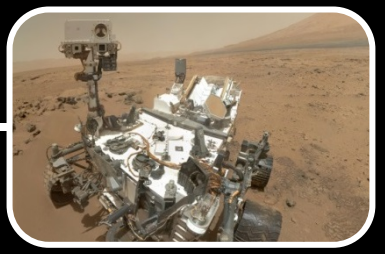
NASA Glenn Research Center Engineering Design Challenge

National Aeronautics and Space Administration



EDC-01:
Gaining Traction on Mars

www.nasa.gov

Next Generation Science Standards Performance Expectations

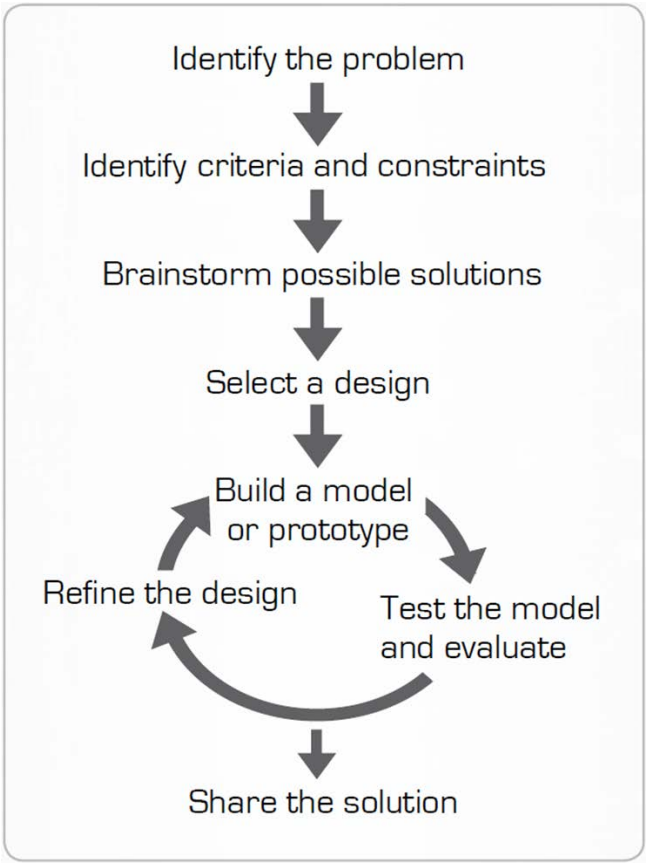
MS-ETS1: Engineering Design

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

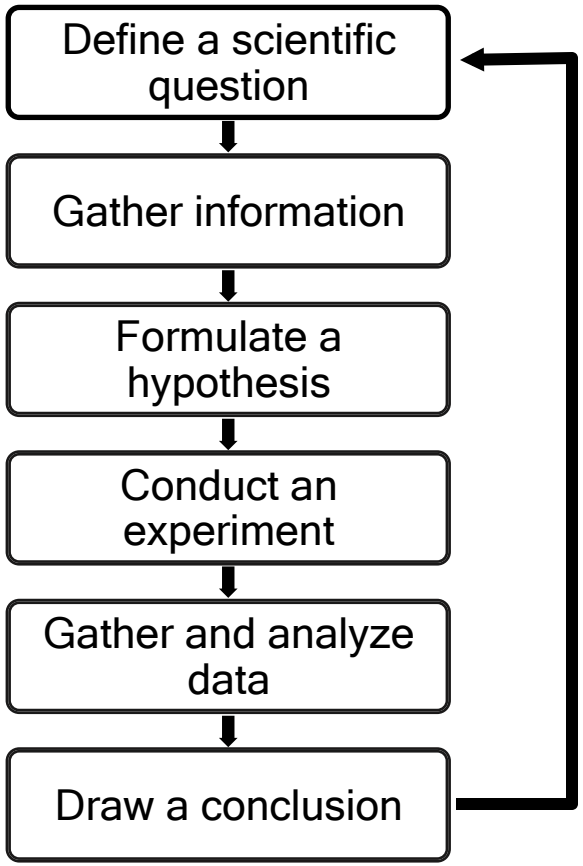
MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

The Engineering Design Process vs. The Scientific Method

Engineering Design Process – Helps to solve a problem in society that humans face by creating or inventing something new



Scientific Method – Asks and answers scientific questions by making observations and doing experiments



The Engineering Design Process

STEP 1: Identify the Problem – Students state the problem in their own words. How can I design a _____ that will _____?

STEP 2: Identify Criteria and Constraints – Students specify the requirements (criteria) and the limits (constraints) on the design due to resources and the environment.

STEP 3: Brainstorm Possible Solutions – Students sketch their ideas as they discuss ways to solve the problem with their team.

