DESIGN challenge

To execute a mini-simulation of a robotic mission with a goal to command a human-robot through a set course to retrieve a piece of lunar ice.

OBJECTIVE

Students will demonstrate an understanding of the Engineering Design Process while utilizing each stage to successfully complete a team challenge.

PROCESS SKILLS

Mapping, communication, measuring, graphing, logical thinking

MATERIALS

Rulers or meter sticks

Blindfolds

"Prize" as lunar ice sample

STUDENT PAGES

Ask, Imagine and Plan

Experiment and Record

Quality Assurance Form

Fun with Engineering at Home

PRE-ACTIVITY SET-UP

Set up a small obstacle course with a few chairs, waste paper baskets, and/or a table. The course does not have to be too complicated, but set it up so students will have to take at least one right turn and one left turn. Also, give the students enough obstacles so there is more than one path to take to the "finish". An area of about 25 square meters is recommended.

Please note: This activity will require two 60-90 minute sessions to complete. Make sure to set up the obstacle course exactly the same for both sessions. Also, student acting as the robot will need to be blindfolded for this activity. *Please take time to discuss with your students about assisting or "spotting" their blindfolded peer.*

MOTIVATE

- Many of NASA's missions are conducted by robots. While some robots can make decisions based on data received from sensors, humans must program the robots - we tell robots what to do and how to execute their missions.

SET THE STAGE:

ASK IMAGINE **& PLAN**

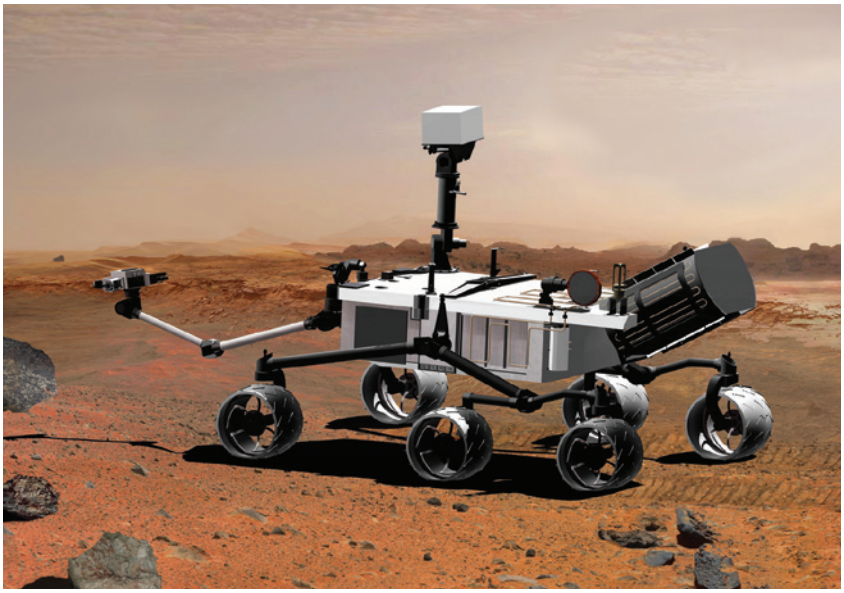
- Share the *Design Challenge* with the students.
- First, have students draw their chosen course on the map. They must include at least one right turn and one left turn. Map should be approved before proceeding to next step.
- Let students practice commands to use with their robot. These commands are simple words, plus a number for steps taken.

CREATE

- Students will identify the robot's route through the lunar landing site and count the number of steps needed for each command to calibrate the distance the robot travels on a given command. From this, a command sequence for their robot can be created, then tested on the planned route of their maps.

EXPERIMENT

- Student teams must navigate the lunar landing site, using the command sequence each team designed. Have students cut out the commands into strips of paper and designate one student per team to deliver each command. Designate another team member to run a stopwatch. Position the robots at the start and have the teams sitting or standing aside from the obstacle course. The students designated to deliver commands are to deliver one command at a time – one student walks to the robot, delivers one command, then returns to the team. Robot performs the command. The next student then walks to the robot



and delivers the command, returns, etc. Only one command is delivered at a time to represent one line of code sent over a radio signal. The rest of the team cannot deliver another command until they have determined if the robot has successfully executed that command. Have each team record how much time it takes to successfully complete the task when the robot picks up the "lunar ice".

