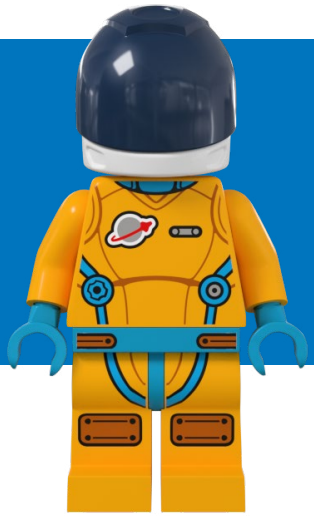
Mission Briefing: Getting to Space Module



Astronauts can't get to space without the work of many team members on the ground, including people like Flight Directors and Program Managers that help keep the mission running smoothly. In this first module students will learn about the people and careers that play a critical role in getting to space. They will explore how vehicles are developed and designed to move autonomously in space and how individual parts of the Space Launch System (SLS) are built in pieces and then stacked together. The Getting to Space Module is a great way to connect what students already know about rocket launches to everything that must happen behind the scenes before liftoff.

Mini-Mission

Time: 15 minutes

Objectives:

- Engage students in thinking about the importance of clear directions.
- Ignite a discussion with students about moving objects.

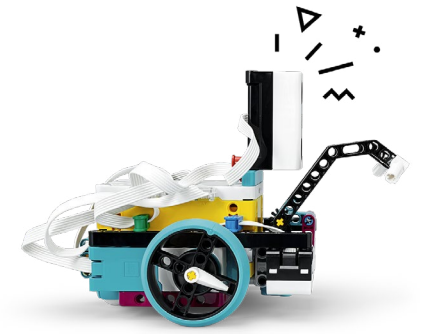
Consider asking questions like:

- How do we move objects?
- How does this change if an object is small versus large? Light versus heavy?
- How can you plan for moving an object over long distances?
- What are different types of vehicles that can move objects?

Prompt your students to do a short activity to think about moving objects. Ask each student to write directions for moving an object of their choosing in the classroom to another place in the school. It could be to another classroom or the gym or the front door. Then have students pair up to test each other's directions (without the object) to their new place in the school.

After, have students reflect on the directions given. How clear were they? Was there enough detail provided that you could have programmed a robot to deliver the item for you? Ask students to record their thoughts on how important clear directions are for transporting objects in their Engineering Design Notebook.

Mission: Operation Autopilot



Time: 45–90 minutes

Objectives:
- Design and build a prototype of an autonomous vehicle similar to a planetary rover
- Investigate autonomous movements
- Explore the role of a Flight Director

STEAM Practices:
- Develop and use models
- Iteratively test and modify designs
- Meet design constraints

Mission Briefing

Brief students on the mission by saying:
Think about driving a remote-controlled car. Seems easy when the vehicle is right in front of you and responds quickly to every turn of the remote dials. However, the distances at which NASA operates makes having direct control like that impossible. The distance from the Earth to Mars, for example, can make a signal take around 14 minutes to reach a vehicle on Mars and another 14 minutes to get a return signal back on Earth. Also, the surface of the Moon and other planets have a lot of rocks, sand, and other obstacles that can cause a vehicle to get damaged or stuck. NASA engineers use a variety of software tools to help vehicles navigate autonomously, which means the vehicles navigate by themselves. Ask students to write what they know about autonomous movements in their Engineering Design Notebook. This could include example types of vehicles or objects that are automated.

Extend Student Curiosity about the Mission
Build curiosity with your students using these resources. Consider asking your students some prompting questions to discuss or to reflect on in their Engineering Design Notebook.

- How can you create a vehicle that can move independently?
- Why does NASA need to have autonomous vehicles and tools when exploring places like the Moon or Mars?

Read this article with your students:
NASA's Perseverance Drives on Mars' Terrain for First Time

Career Connection

Connect the Mission to Careers at NASA

Connect students to an actual career at NASA to learn more about what people do each day. Share with students:

Meet the LEGO® Space Team Flight Director, Maria! As Flight Director, she takes over after the launch of a spacecraft all the way through entry, descent, and landing.

