Family Space Day Overview - Robotics

Family Space Day is a three hour event. The activities are set up so that children and their parents can select the order in which they undertake activities. Parents and children are encouraged to learn, play, and explore *together.*

Objectives of the Day

Children will:

- learn about some of the types of robots being used in the space program, and how they are being used.
- learn how robots help NASA's science missions.
- use robots to undertake tasks, just as NASA scientists and engineers do!

Activities

- Station 1: Driving Over Distances
  Children learn the difficulties of maneuvering a rover from a remote location by directing a rover through obstacles while watching it on a monitor.

- Station 2: Robotic Arms
  Children discover the challenges that astronauts face while completing an EVA mission on the International Space Station by guiding a robotic arm.

- Station 3: Make Your Own Robotic Rover
  Children learn about rovers while building their own!

- Station 4: What Can My Rover Do?
  Children learn about the capabilities of rovers as they design and create instruments to place on their rovers using craft items.

- Station 5: The Robot in Me!
  Children synthesize the information they have learned through the activities to imagine and illustrate a human-sized humanoid robot of their own.

- Station 6: Coloring Sheets and Games
  Children relax and color and play simple games related to robotics.

- Station 7: Reading Room
  Children and their parents browse and read a selection of books about robotics (refer to book list for suggested reading).

Other Materials

- *Facilitator Information* – Robotics
- *Explore Robotics* – Book and Website References
- *All About Robotics* – A Robotics Fact Sheet

Facilitator Information

(All you need to know about Robotics to survive the day)

Robots are used for several different tasks. They help us achieve complicated tasks. They provide the first information about places of which we know little. They explore remote places that are too far for people to go at this time. They explore places that may be dangerous for humans. Robotic missions are exploring all over our solar system right now! Satellites are orbiting the Moon, Mars, Saturn, and Mercury. Spacecraft are on their way to Pluto and beyond into the Kuiper Belt, and are exploring the very edge of our solar system.

Mars Rovers – Robots Help Scientists Explore Mars!

NASA's twin robot geologists, the Mars Exploration Rovers, landed on Mars in January 2004 to begin their search for answers about the history of water on Mars. Other robots have visited Mars, including Viking 1 and 2 in the 1970's and Pathfinder (and little Sojourner) in the 1990's. New robots bring different capabilities and new engineering and technology to address the evolving questions of science.

The Mars Exploration Rover mission is part of NASA's Mars Exploration Program, a long-term effort of robotic exploration of the red planet. Robots include orbiting space craft, landers, and rovers. The main goal of the Mars Exploration Rover mission is to search for and characterize a wide range of rocks and soils that hold clues to past water activity on Mars. The rovers went to sites on opposite sides of Mars that appear to have been affected by liquid water in the past.

The landings were spectacular! After the airbag-protected landing, the craft settled onto the surface and opened, and the little robots rolled out to take panoramic images. These real-time images give scientists information they need to select promising geological targets that tell part of the story of water in Mars' past. Then, the rovers – instructed by the scientists on Earth - drive to those locations to perform on-site scientific investigations. The original goal for each rover was to drive up to 40 meters (about 44 yards) in a single day, for a total of up to one 1 kilometer (about three-quarters of a mile). Both goals have been far exceeded!

Moving from place to place, the rovers perform on-site geological investigations. Each rover is sort of the mechanical equivalent of a geologist walking the surface of Mars. The mast-mounted cameras are 1.5 meters(5 feet) high and provide 360-degree, stereoscopic, humanlike views of the terrain. The robotic arm is capable of movement in much the same way as a human arm with an elbow and wrist, and can place instruments directly up against rock and soil targets of interest. In the mechanical "fist" of the arm is a microscopic camera that serves the same purpose

as a geologist's handheld magnifying lens. The Rock Abrasion Tool – the RAT! - serves the purpose of a geologist's rock hammer to expose the insides of rocks.

The International Space Station – Robots and Humans Working Together

To build and maintain the International Space Station, astronauts work in partnership with a new generation of space robotics. The space shuttle's mechanical arm and a new space station arm operate both as "space cranes" to precisely maneuver large modules and components and also as space "cherry pickers" to maneuver astronauts to work areas.