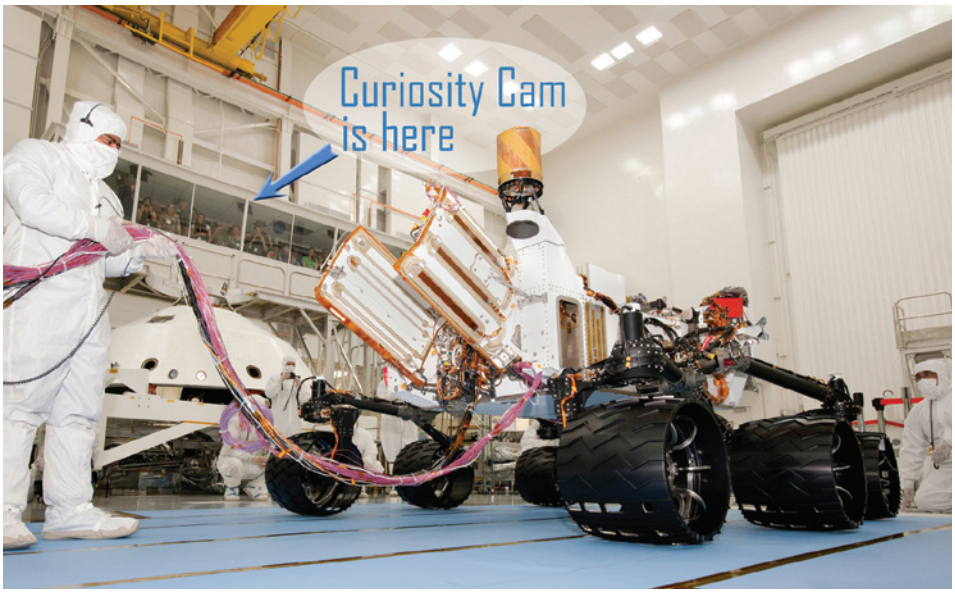
CHALLENGE CLOSURE

Engage students in the following questions:

- Did each team pick the same route or were there several routes to get to the lunar ice? Which route worked the best?
- Why did you have to deliver each command separately? How does it relate to communicating with robots in space?

PREVIEWING NEXT SESSION

Ask teams to think about how a spacecraft might land on the Moon safely. Ask them to think about why it does not make sense to use a parachute on the Moon. Answer. There is no air on the Moon to fill up the parachute.



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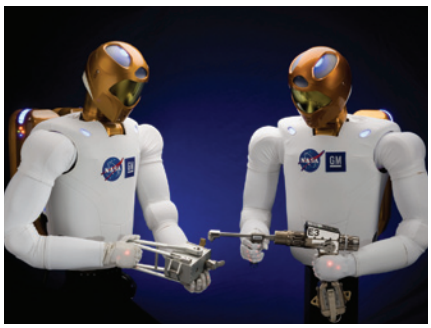
Teacher page

The Discovery Mission

Every NASA mission has several parts leading to its success. When leading a remote mission on another planet or moon, NASA scientists and engineers must plan every step of the mission carefully. When using robots or rovers, each mission team must calibrate and program these machines to accomplish the mission objective, such as to travel to certain locations on that planet or moon.



The Challenge:

Your team has been chosen to operate a robotic Discovery Mission on the surface of the Moon. You will be given a specific starting location, and your robot must move through a lunar landscape to the location of the "lunar ice" without bumping into any "lunar boulders" or other obstacles. To successfully complete the Discovery Mission, your robot must retrieve a piece of "lunar ice" for analysis.

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Student page

Before your robot begins to move on the lunar surface, you will have to complete the following activities:

1. ***Designate your robot*** *- One student per team must volunteer to be the robot. The robot is the person who actually walks through the course, blindfolded, following the instructions of her/his team. Select a name for your robot.*
2. ***Map the landing site*** *– Using the enclosed chart on page 53, create a map of the landing site, making sure to accurately measure the distances between objects.*
3. ***Learn to communicate with your robot*** *– Each team must develop commands for your robot. You will practice these commands until you and the robot are comfortable with them. These will be the commands that you will give the robot to travel through the path you have drawn on the map.*
4. ***Calibrate your robot*** *– After practicing a set of commands with your robot, you must measure the distance the robot travels with each step or command sequence.*
5. ***Program the robot*** *– Use the commands you developed to successfully direct the robot through the predetermined route based on the calibrations you made of how far your robot travels with each step.*

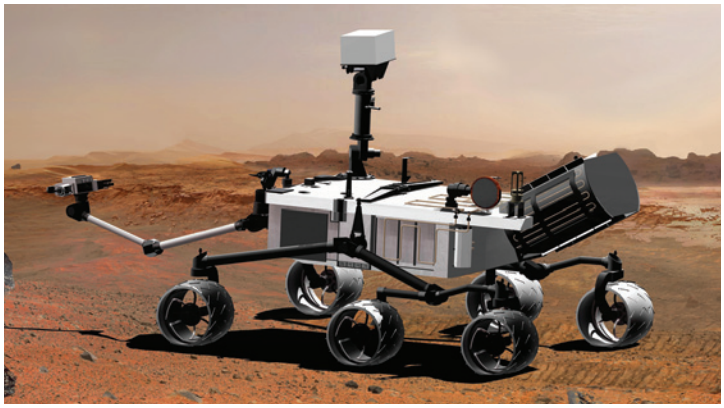
prepare for a mission

ASK IMAGINE &PLAN

What questions do you have about today's challenge?