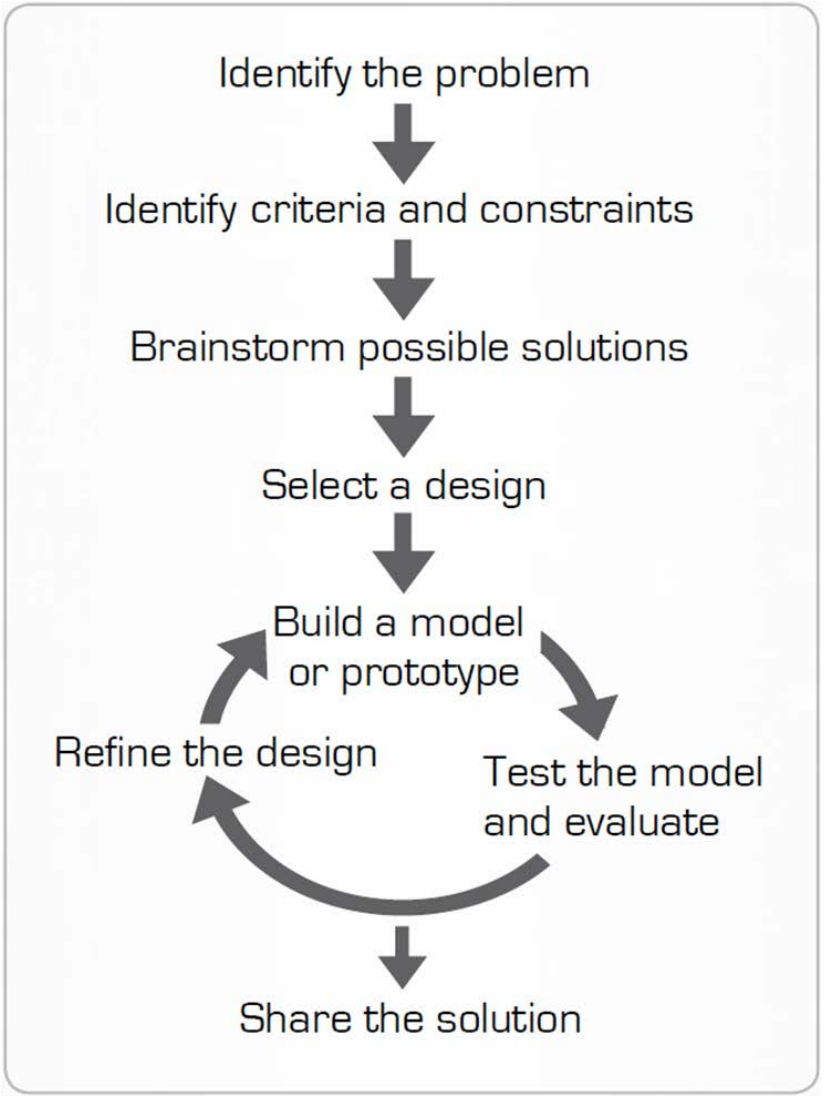
STEP 4: Select a Design – Students share their designs with their team and the team chooses a design.

STEP 5: Build a Model or Prototype – The team builds a model based on their selected design.

STEP 6: Test the Model and Evaluate – The team tests their solution in a controlled environment by taking measurements, making observations, considering modifications.

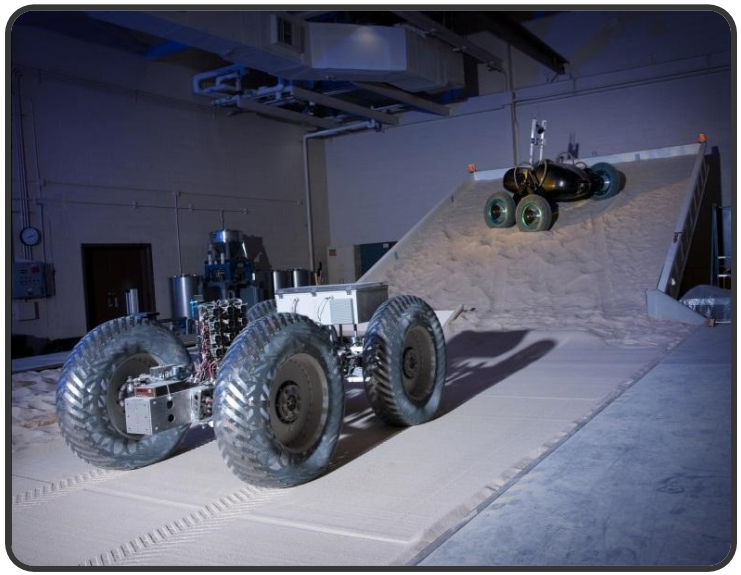
STEP 7: Refine the Design – The team examines and evaluates their prototype based on the criteria and constraints, and identifies changes that need to be made to improve the design.

STEP 8: Share the Solution – The team demonstrates their final solution and the knowledge they gained in a public forum.



NASA Glenn Research Center
Simulated Lunar Operations Lab

- NASA Glenn Research Center (GRC) in Cleveland is home to the Simulated Lunar Operations (SLOPE) laboratory and its Traction and Excavation Capabilities (TREC) Testbed.



- These test rigs are used to study how rover wheels operate in simulated extraterrestrial soils. For example, engineers are studying how damage on the wheels of the Curiosity rover affects its mobility as it explores Mars.