The shuttle's Canadian-built mechanical arm has been enhanced with a new "Space Vision System" (SVS) that helps the operator literally see around corners. The SVS allows the shuttle arm to be operated with great precision even when visibility is obstructed. Astronaut Nancy Currie, with her view partially obstructed, used the mechanical arm to attach the first station component, the Zarya Control Module, to the second component, the Unity Connecting Module.

Canada also has provided the new station mechanical arm. Called the Space Station Remote Manipulator System (SSRMS), or Canadarm2, the 55-foot-long arm has the capability to move around the station's exterior like an inchworm.

Two other robotic arms will be on the International Space Station. A European Robotic Arm (ERA) built by the European Space Agency will be used for maintenance on the Russian segment of the station and the Japanese laboratory module will include a Japanese robotic arm that will tend exterior experiments mounted on a "back porch" of the lab. In addition to mechanical arms, other robotics that may be used aboard the station include a free-flying robotic camera that will be used to inspect the exterior of the station, including the solar panels.

Robonaut

NASA is also working on the development of a robot astronaut called Robonaut, a humanoid robot. The Robonaut may eventually function just like an EVA astronaut. While Robonaut jumps generations ahead, it still keeps a human operator in the loop. The challenge engineers face is to build machines that can help humans work and explore in space. Working side by side with humans, or going where the risks are too great for people, machines like Robonaut expand our ability for construction and discovery.

Driving Over Distances

Robots are the eyes of scientists. They allow scientists to see, sample, and learn about places that scientists can't directly explore yet – like Mars. Directing a robot is challenging; the science team has to decide what they want the robot to do, then upload the commands in the computer, then wait while the commands are transmitted across space. The robot then carries out the command and transmits the result back to the science team. Each step has to be carefully planned. Sometimes surprises happen - the robot gets stuck unexpectedly, or a piece of equipment malfunctions - and the science team has to figure out how to troubleshoot the problem.

Your child will attempt to move a "rover" while watching it on a monitor, and have it go around obstacles to arrive at a destination.

What You Need:

- One remote-control "rover" (a remote-control vehicle can be made to look like a "rover" by removing the vehicle's casing).
- Video camera
- Monitor for video display
- Planet Surface: A area 10x10 or larger for rover to maneuver remotely
- Several obstacles (blocks, boxes, parking cones, thin pillows, etc.)
- Several sheets to cover the obstacles to make the surface look like a planetary surface
- Rocks
- 4 sheets bright cardstock, mark one North, one South, one East, and one West
- Plastic or cardboard displays for standing the cardstock upright
- Mission Control: A separate area where the video monitor and rover remote-control are accessed by the children

What To Do:

- Set up the Planet Surface. Scatter several obstacles for the rover to maneuver around and over on the floor. Cover loosely with sheets. Scatter rocks on the surface. Set up the video camera so that it observes the planet surface area. Place the directional markers on the surface so that they are standing up facing the video camera.
- Optional: create a scoop for the rover front (similar to a bull-dozer bucket) that will allow the rover collect rocks. Place rover on the planet surface.
- Create a mission sheet in which obstacles are named and described (example below) that has directions for the children to go in a particular order from one to another.

- Set up Mission Control so that the video signal displays the planet surface. Install the remote control for the rover.
- Invite your child to watch the "rover" move for awhile on the Planet Surface. Observe the general landscape across which it is moving.
- Invite your child to go to Mission Control. Have them practice using the remote control while watching the rover on the screen.
- Maneuver the rover through the obstacle course from the start to the end point with the remote-control and by viewing the rover on the screen only.

Example Mission Sheet

Goal: Learn about the features on the planet surface. The stationary lander has a video camera that will watch the rover as it moves over the surface.

Command Set 1: Send your rover to the tallest feature on the landscape. How tall is it compared to your rover? (The same height? Twice as high? Other?)

Command Set 2: Move the rover north to the low hill. Mission specialists agree that the slope should be low enough for the rover to go over it. However, they don't know if the hill is firm or soft. Send the rover over the hill. Is it firm enough to support the rover?

Command Set 3: Send your rover to the rock pile to the west. Collect a sample. Return to the lander video camera to get a close-up view of the rocks. What do they look like?

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Parent Prompts:

Is it more difficult to control the rover watching the screen than it would be if you were next to the rover?

What was hard to do? Easy? Were there any problems that the rover encountered?