Maria is responsible for flight operations, which means making sure the spacecraft stays on course and making decisions on when the spacecraft needs a trajectory correction. She also develops policy and procedures addressing any issues that come up. This can be tricky since she is not there beside the vehicle but must give commands that allow it to move safely.

Let's meet a Flight Director from one of the Mars Rover Missions

Diana Trujillo was one of the surface Flight Directors behind the Perseverance Mars Rover Mission. She led the analysis of every single part of the spacecraft to ensure that the rover was okay. Diana made sure that as data came in everyone was looking at it from the right perspective and digging in if anything seemed strange. If something wasn't right, Diana's team was responsible for working with program management and the anomaly response team to solve the problem and recover the spacecraft.

Diana has held many roles on the Perseverance mission. She worked closely on the rover's Robotic Arm while it was in ATLO (Assembly, Test and Launch Operations). After that, she moved into the Flight Director role during critical commissioning activities on Mars. Finally, when critical commissioning completed its responsibilities, she moved to her current role as Tactical Mission Lead.

For more about Diana Trujillo check out this inspiring video:

From Colombia to Mars

To learn more about Mars Rovers and the people who operate them check out:

Vandi Verma, Chief Engineer Robotic Operations, Perseverance Rover Driver

Paolo Belluta: Mars Rover Driver

The Mission

Explain the mission to students by saying:

Now it's time for you to become the Flight Director and take over flight operations for an autonomous vehicle. Design and create a vehicle that could drive on the lunar surface. Think about how you will navigate your vehicle from Earth. What type of sensors will be needed on your vehicle to control the vehicle autonomously? What type of motors will be needed to move the vehicle? Think about different ways you can control the movements of your vehicle. Will it use an ultrasonic sensor to keep from running into things? Or a different type of sensor?

If you don't have sensors and motors, don't worry. Just create a prototype of the vehicle. Design a model of what the actual vehicle will look like. Brainstorm and sketch out your ideas. Be sure to explain what task you are trying to complete with your tool. Build, test, and iterate on your model. Don't be afraid to try different ideas. If it doesn't work, that's ok, you can try something new!

Be sure to leave enough time for all students to share their prototypes and explain why this is the best fit for the problem they were trying to solve.

Additional Resources:

NASA's Artemis Base Camp on the Moon Will Need Light, Water, Elevation

VIPER

Additional Inspiration Lessons

Consider completing these lessons from LEGO® Education prior to students completing their mission to scaffold their engineering skills.

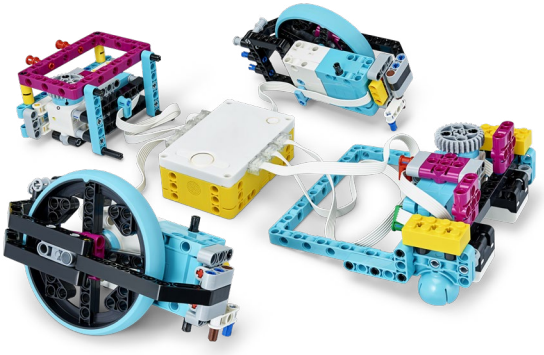
- LEGO® Education SPIKE™ Prime Out of Order
- LEGO® Education SPIKE™ Prime Training Camp 2
- LEGO® Education SPIKE™ Prime Automate It
- LEGO® Education BricQ Motion Prime Propeller Car
- LEGO® Education BricQ Motion Essential Race Car

Differentiation for All Learners

For younger or less experienced designers, consider providing students with a set type of autonomous movement to make. For example, you might scaffold students by providing them with an example path to take with their vehicles with known obstacles to overcome.

For older or more experienced designers, consider having students map a terrain out as well. Students can create their own lunar surface to illustrate their understanding of what terrain their vehicle needs to move across and then create a vehicle for that specific terrain.