Gaining Traction on Mars Engineering Design Challenge

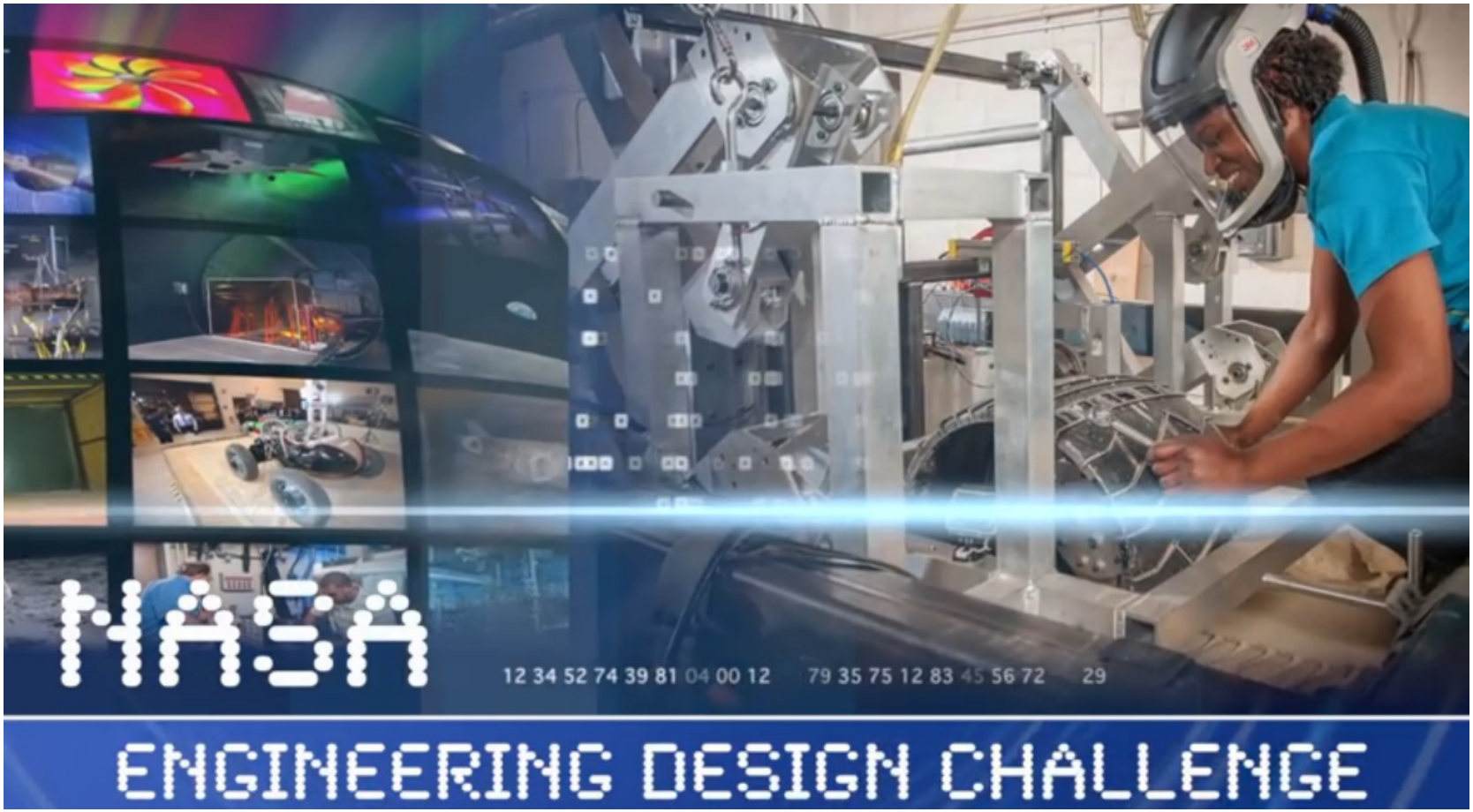
- This Engineering Design Challenge (EDC) serves as an authentic standards-based investigation that allows students to engage in the process of solving problems like today's scientists and engineers do.

- The Facilitation Guide includes a main challenge and four lead-up investigations to support Next Generation Science Standards.

Supports for Educators

- Downloadable curriculum enhancement Facilitation Guide which includes
  - Differentiated instruction suggestions and pre and post assessments (see pages 9 to 16)
  - Materials list for the challenge and investigations (see pages 17 to 18)
  - Rubric for the EDC and investigations (see pages 35 to 36 and 42)
- Opportunities to connect LIVE with NASA subject matter experts (SMEs)
- A platform for students to submit their solutions to NASA, and share designs with participants across the country.

Introductory Video

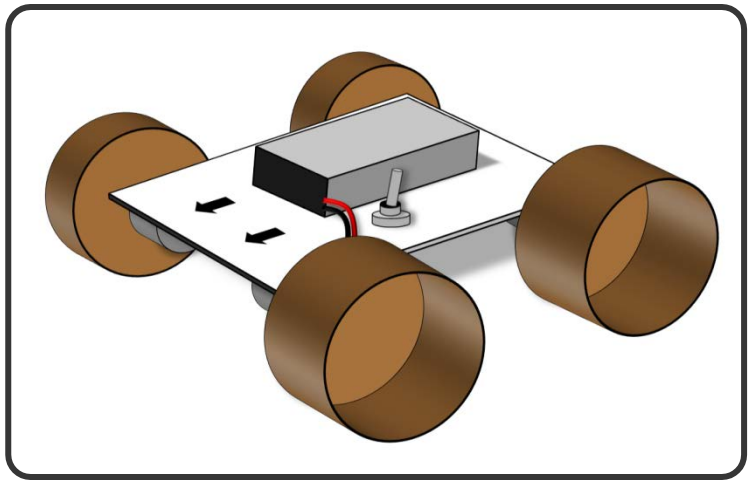


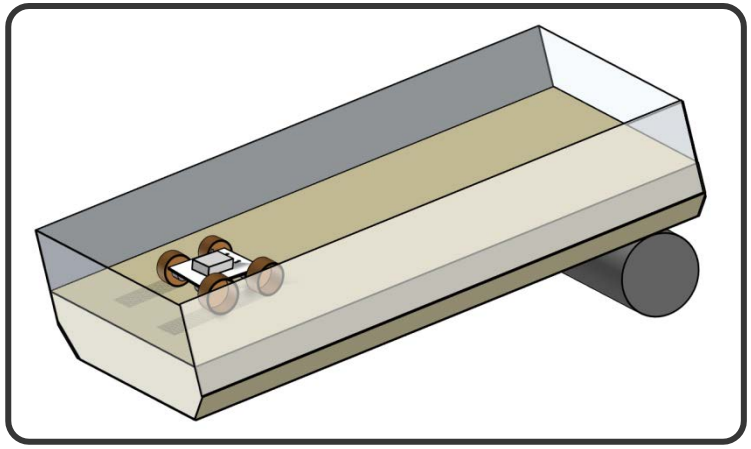
http://youtu.be/4ug-e4QIPEE

Gaining Traction on Mars
Engineering Design Challenge

The Challenge:

- Student teams will design and build the most effective wheel configuration to use on a simulated Martian surface. It will be installed and tested as part of a battery-operated model rover.
- The best design will move from one end of the test bed to the other in the least amount of time and with the least amount of wheel damage.
- Bonus points will be awarded for designs that climb the test bed at an inclined angle to be determined by the team.