After doing this, what type of challenges does your child think that scientists face in conducting robotic missions on other planets?

Robotic Arms

Humans pick things up without thinking about the steps involved. In order for a robot or a robotic arm to pick up or move something, someone has to tell it to perform several actions in a particular order — from moving the arm, to rotating the "wrist" to opening and closing the "hand" or "fingers."

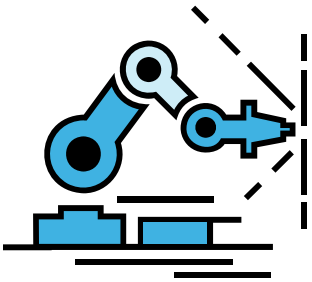
Astronauts that use robotic arms to do things in space need to practice simple tasks here on Earth first. Scientists working with robots on other planets design them to know the best procedure to use their arms.

Your child will explore the steps involved in using a robotic arm to pick up, move, and drop an object into a cup.

Note: this activity was written for the Armatron / Radio Shack Robot Mechanical Arm, which is no longer for sale. Products, such as the Lynx 5 Programmable Robotic Arm Kit by Hobitron (http://www.hobbytron.com/lynx-arm.html?AID=10289758&PID=2224652) or a remotely controlled toy can be used with modifications.

What You Need:

- A robotic arm
- Fuzzy pom-poms or candies on a plate
- A paper cup



What To Do:

The joystick on the left operates the "elbow" and your child can manipulate the hand by turning the knob on top of the stick. The joystick on the right operates the "shoulder".

- Ask your child to test each of the motions on the robotic arms by moving the knobs and sticks, one at a time.
    - What do they need to do to open and close the "hand" or clamp?
    - How can they move it to the left or right?
    - How can they move it up and down?
    - Ask your child to move the arm and hand so that the robotic arm picks up the fuzzy pom-pom or a piece of candy.
    - Finally, your child can move the arm over his/her cup, and drop the pom-pom or candy into the cup.

Parent Prompts:

How many steps did it take you to pick up and move the object to the cup?

Why do astronauts practice using the robotic arm?

How easy or difficult would it be to unscrew a screw,
or to tie something together using the robotic arm?

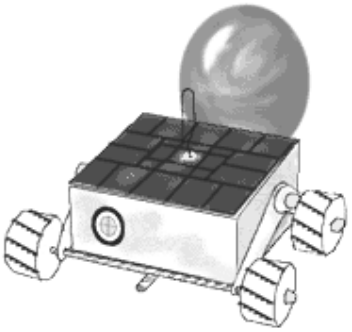
What kind of tasks might astronauts or scientists perform with a robotic arm on the space station or on another planet?

Make Your Own Robotic Rover

Why send robots to another planet? NASA is not yet ready to send humans to Mars or other planets—we need to learn more about the conditions to prepare for visiting and working in these places. Orbiting spacecraft, probes, landers, and rovers help scientists and engineers SAFELY gather data about the temperatures and radiation and resources that occur on a planet's surface. They help us test our technology for getting to, and living on, other planets and moons. Sending robots is less expensive than sending a human mission and more efficient for the initial exploration. Once the robots have provided the initial information, humans are better prepared to follow and learn more than robots can do alone. Space exploration is about humans and robots working together.

You and your child will learn about the different parts of a rover as you build one out of various craft items.

What You Need:



- One Chinette plate
- Two wooden dowels
- Four wooden spools
- Pea-sized blobs of white clay or Play-doh©
- One party balloon
- Tape
- Pencil
- Scissors
- Lots of patience and, maybe, a grown-up (or teen) assistant!
- Demo model

What To Do:

- Cut a rectangle out of the chinette plate – this will be the body of your rover.
- Place two of the wooden spools onto each of the two wooden sticks.
- Cover the ends of the sticks with the Pea-sized blobs of white clay or Play-doh© (hubcaps), to keep the spools (wheels) from coming off the sticks.
- Move the wheels toward the ends of the sticks and place another blob of the clay in the center of the stick – this will act as glue for the rover template.
- Stick the template to the wheel axel (sticks) by pressing the plate to the center blob of clay (see Demo model).

What To Do (cont'd):

- Tape the party balloon to one end of the rover and inflate the balloon. Release the air to make the rover move.
- Test how well it moves around the landscape.

