NOVA

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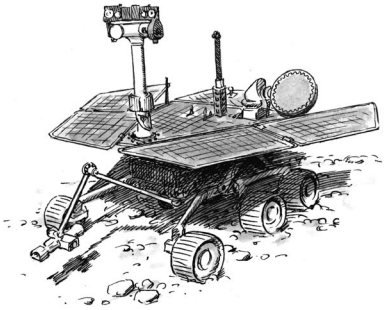
Welcome to Mars

PROGRAM OVERVIEW



NOVA follows the day-to-day operations of the Mars Exploration Rover team as it experiences hurdles, decisions, triumphs, and disappointments during its explorations of the Red Planet.

The program:

- recounts the scientists' first obstacle: maneuvering around an airbag that blocks Spirit's direct descent off its lander.
- reports on Spirit's sudden silence just before it is about to make its first measurement.
- follows team efforts to diagnose and repair the Spirit rover, and the resulting discovery that the robot's flash memory is filled with too many old files.
- chronicles Opportunity's landing, a period of six minutes during which automated parachutes and airbags must all work perfectly to safely land the rover.
- describes scientists' primary reasons for the missions: to find out whether Mars ever had the liquid water required for life (as it is currently understood) to exist.
- notes Opportunity's fortune in landing in a shallow crater just a few feet from a bedrock outcropping with exposed layers of rock.
- documents how scientists used Opportunity's spectrometers to identify minerals such as hematite and elements such as sulfur, and used its microscopic imager to obtain close-up views of the rocks and soil that revealed round objects the size of ball bearings that they nicknamed "blueberries."
- reports on how scientists decided which rock to drill into with Opportunity's Rock Abrasion Tool.
- outlines the challenges of working on martian time—because a Mars day is 40 minutes longer than an Earth day, rover team members must shift their schedules by 40 minutes each day.
- follows Spirit's explorations of Gusev Crater, noting that much of the crater contained basalt, the most common type of lava.
- states how the evidence found by Opportunity—the round concretions, the discovery of hematite and sulfate salts, and the surface ripples—points to the first proof of liquid water on another planet.

BEFORE WATCHING

1 Find a map of Mars and help students locate where on Mars each of the rovers were directed to land (Spirit was sent to Gusev Crater, Opportunity to Meridiani Planum). What do students notice about the geographical features of each landing site?

2 Organize the class into six groups. Assign three groups to take notes on one of each of the following categories: problems Spirit encountered, how those problems were addressed, and what the rover discovered. Have the other three groups take notes on one each of the same categories for Opportunity.

AFTER WATCHING

1 List each rover and its landing site on the board. Have members of each team contribute examples of the problems each rover confronted, how the scientists worked to solve the problems, and what each rover discovered. How did scientists go about solving problems that arose? What findings surprised scientists?

2 Discuss the evidence scientists found regarding whether an environment that could have supported life on Mars ever existed. Why are scientists interested in learning about this?

CLASSROOM ACTIVITY

Objective

To learn more about some of the scientists and engineers involved with the Mars Rover mission and to find out how to begin identifying and exploring career interests.

Materials for each team member

- copy of the "Who Works with the Rovers?" student handout
- access to print and Internet resources

Procedure

1. Several hundred people helped support the Mars Exploration Rover missions. Who are some of the people that assisted in the missions' success? How did they get from being middle and high school students to exploring Mars? Students will think about these questions and career interests of their own in this activity.
2. Ask students to name the kinds of careers they think are involved with the Mars rover mission. Write their answers on the board. Discuss the kind of team it takes to make a mission like this work. (You may want to note to students that in addition to the many different kinds of scientists and engineers that are part of the Mars mission, there are also many other types of jobs that are directly involved with or support the operation. See Activity Answer on page 4 for more information on these careers.)
3. Copy and distribute a handout to each student. Have students read the brief biographies of four of the scientists and engineers who were involved with the Mars Exploration Rover mission.
4. Discuss the biographies with students. What skills and interests do students think each job requires? If students don't mention it, point out that some of the scientists knew they wanted to study science or engineering when they went to college while others were pursuing other interests and eventually moved into science or engineering.
5. Tell students that determining a career is a process that happens over time. Although some students may know what field or career they want to enter, many will need to learn over time what vocation they would like to pursue.