Choosing a Test Vehicle

- The test vehicle given in the Facilitation Guide is an inexpensive and effective model to help facilitators get to the wheel design challenge with students.
- The vehicle is an example of what test apparatus can be used but is not required. Facilitators can use whatever test vehicle works best for them and fits within their budget. Size and weight constraints should be modified to accommodate a different test vehicle.

Safely Testing in Sand

- Generally, play sand is
  - Washed to remove any dirt, dust, and fines
  - Screened to filter out smaller sized particles to reduce the risk of airborne silica particles
- Particles that are smaller than 10 micrometers (µm) are respirable. Play Sand (Quikrete®) particle sizes range from 297 to 1190 µm, and are too large to be breathed.
- **Use personal protective equipment (PPE)**, like safety glasses, to prevent sand from getting into eyes or mouths if vehicle wheels kick up sand in the test bed.
- Avoid standing directly behind the vehicle during testing.

Gaining Traction on Mars
Facilitator Practice

- Work in groups of four to design and build wheels.
- Complete at least two wheel design iterations and test them in the sand.
- Assign each group member to one of the following roles and tasks
  - **Design engineer** – makes sketches, outlines, patterns, and plans based on the ideas the team generates
  - **Technical engineer** – assembles, maintains, repairs, or modifies the mechanical and electrical components of the system
  - **Operations engineer** – sets up and operates the system to complete a process or test
  - **Technical writer** – records and organizes information, data, and prepares documentation to be published

Directed Questioning for Students

Establish several time periods throughout the engineering design process for teams to share findings with the whole group. Enhance discussion by asking questions like

- What do you need to consider when designing your wheels?
- What did you find out after your first design brainstorming session?
- What do you know about traction that may help you in this challenge?
- Can any other team contribute to the idea that was just discussed?

Acknowledge what each group reports and have teams try to incorporate those ideas into their new designs.

Next Generation Science Standards Performance Expectations for Lead-up Investigations

MS-PS2: Motion and Stability: Forces and Interactions

MS-PS2-2: Plan an investigation to provide evidence that the change in a object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

Lead-up Investigations

Investigation One – Racing Against Friction

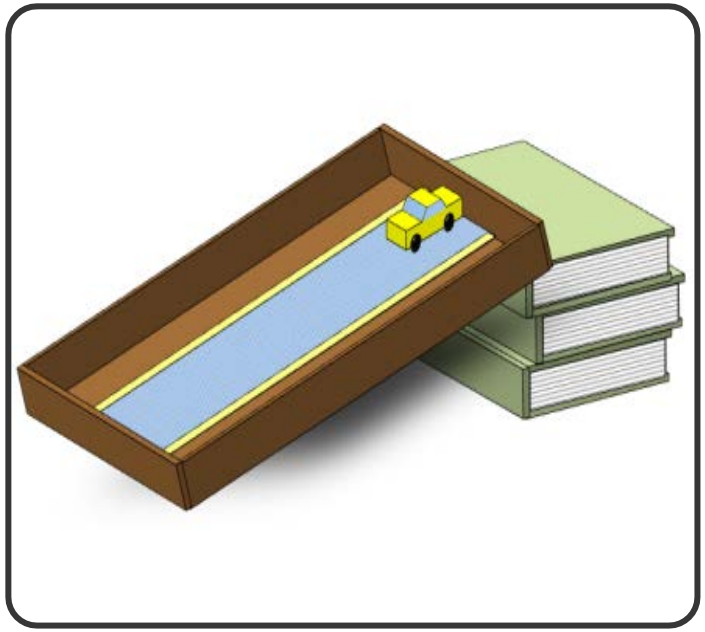
Investigation Two – Stacked for Power

Investigation Three – Charged Attraction

Investigation Four – Fine Motor Skills

Safety warnings:
Creating short circuits, even with relatively low-voltage and low-amperage circuits, can eventually create enough heat to burn skin or start fires. Instruct your students about the dangers of short circuits and how to avoid getting burned. **Wear goggles at all times.**

Racing Against Friction



Students will

- Demonstrate their understanding of force, gravity, friction, and speed
- Test how friction affects speed and motion
- Describe the ways multiple forces interact and the balance, or imbalance, of those forces

Connection to Gaining Traction on Mars

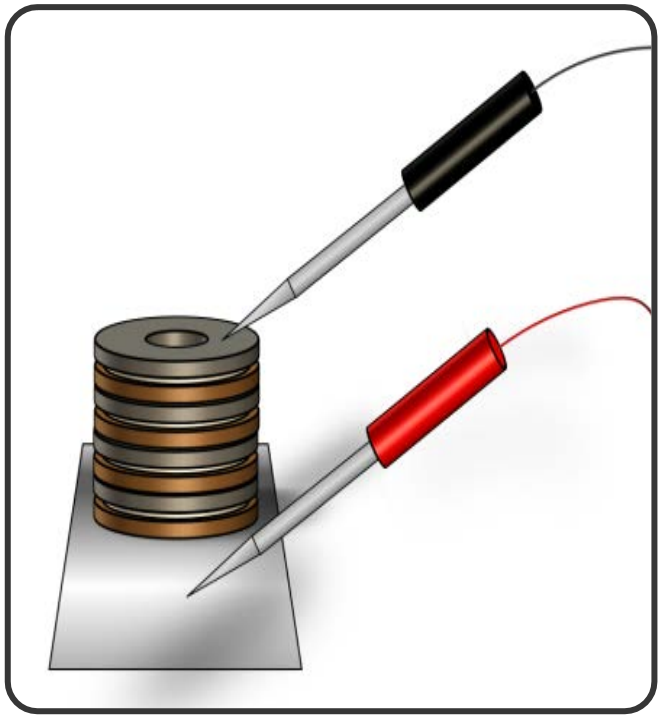
Students study the interaction between the car wheels and various ramp surfaces compare it to the friction between their wheel designs and the sand in the test bed.