Mission: STEAM Work is Teamwork



Time: 45–90 minutes

Objectives:
- Plan and design a Space Launch System rocket to be built in sections
- Build a section of a spacecraft
- Work together to assemble all parts of the spacecraft

STEAM Practices:
- Plan and carry out investigations
- Investigate systems and system models
- Develop and use models

Mission Briefing

Brief students on the mission by saying:
Think about a time that you worked with another person to accomplish a task. Did you work together on all parts of the task? Or did you each take a part of the task to complete and then put the parts together to finish it? NASA often works in specialized teams to complete large tasks. Each team does a piece of the task based on their area of specialty and then all the teams put their pieces together. This takes a lot of planning to ensure that the pieces will work well together in the end. Ask students to write what they think working together looks like in their Engineering Design Notebook.

Extend Student Curiosity about the Mission
Build curiosity with your students using these resources. Consider asking your students some prompting questions to discuss or to reflect on in their Engineering Design Notebook.

- How does NASA work in specialized teams to create the components of a Space Launch System?
- What is important to think about when creating individual parts separately that need to come together to work as one in the end?

Read these articles with your students:
Space Launch System (SLS) Overview
Vehicle Assembly Building
It Took Teamwork to Make It to 20 Years

Career Connection

Connect the Mission to Careers at NASA

Connect students to an actual career at NASA to learn more about what people do each day. Share with students:

Meet the LEGO® Space Team Program Manager, Daniel! He leads a whole team of folks from different areas and ensures everything is going smoothly, everyone understands the goals and objectives, and is working together to achieve them on time!

As the program manager Daniel has a deep toolbox of skills to call on. From project planning to managing a space team he does it all.

Let's meet another NASA Program Manager

John Honeycutt is the Program Manager for the Space Launch System (SLS). He leads a workforce of more than 4,200 civil servants and contractors, and is responsible for all facets of the program, including planning, procurement, development, testing, evaluation, production and operation of the integrated SLS.

The SLS is built in sections with more than 1,000 companies from across the U.S. and every NASA center supporting the development of the world's most powerful rocket. These sections are then sent to the Vehicle Assembly Building at Kennedy Space Center in Florida to be stacked together. The SLS Program, managed by NASA's Marshall Space Flight Center, works closely with the Orion Program, managed by NASA's Johnson Space Center, and the Exploration Ground Systems, managed at the Kennedy Space Center.

For more inspiration checkout this article:

Space Launch System (SLS) Overview

The Mission

Explain the mission to students by saying:

Now it's your turn to work together to assemble a prototype Space Launch System. Work in a team of three people. One person should build stage 1 or the base of the rocket that includes the main engines. The second person will build stage 2 or the middle of the rocket that includes the propellant. The third person will build the launch abort system for the rocket and the Orion Crew

Module. The launch abort system is located at the top of the rocket and fits over the Orion Crew Module. Think about different ways you can control the movements of your vehicle. Will it use an ultrasonic sensor to keep from running into things? Or a different type of sensor? The launch abort system protects astronauts if a problem arises during launch by pulling the spacecraft away from a failing rocket. After all three stages are complete, you will work together to stack or assemble the Space Launch System and Orion Crew Capsule.

Remember it will be important to communicate with each other about your individual pieces to ensure they will fit together in the end. Brainstorm and sketch out your ideas. Build, test, and iterate on your models. Don't be afraid to try something new. If it doesn't work, that's ok, you can try something new!

Be sure to leave enough time for all students to share their prototypes and explain why this is the best fit for the problem they were trying to solve.

Additional Inspiration Lessons

Consider completing these lessons from LEGO® Education prior to students completing their mission to scaffold their engineering skills.

- LEGO® Education SPIKE™ Prime Assembling an Advanced Driving Base
- LEGO® Education SPIKE™ Prime Break Dance
- LEGO® Education BricQ Motion Prime Pass the Ball
- LEGO® Education BricQ Motion Essential Track and Field

Differentiation for All Learners

For younger or less experienced designers, consider reducing the number of stages to connect to only two sections. Also consider scaffolding needed for students during the design phase to think about how the parts will connect together.

For older or more experienced designers, consider including additional parts to the design of the rocket. Having additional team members working together and additional parts to design to fit together will add complexity.