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

To 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

Design Challenge

Ask, Imagine and Plan

Experiment and Record

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, the 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

- Explain to the students that many of NASA's missions are conducted by robots. Ask students to draw their ideas of what a robot looks like and compare the differences.

SET THE STAGE:

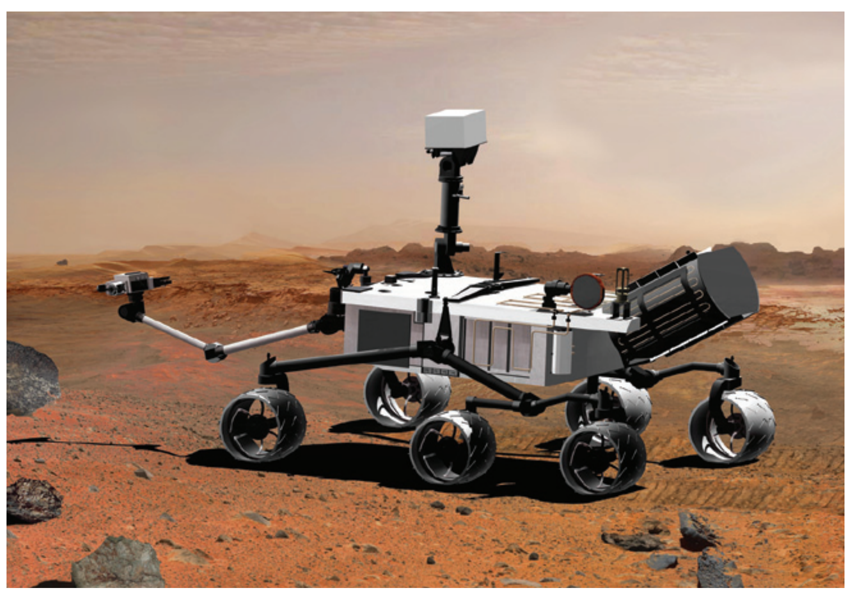
ASK IMAGINE & PLAN

- Share the *Design Challenge* with the students.
- Students must draw their chosen course on the map and 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”.

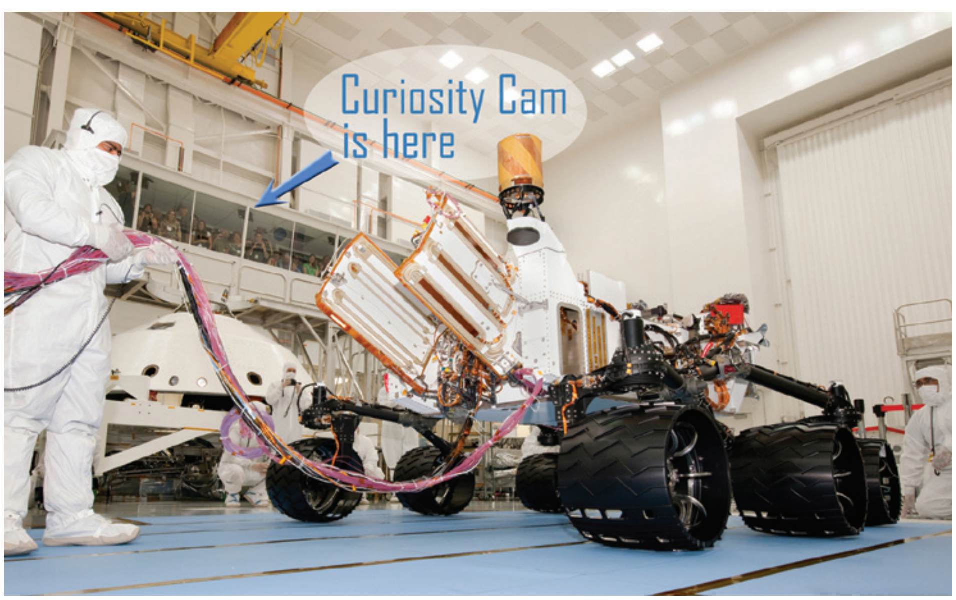
CHALLENGE CLOSURE

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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Prepare for a Mission
Teacher page

prepare for a mission

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 calibrates and programs these machines to accomplish the mission objective, such as to travel to certain locations on that planet or moon. In addition, NASA must use radio signals to send their commands. So a mission on a distant planet could take minutes to hours to days to communicate to that robot.