STANDARDS CONNECTION

The "Who Works with the Rovers?" activity aligns with the following National Science Education Standards.

Science Standard G:
History and Nature of Science
Science as a human endeavor

- Women and men of various social and ethnic backgrounds—and with diverse interests, talents, qualities, and motivations—engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, some work alone, but all communicate extensively with others.

- Science requires different abilities, depending on such factors as the field of study and type of inquiry. Science is very much a human endeavor, and the work of science relies on basic human qualities, such as reasoning, insight, energy, skill, and creativity—as well as scientific habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

Science Standard G:
History and Nature of Science
Science as a human endeavor

- Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Doing science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem.

Video is not required for this activity.

Classroom Activity Author
Developed by WGBH Educational Outreach staff.

CLASSROOM ACTIVITY

6 Have students interview five people they interact with who are involved in a career (i.e., their caregivers, siblings of their friends, people in their neighborhoods) and have them answer the following questions:
- What does your job entail?
- What training, if any, does your job require?
- What job tasks do you like best? What tasks do you like least?
- How did you choose your career? Who or what inspired you to first consider your career?
- What did you start out doing after high school? How, if at all, has your career path changed over time?
- If you had it to do over again, what, if anything, would you do differently?
- What advice would you give to someone starting to think about choosing a career?

7 Assign students to teams to discuss the jobs they learned about. Have each team choose two or three careers from its pool of careers and share with the class what the jobs entail and what skills are necessary for the jobs.

8 Make a list on the board of each of the careers mentioned. What did students learn about the types of jobs that are available? What, if anything, surprised students about what they learned? How many of the people interviewed were in the same career they started out in after high school? Of the careers listed on the board, which are of interest to students? Have each student pick one career on the board, or one other they are interested in, for additional research.

9 Have students use print and Internet research tools to find out more about their career choice, including what the job entails, what education and training is needed, the kinds of organizations that employ the position, the missions of the organizations, the typical salary range, the demand for the job, and where geographically the job can be found.

10 To conclude, discuss what students learned in their research. Point out to students that within many vocations there are often varying levels of expertise needed that require different levels of education.

11 As an extension, ask students what they would like to do next to learn more about the career choices they investigated, or other new career choices. Students may be at different points in their career exploration and be interested in different aspects of career discovery. Some students may be ready to take skills, personality, and interests tests; others may just want to find out what careers are available in certain geographical areas; others may want to explore how to pay for continuing education. Design the next steps for career investigation according to students' interests (see Links and Books on page 4 for some career resources.) Note to students that finding a career can be a lifelong process that is constantly refined by new experiences.

ACTIVITY ANSWER

Students might think that most of the people involved in the Mars missions are scientists and engineers. But the team needed to successfully plan, implement, and report on a mission to Mars is much more diverse. Among the many team members are scientists who choose what the rovers should study, engineers who help plan and build the rovers, computer scientists who write programs that run the rovers, mission control specialists who launch and control the vehicles, public relations professionals who provide accurate information to journalists and others, education specialists who write lesson plans, and many, many more. Scientists representing many disciplines are involved with the mission, including such areas as astronomy, astrobiology, atmospheric science, geochemistry, geophysics, meteorology, and planetary geology. In addition, many different kinds of engineers are needed, in such areas as electrical, mechanical, aerospace, robotics, safety, systems, and software engineering, to name a few. Many technicians are also necessary to help the scientists and engineers do their jobs. And supporting all of these people are numerous administrative staff who help ensure the project stays on track.

LINKS AND BOOKS

Links

NOVA Web Site—Welcome to Mars
www.pbs.org/nova/mars/
In this companion Web site to the NOVA program, learn why water is necessary for life, investigate the rovers' parts, take a visual tour of the rovers' most revealing discoveries, design your own parachute, and more.

America's Career InfoNet
www.acinet.org/acinet/
Presents wage and employment trends, occupational requirements, and state-by-state labor market conditions.

The Career Key
www.careerkey.org/english/
Provides a career guidance test, ways to identify job skills, and help on job search strategies and networking.

Engineering and Science Career Resources
www.khake.com/page53.html
Includes information such as daily activities, skill requirements, salary and training required for a variety of science and engineering jobs.

JobStar Central: Career Guides
jobstar.org/tools/career/career.cfm
Offers online career tests, guides to career resources in libraries, and guidance for specific careers across many disciplines.