Stacked for Power

Students will

- Demonstrate their understanding of how a battery creates electric potential
- Create a circuit through which electricity moves
- Measure electric potential in volts

Connection to Gaining Traction on Mars
Students will build a simple battery and measure its electric potential and compare it to the batteries powering their test vehicles.



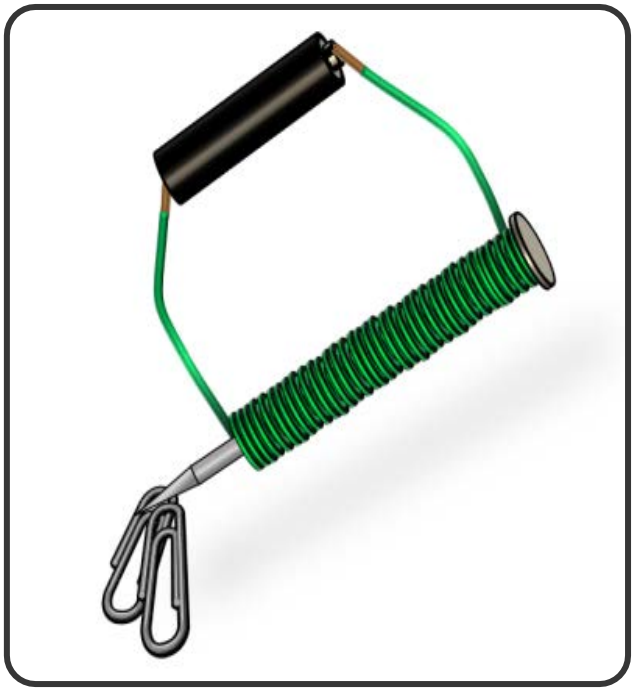
Charged Attraction

Students will

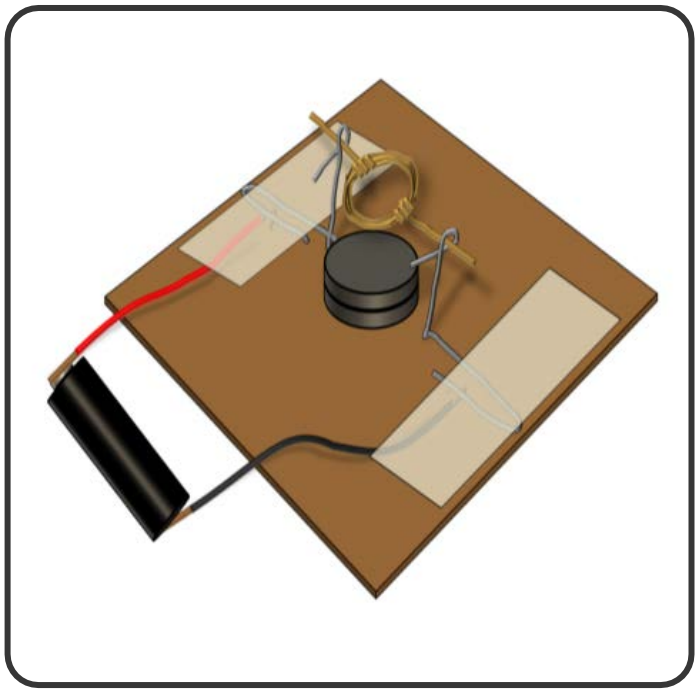
- Demonstrate how electromagnetic forces work
- Create an electronic circuit showing how forces interact with each other
- Use magnets to detect forces between objects that are not necessarily in contact

Connection to Gaining Traction on Mars

Students build a simple electromagnet and compare it to the electromagnets in the motors of their test vehicles.



Fine Motor Skills



Students will

- Create a model motor
- Increase their understanding of magnetic forces
- Explore how electrical force can change into magnetic force, which can change into mechanical force

