MISSION BRIEFING

Activity: Assess the Structural Integrity of a Space Module

Prep time: 15 min

Activity length: 60 min

Task: Participants will design, build, and test their own space module.

Gateway, a vital component of NASA's Artemis program, will serve as a multipurpose outpost orbiting the Moon. It will provide essential support for long-term human return to the lunar surface and serve as a staging point for deep space exploration. For more information about Gateway, visit www.nasa.gov/gateway.

By the end of this activity participants will

- Know that space modules must be lightweight to make liftoff less difficult, but sturdy enough to withstand conditions in space.
- Understand the relationship between mass and weight.
- Be able to construct a space module that is sturdy and lightweight.

Materials

- Cardboard tubes (10 cm), aluminum cans, or similar lightweight cylinders (1 per team for use as an inside cylinder)
- Mass (lead weights, coins, large washers, or similar)
- 30 pieces of uncooked spaghetti for each team
- Clear tape or low-temperature glue gun with cool-melt glue
- Index cards
- Paper and pencils
- Scissors
- Metric scale
- Rulers

Preparation

1. If using a glue gun, even with cool-melt glue, set up a glue gun station for safety and supervision.
2. Determine the internal volume constraint for the space module in advance of the lesson. Any lightweight cylinder ranging in size from a toilet paper tube to a 12-oz aluminum can will work.

Procedure

1. Provide each team 25 pieces of dry spaghetti noodles and 50 cm of tape (or one small glue stick).
2. When building is done, teams will test their structures (record the mass held).
3. After testing, provide 5 additional spaghetti noodles and 10 cm of tape for improvements.
4. Participants should test a second time and record the new mass held.

MISSION GUIDANCE...

DO

- Provide all teams the same number of spaghetti noodles.
- Discuss challenge constraints.

MAYBE

- Have participants build again with a different fragile material.
- Try spaghetti with a different thickness to manipulate difficulty.

DON'T

- Allow participants to use materials that are not provided.
- Give participants structural suggestions or show examples.

Design Constraints

- The volume-constraint cylinder must fit completely and securely within the spaghetti structure each team builds.
- Teams are only allowed to use the supplies provided. If they make a mistake, they must reuse materials.
- Test the module frame standing upright on its end (oriented like a soda can). There should be a gap between the top of the volume-constraint cylinder and the spaghetti structure.

Test

Teams will test their designs by increasing the mass on the top of the design. The test stops if one (or more) of these three things happen:

1. One of the pieces of spaghetti breaks/snaps.
2. The end of one of the pieces of spaghetti is detached from the tape or glue.
3. Any of the spaghetti pieces bend to the point of touching the top of the cylinder.

Extension

- Ask participants to build a new structure to protect a taller cylinder.
- Add a cost constraint to the challenge and create a budget for participants to “purchase” materials. Assign cost to each piece of spaghetti and centimeter of tape. Challenge participants to create the most efficient design (smallest ratio of cost to mass supported).
- Repeat the challenge using different materials for the structure.

Challenge Questions

- Which was most difficult: keeping the spaghetti from bending, breaking, or becoming detached?
- Would this challenge be more difficult with a larger or smaller cylinder used as a size constraint? Why?
- What was the purpose of the design constraints? Why were you limited in how much the spaghetti could bend?