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 pick up a piece of "lunar ice."

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

1. ***Designate your robot** – One student in each team must volunteer to be the robot. The robot will be the person who actually walks through the course, blindfolded, following the instructions of her/his team. The team should give their robot a name.*
2. ***Map the robot's route** – Using the map in your worksheets, mark out a route for the robot.*
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. ***Program the robot** – Use the commands that your team practiced to tell the robot how to navigate the path you have drawn on the map. First you will make measurements of the distances in the course and the distance in one robot step. You will use these calculations to determine how many steps the robot needs to take in each direction.*

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ASK IMAGINE & PLAN

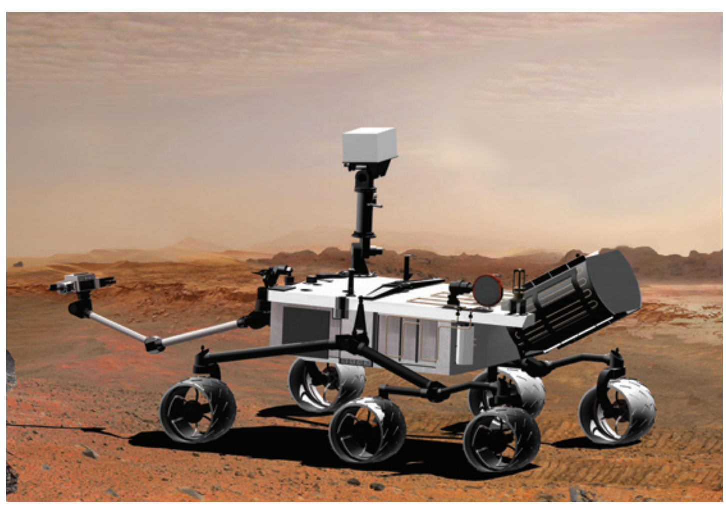
What questions do you have about today's challenge?

STEP 1 – Designate your robot.

One person from your team must volunteer to be the robot.