Parent Prompts:

What is supplying the power to the rover?

What does a robotic rover need to have in order to move?

Why would we want to send a rover to another world?

What Can My Rover Do?

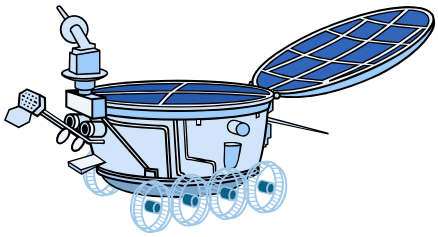
The Mars Exploration Rover (MER) robots are the largest rovers to ever successfully land on another planet. NASA designed the MER robots to act as robotic geologists. The instruments packed into the rovers are primarily designed to look at the rocks and minerals to tell us more about their composition and how they formed. Here are some of the instruments that help the MER rovers in their mission:

- Cameras that let them take color, stereoscopic (3D) images of the landscape
- Thermal-emission spectrometers that give measurements about how hot surfaces are
- Three pairs of black-and-white cameras on the front, back and mast of the rover to help the robot see its surroundings and navigate around obstacles
- Rock Abrasion Tools - or RATs - mounted on a small arm, to bore into a rock to collect samples
- Magnifying cameras, mounted on the same arm as the drill, so that scientists can see the rock up close
- Mass spectrometers that determine the compositions of minerals in rocks
- Magnets to attract iron-bearing sand particles. The particles stick to the magnets and scientists look at them with the cameras or analyze them with the spectrometers.

Now it is your turn! You have designed a rover and experimented with its capabilities. Add instruments to your rover. These items will make the rover capable of doing many things to help explore a planet!

What You Need:

- Various craft items
- Tape
- Glue



What To Do:

- Using the various craft items available, design instruments that can be placed on your rover to help in its mission. Be sure to determine what each instrument is supposed to do!
- Using tape or glue, place the items on your rover.

Parent Prompts:

Where will the rover be working?

What is the rover's mission—what science is it doing?

What instruments does it need to do its job?

The Robot in Me!

Robots come in different shapes and sizes, and are designed for different purposes. A robotic vacuum cleaner looks very different from the Mars rovers, *Spirit* and *Opportunity*, and yet they are both robots.

After completing the other activities with your child today, your child can synthesize the information they have learned to create a robot of their own. Discover how your child pictures a robot, and the parts that go into a working robot.

What You Need:

- Butcher Paper
- Markers or Crayons
- Craft items (optional)

What To Do:

- Have your child lie down on the butcher paper, so that you can trace his/her outline.
- Then ask your child to illustrate the parts of their robot:
  - Parts to make the robot work properly (power source, computer processor, communications devices to receive instructions and share information)
  - Instruments for action (for moving, for measuring, for lifting or carrying, for collecting, for "seeing" and sensing, etc.)
- Help your child label the different parts and what they do.

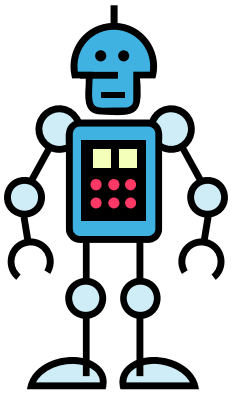
Parent Prompts:

What type of work would you like your robot to do?

Where would you like your robot to work?

Why is it good to have a robot for this task?

What else does your robot need to do its job?



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Coloring Pages and Games

Mars Rover
http://astrogeology.usgs.gov/Kids/Activities/ColoringandActivitySheets/

Mars Word Find
http://space.about.com/od/puzzles/ig/Word-Search-Puzzles/Mars-Word-Search-Puzzle.htm

Robot Word Find
http://www.sciencenewsforkids.org/articles/20040421/wordfind.asp

Mars Rover
http://www.edupics.com/en-coloring-pictures-pages-photo-11-mars-expedition-i4191.html

Space Robot
http://www.edupics.com/en-coloring-pictures-pages-photo-13-space-robots-i4193.html

Robot
http://www.kidscolorpages.com/robot.htm

Robot Word Pieces Puzzle
http://www.enchantedlearning.com/alphabet/wordpieces/robot/

Explore Robotics!