NASA Quest's Biography and Journal Locator
questdb.arc.nasa.gov/bio_search.htm
Choose job titles or occupations from a list and search for current NASA biographies and journal entries from people currently doing those jobs.

NASA's Mars Exploration Program: People
marsprogram.jpl.nasa.gov/people/
Provides links by state to team members involved in all Mars missions.

Occupational Outlook Handbook
stats.bls.gov/oco/home.htm
Describes what workers do on the job, working conditions, the training and education needed, earnings, and expected job prospects in a wide range of occupations.

The Princeton Review: Career
www.princetonreview.com/cte/
Includes a personality test, career quiz, information on creating a career path, and more.

School to Careers
www.careers.iptv.org/about.cfm
Introduces students to career professionals, projects and ideas.

Books

Fellman, Wilma.
Finding a Career That Works for You.
Plantation, FL: Specialty Press, 2000.
Provides ways to match interests, aptitudes, personality, and goals with choosing a career and provides practical tips on how to find a job in a chosen field.

Reeves, Diane Lindsey.
Career Ideas for Kids Who Like Science.
New York: Facts on File, 1998.
Describes 15 science careers and provides advice on how to choose a career direction.

Weiss, Jodi and Russell Kahn.
145 Things To Be When You Grow Up.
New York: Random House, 2004.
Profiles 145 professions and offers information on high school activities, college majors, and work experience that will help students achieve their career goals.

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Who Works with the Rovers?

So what does it take to be part of a team that studies Mars? The Mars Exploration Rover team is made up of men and women who have a range of different skills, interests, and paths that led them to their jobs. On this page you can read a little bit more about four of the many scientists and engineers who got to study Mars on the recent Spirit and Opportunity Mars rover mission. Then you will take some time to explore what some other people you know do for work before investigating some career interests of your own.

Cindy Oda *Software Engineer, Mars Exploration Rover*

Cindy helped develop some of the rover's software. The code she wrote was used to allow the rover to communicate with Earth.

Upon entering college, Cindy wanted to pursue either business or engineering. When she started taking computer science courses, she found she enjoyed the mentally challenging aspects of programming as well as the creative aspects of designing well-written code.

Cindy thinks it's important to try to get experience in areas that interest you while you are still going to school. She notes: "It's important while you're still in the deciding process to take the time to try different things to see whether that's what you want to do."

Steve Squyres *Scientist, Mars Exploration Rover*

Steve was in charge of the rovers' science payload, which means all the science instruments on board. His science goal was to find out whether Mars ever had an environment suitable for life.

While a geology major, Steve took a course on the Mars Viking mission results. The course made him realize that he wanted to be involved in space science, which he has focused on ever since.

Steve gives this advice to young scientists or engineers: "There is no substitute for persistence. You must get all the training you need, and you must do well at it . . . that's a given. But in order to succeed in this business, the most important thing is to not let setbacks stop you."

Stephen Gorevan *Engineer, Rock Abrasion Tool*

Stephen was in charge of the design for the Rock Abrasion Tool, or RAT, that was used on Mars to sample inside martian rocks to look for signs of past life.

Initially, Stephen was interested in studying music. Over time, however, he became more interested in the instrument he played—the piano. "Instead of being interested in playing the piano, I found myself becoming more interested in how the piano worked!" he says.

Stephen thinks that having an engineering degree from college may be the best way to become involved in the space program. "I understood (finally) that I loved understanding how machines worked and that it was logical for me to become an engineer and actually design machines."

Tracy Neilson *Engineer, Fault Protection Team*

Tracy worked on designing the fault protection system, which helps put the rovers in safe mode when things go wrong.

After high school Tracy worked as a secretary in a real estate and property management company. She decided to pursue accounting in college, but because all the accounting classes were filled up she ended up in an engineering drawing class. "I really liked it," she says, "and the engineering classes were always available, so I stuck with it."

Tracy points out that it's not just engineers and scientists who work for NASA. "We are teachers, accountants, lawyers, secretaries, public outreach experts, camera operators, managers, students, physicists, and more," she notes. "And everyone contributes to the success of a mission. If you are enthusiastic about being a space explorer, we need you."

Sources:
Meet the Men and Women of NASA
quest.arc.nasa.gov/people

NASA Zip Code Mars
zipcodemars.jpl.nasa.gov/

Personal communication