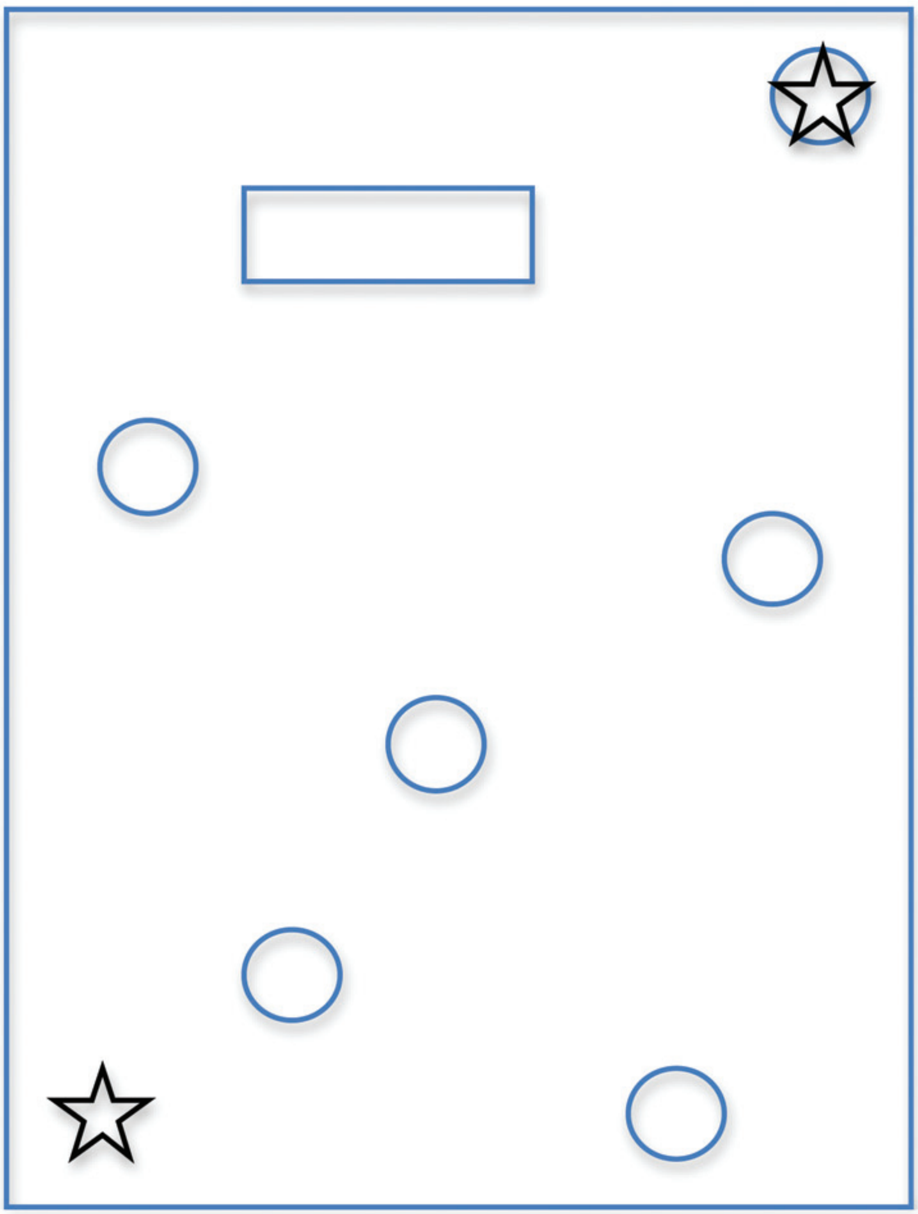
STEP 2 - Mapping

On the next page is a map for the Discovery Mission. Using a pencil, draw arrows on your map and create a route your robot will take to get to the lunar ice sample. You must include at least one right turn and one left turn.



Create the route for your robot within the diagram below.

Finish



Start

Approved by: ____

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Prepare for a Mission
Student page

prepare for a mission

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?

1. **Measure your robot's step length in centimeters with a meter stick.**

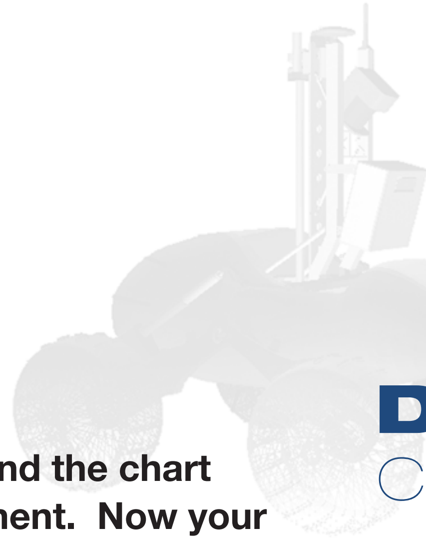
   Our robot's step length is _____________ centimeters.

2. **For example, if your first robotic movement is 420 centimeters and your robot's step length is 30 centimeters you can solve for the number of steps using this formula:**

Distance of movement divided by Step length = Number of Robot Steps

420 cm / 30 cm = 14 steps

Robot Calibration			
Path Taken by Robot	Distance (cm)	Do the Math (Distance / Robot step length)	Number of Robot Steps
Movement #1			
Movement #2			
Movement #3			
Movement #4			
Movement #5			
Movement #6			
Movement #7			
Movement #8			



STEP 4 – Program your robot

Review the map with your robot's route and the chart with the number of steps for each movement. Now your team needs to create commands for your robot to match your route. Write down one command that matches each arrow on your map.

Command Sequence

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

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Prepare for a Mission
Student page

prepare for a mission

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. One team member will be responsible for delivering the commands. Another team member must use a stopwatch to time how long it takes for the Robot to make each movement to reach the Lunar ice sample. Record each time on the next page to compare how long the mission took for each team!

prepare for a mission

Record each team's time in the table below to compare how long the mission took for each team!

Discovery Mission Data Table

Command and Movement	Time (seconds)
Movement #1	
Movement #2	
Movement #3	
Movement #4	
Movement #5	
Movement #6	
Movement #7	
Movement #8	

prepare for a mission