Websites

http://electronics.howstuffworks.com/robot.htm
Visit this site to learn how a robot works and the similarities between robots and humans.

http://homeschooling.gomilpitas.com/explore/robots.htm
Learn about all aspects of robotics through the links on this site. There is a link that offers instructions on making your own nanorover. Another link provides tips and advice about teaching robotics to home schooled children.

http://robonaut.jsc.nasa.gov/
Visit this site for the latest information on NASA's current "Robonaut" project. Learn how NASA designed the human-like robot as well as how is functions.

http://robotics.nasa.gov/
Robotics Alliance Project: This site offers information on Robotics Summer Camps, Courses as well as other great opportunities for middle school and high school students. There is also a virtual astronaut school that is good for all ages.

http://news.bbc.co.uk/cbbcnews/hi/newsid_3910000/newsid_3914100/3914167.stm
Good BBC site for kids to investigate what a robot is, robot gadgets and toys, robots in films, robots in space and more.

http://moon.msfc.nasa.gov/
The Lunar Precursor Robotic Program oversees robotic missions to the Moon that are helping us prepare the way for humans to live and work there.

http://nasascience.nasa.gov/planetary-science/mission_list
Check out all the robotic missions – past, present, and future - working across our solar system!

Explore Robotics!

Books

Robotic Scorpion, Stewart, Silver Dolphin Books; Book & Toy edition, 2004, ISBN: 1592232116.
The author introduces budding scientists to the field of biomimetics, the science of creating machines or materials by copying nature.

The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects, McComb, Tab Books, 1987, ISBN: 0830628002.
This is a collection of tested and proven projects that can be mixed and matched to create a wide range of highly intelligent and workable robot creatures.

Robotics: How They Work and What They Can Do, Vowles, Penworthy Pub Co, 1985, ISBN: 0876170092.
This book discusses different kinds of robots, how they work, how they are being used in industry and research, and what may lie in the future for robotics.

Robots, Bergin, Franklin Watts, 2000, ISBN: 0531148084.
Children will learn what robots are, how they function and what they are used for.

Robots, Gifford, Kingfisher Books Ltd., 2003, ISBN: 0753408422.
This book introduces children ages 9-12 to robots and all of the things that robots are capable of. Great illustrations accompany the text.

Robots: What They Are, What They Do, Berger, Greenwillow, 1992, ISBN: 0688098630.
Berger discusses the beginnings of robots to the current robots. This book could get children ages 4-8 interested in technology.

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All About Robotics

- There are many benefits to using robots instead of humans. Can you imagine working in a factory all day, every day, doing the exact same thing over and over again?
- Robots can be used in situations that may be – or are - hazardous for humans and robotic missions are less expensive than human missions. Because of these factors, robots are idea for gathering information about remote locations so that we can select those of interest and prepare for humans to visit.
- There are things that humans can do that robots cannot. Humans can make rapid assessments of their surroundings and decide what needs to be done first, second, and third – or what does not need to be done. Robots need to be programmed for each and every step; robots are the tool - humans still have to make the determinations.
- The good thing about robots is that they will never get bored, and they will do things more efficiently than people. Also, robots never get sick, or need to rest. This means they can work for 24 hours a day, 7 days a week.
- Robots can be made from a variety of materials including metals and plastics.
- The hardest thing for a robot to do is to walk. This is hard for the creators of the robot as well, since the act of walking involves hundreds of specific motions.
- Some real robots must walk on uneven surfaces, like the surface of Mars, so these robots need sensors in their legs to find good footholds!
- Most robots usually have at least 3 main parts that work together for the robot to operate: 1) the Controller, also known as the "brain" which is run by a computer program; 2) mechanical parts; and 3) sensors to tell the robot about its surroundings.
- Several robots have been sent to Mars, including the Viking Landers, Pathfinder, and the Mars Exploration Rovers. These robots collect soil, rock and atmosphere samples, analyze them and then send the data back to Earth.
- Lots of robotic spacecraft are operating across our solar system, around the Moon, Mars, Mercury, Saturn, on the way to Pluto, and even beyond. They are collecting information to help us understand what our solar system is like and how it formed, and to help us prepare for future exploration.
- Robonaut is a humanoid robot. It looks like an astronaut, is highly mobile, and has a large range of motion in its sensor-covered “hands.” Robonaut is intended to perform many of the mechanical functions of astronauts.

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