return	Capsule that houses samples to return to Earth
Flight Teams	**Responsible for power and energy**	**Driving the spacecraft**
1 student	Thrusters, Mount & Base	System used to move and maneuver the spacecraft
	Solar Arrays	Energy collection to power the spacecraft with sunlight
	GN&C & LIDAR: Guidance, navigation and control with light detection and ranging camera	Gathers information for safe navigation and 3-D modeling at Bennu
Science Teams	**Responsible for the science payload**	**The eyes, ears, hands & voice of the spacecraft**
1 student	TAGSAM: Touch and Go Sample Acquisition Mechanism	Special robotic arm that collects samples of Bennu's surface
	HGA: High Gain Antenna	Two way communication with Earth
	OCAMS: OSIRIS-REx Camera Suite	3 Camera Systems: • PolyCam - an 8" telescope • MapCam - maps the asteroid in 4 colors and provides high resolution images of the sample site • SamCam - documents the sample acquisition
	OVIRS: OSIRIS-REx Visible and Infrared Spectrometer	Measures reflected light • Looks for minerals and organic elements
	OTES: OSIRIS-REx Thermal Emission Spectrometer	Measures energy emitted by Bennu • Create maps to help team choose a landing site
Mission Manager	**Responsible for managing project**	**Special operations and spacecraft assembly**
1 student	Project Manager and Trouble-shooter	• Collects materials • Helps with hot gluing • In charge of assembling instrument parts to bus