STEP 1 – Designate a team member to be your robot and create a name for your robot.

STEP 2 – Map the landing site. Produce a map of the lunar "landing site" to plan your robot's route. Observe the site, measure the distance between objects and accurately replicate their positions in the grid on the next page. Think about the units you need to use for your measurement and what strategy you will use to make your measurement. For example, can you use floor tiles?



Create your map below. Each square represents a unit of _____.

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STEP 3 – Communicate with your robot

When you program a robot, you must use simple words and be specific in your directions. If you want your robot to go forward, how many steps should the robot go? Practice the words below with your robot and see if your robot follows the commands correctly.

Sample Command for Robot	Action by robot
MOVE FORWARD TWO STEPS	Walk forward two steps.
MOVE BACKWARD ONE STEP	Walk backward one step.
TURN RIGHT 90°	Turn to the right.
TURN LEFT 180°	Turn to the left to face the opposite direction.
BEND AND GRAB	Bend at the waist and pick up the lunar ice sample.

As a team, decide on the type of commands you want to use to program your robot. You may use the ones suggested above and create your own, but once those vocabulary terms are designated on your list, you may not use any other new commands once your robot has landed in the starting position.

Additional commands to use:

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STEP 4 – Calibrate your robot

Practice delivering forward commands to your blindfolded robot. Measure the distance traveled by the robot for each command. Repeat three times and calculate a mean. Graph your results.

	Trial 1	Trial 2	Trial 3	Mean
Forward 1 step	cm	cm	cm	cm
Forward 2 steps	cm	cm	cm	cm
Forward 4 steps	cm	cm	cm	cm
Forward 6 steps	cm	cm	cm	cm
Forward 8 steps	cm	cm	cm	cm

Can you predict how far your robot will travel in 10 steps? _____ cm

STEP 4 – Program your robot

Review the map with your team and plan a route for your robot. Based upon the calibration results, create commands for your robot to match your route. Write down one command for each slot below.

Command Sequence

1.	*11.*
2.	*12.*
3.	*13.*
4.	*14.*
5.	*15.*
6.	*16.*
7.	*17.*
8.	*18.*
9.	*19.*
10.	*20.*

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Experiment & Record

Execute the Discovery Mission!

It is time to let your Robot explore the Moon! You planned your route and practiced your commands. Now let's complete the mission. Take the complete command sequence your team designed and cut each command out of the page as separate strips of paper. Designate two team members to deliver the commands to the Robot and divide those strips of paper among them. Another team member, using a stopwatch, should time how long it takes for the Robot to reach the Lunar ice sample and successfully complete the mission. Don't forget that the Robot must be blindfolded! If the Robot makes a mistake or runs into an obstacle, the team must stop the mission, return to mission control to reconvene and discuss the issue, then modify the command sequence and resend the radio signal (strip of paper with command) to the Robot.

Record each team's time in the table below to compare how long the mission took for each team! Afterwards, pair up with another team to complete your Quality Assurance assessment.

Discovery Mission Data Table

Team Name	*Time (seconds)*
1.	
2.	
3.	
4.	
5.	

prepare for a mission

QUALITY ASSURANCE FORM

Each team is to review another team's design and model, then answer the following questions.

Name of Robot and team reviewed: _____

Did the team deliver commands to the Robot one sequence at a time? (only one radio signal per command sequence)

Did the Robot execute commands correctly?

Did the Robot reach its destination with the original set of commands?

If not, how many times did the team have to reprogram the Robot to reach the lunar sample?

List 2 or 3 recommendations you have for this team:

Inspected by: _____

_____

_____

_____

Fun with Engineering at Home

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Today you conducted a simulated, robotic Discovery Mission. You practiced many of the very same activities that NASA scientists and engineers do when planning and executing a remote exploration mission, such as mapping, calibrating, communicating and programming. Learn more about the efforts to develop a Lunar robotic rover prototype to further study the Moon:

www.frc.ri.cmu.edu/projects/lri/scarab/index.html

CHALLENGE: Recruit your family members to try a Discovery Mission at home! Rearrange some furniture or household items to set up the Lunar Landing Site. Demonstrate to everyone the steps needed to accomplish the mission – ask your teacher for new worksheets from the activity to give to your family to use. If you have a big family or are doing this with lots of friends, you could break into teams and race to the end. Just be careful and considerate of your robot, who is blindfolded. Be creative with an item to collect as a Lunar ice sample, and have fun!

YOU BE THE TEACHER! Explain to your family why it is important to map the site prior to sending a rover to retrieve a sample. Emphasize why engineers must repeat an exercise before getting repeatable results.

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