Connection to Gaining Traction on Mars

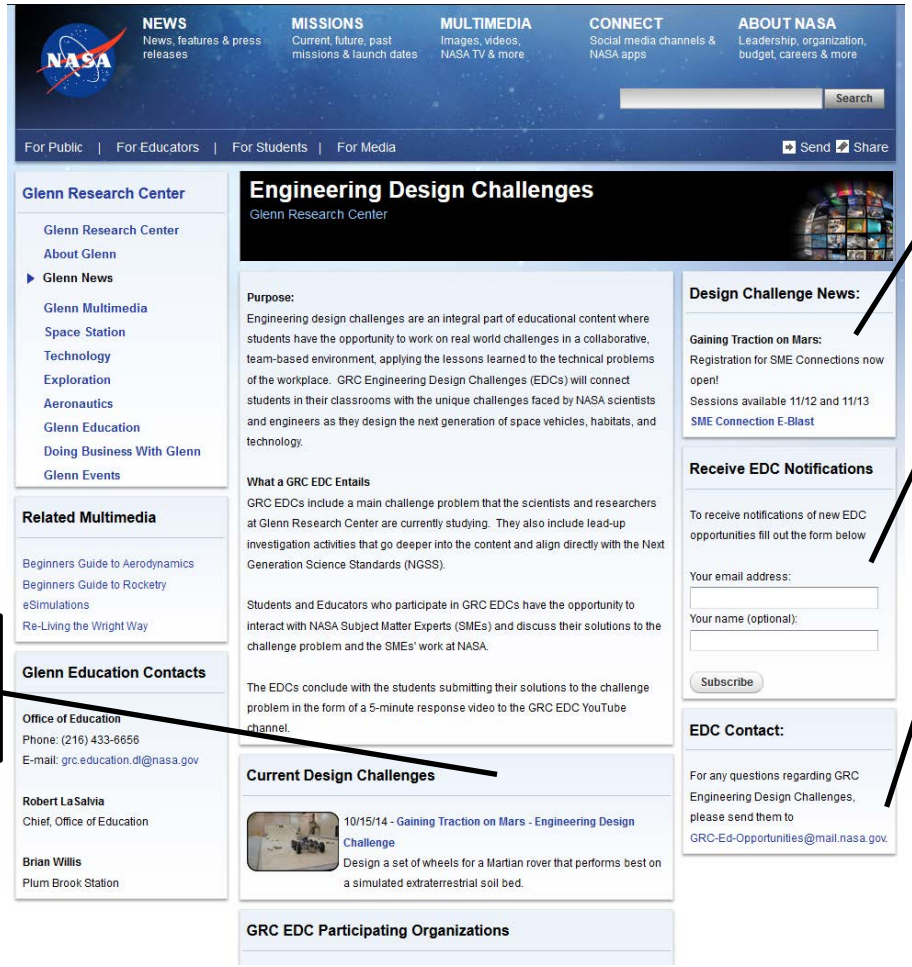
Students build a working motor and compare it to how the motors on their test vehicles function.

Available Technical Supports from NASA

- Engineering Design Challenge Website
- EDC training and support videos
- Making a solution video
- Uploading to YouTube
- Submitting to NASA
- SME Connections

Engineering Design Challenge - Home Page

http://www.nasa.gov/content/grc-engineering-design-challenges/



News and updates

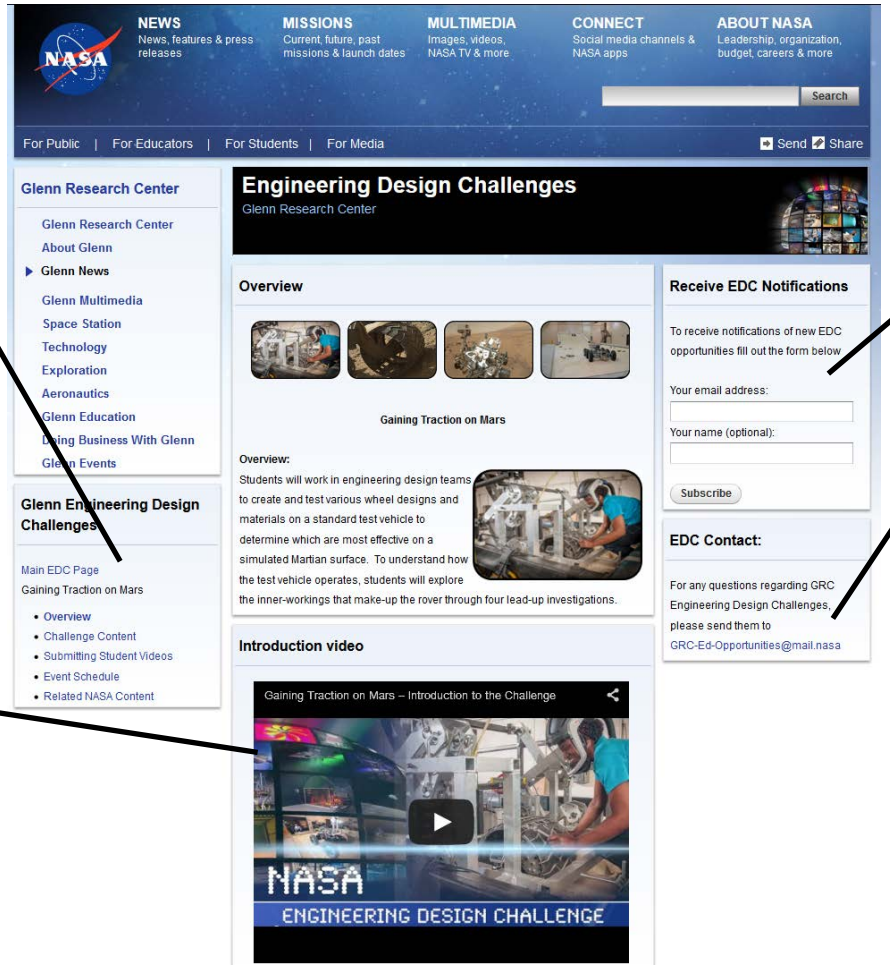
Email subscription

List of challenges

NASA email contact
GRC-Ed-Opportunities@mail.nasa.gov

Engineering Design Challenge
Gaining Traction on Mars - Overview

http://www.nasa.gov/content/gaining-traction-on-mars-overview/



Challenge navigation

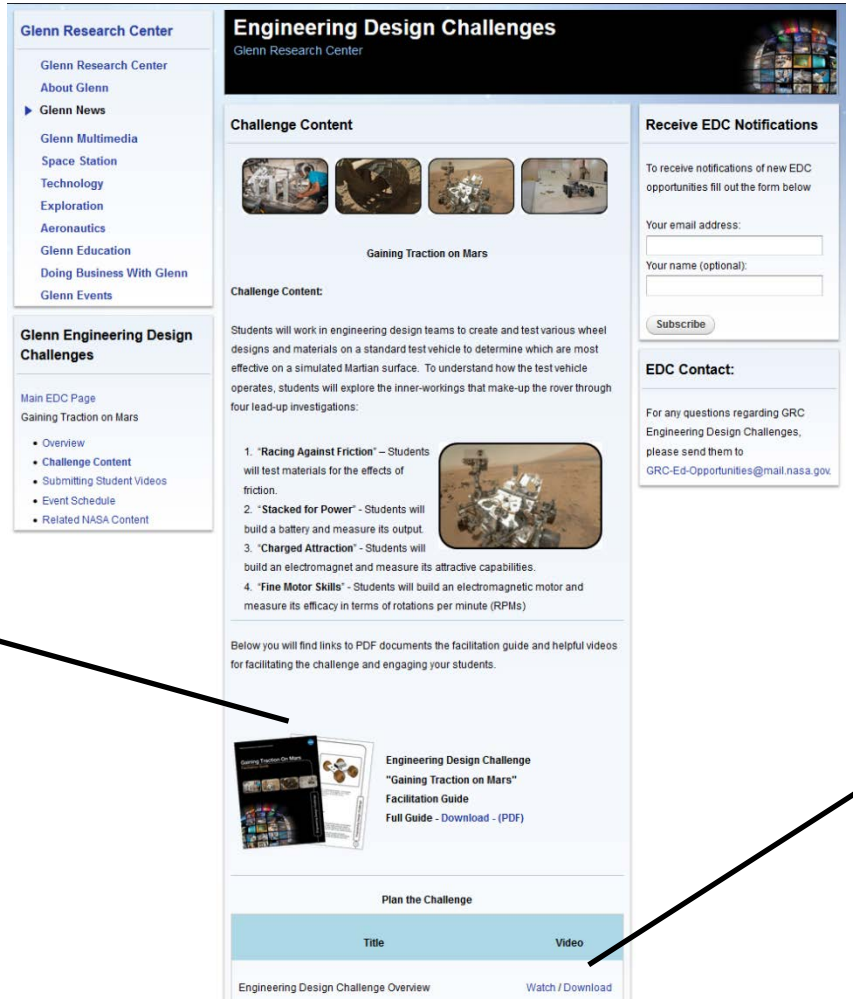
Introductory video

Email subscription

NASA email contact
GRC-Ed-Opportunities@mail.nasa.gov

Engineering Design Challenge
Gaining Traction on Mars – Content

http://www.nasa.gov/content/gaining-traction-on-mars-challenge-content/



Link to download Facilitation Guide

Training and support videos

Engineering Design Challenge
Gaining Traction on Mars – Student Videos

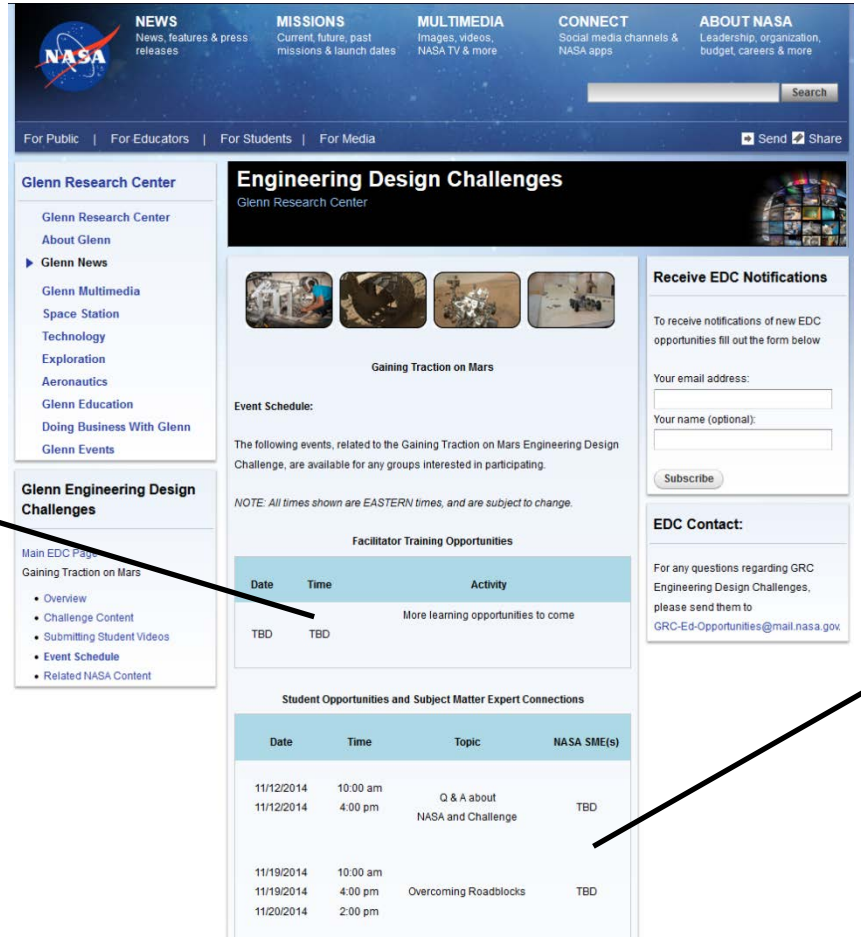
http://www.nasa.gov/content/gaining-traction-on-mars-submitting-student-videos/

Tips for creating student videos

Release forms for NASA media

Engineering Design Challenge
Gaining Traction on Mars – Event Schedule

http://www.nasa.gov/content/gaining-traction-on-mars-event-schedule/



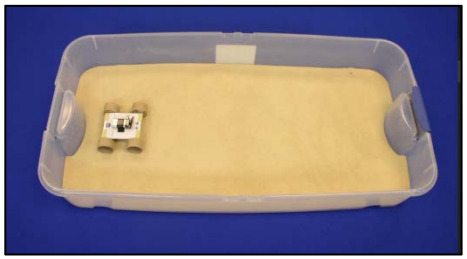
Training session schedules

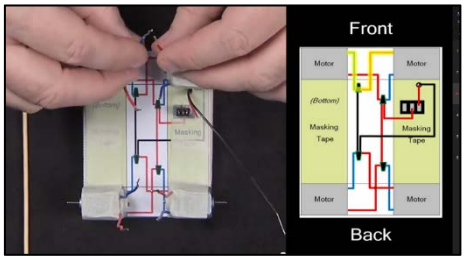
Student opportunity schedules

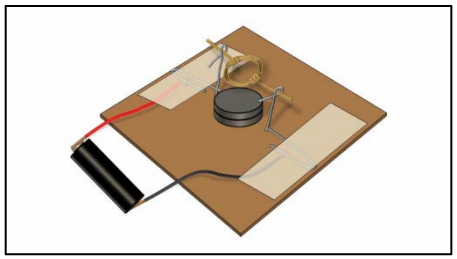
EDC Training Support Videos

Videos available for facilitators include

- Engineering Design Challenge Overview
- Building the Test Vehicle
- Investigation Four: Fine Motor Skills
- Creating and Submitting Solutions
- Connecting With Subject Matter Experts







http://www.youtube.com/playlist?list=PLTUZypZ67cduoz4n5fu8j-K8yzrgxRZ75

Making a Student Solution Video

Tips for students on how to create quality video submissions

http://youtu.be/TWHx95-8kBs

Submitting Solution Videos to NASA

To submit a student solution video:

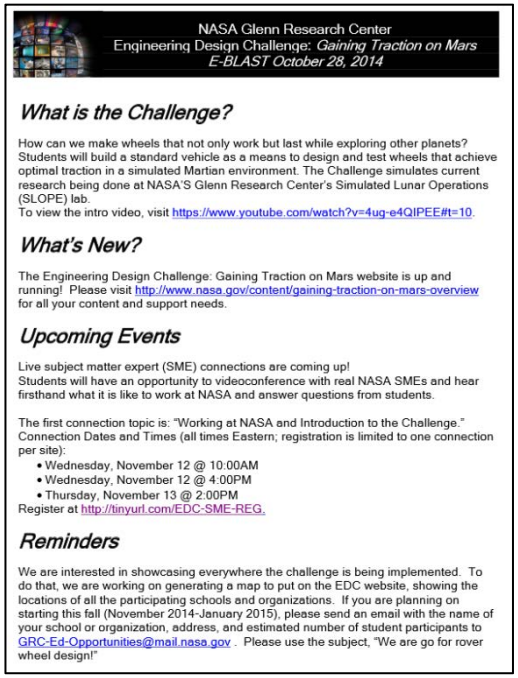
1. Upload your student video to a YouTube account. **Do not reveal any names of students, teachers, schools, or locations in the video.**
2. Use the “Share” button to locate your video’s URL.
3. Post your video’s URL in the comments section of the Introduction to the Challenge video.

Comments and video links are moderated and will appear on the feed once they are approved.

SMEs will review your submissions and provide feedback.

Subject Matter Expert Connections

- SME connections are posted on the Event Schedule page of the EDC website and announced by emails sent to the EDC distribution list.
- Registration instructions are included in the email.
- Currently, there is no limit to the number of SME connections a school or organization can join.



NASA Glenn Research Center
Engineering Design Challenge: *Gaining Traction on Mars*
E-BLAST October 28, 2014

What is the Challenge?

How can we make wheels that not only work but last while exploring other planets? Students will build a standard vehicle as a means to design and test wheels that achieve optimal traction in a simulated Martian environment. The Challenge simulates current research being done at NASA'S Glenn Research Center's Simulated Lunar Operations (SLOPE) lab.
To view the intro video, visit https://www.youtube.com/watch?v=4ug-e4QIPEE#t=10.

What's New?

The Engineering Design Challenge: Gaining Traction on Mars website is up and running! Please visit http://www.nasa.gov/content/gaining-traction-on-mars-overview for all your content and support needs.

Upcoming Events

Live subject matter expert (SME) connections are coming up!
Students will have an opportunity to videoconference with real NASA SMEs and hear firsthand what it is like to work at NASA and answer questions from students.

The first connection topic is: "Working at NASA and Introduction to the Challenge."
Connection Dates and Times (all times Eastern; registration is limited to one connection per site):

- Wednesday, November 12 @ 10:00AM
- Wednesday, November 12 @ 4:00PM
- Thursday, November 13 @ 2:00PM

Register at http://tinyurl.com/EDC-SME-REG.

Reminders

We are interested in showcasing everywhere the challenge is being implemented. To do that, we are working on generating a map to put on the EDC website, showing the locations of all the participating schools and organizations. If you are planning on starting this fall (November 2014-January 2015), please send an email with the name of your school or organization, address, and estimated number of student participants to GRC-Ed-Opportunities@mail.nasa.gov . Please use the subject, "We are go for rover wheel design!"

Gaining Traction on Mars
Facilitator Debriefing

Guiding questions

- What will the challenge look like in your educational setting?
- What difficulties might you encounter facilitating the challenge?
- How will this fit into your assessment cycle?
- What suggestions for facilitating the challenge can you share with this group?

Questions?

- For any questions, email GRC-Ed-Opportunities@mail.nasa.gov.