

CHALLENGE 4 SPEEDY SHELTER



SHOW KIDS THE
RELATED TV EPISODE



Photo: Mika Tomczak

The Design Squad teams take a crash course in pre-industrial building techniques as they compete to build 20-foot bridges without the aid of power tools, forklifts, or flushable toilets. Watch the “DS Unplugged” episode at pbs.org/designsquad.

The invention challenge

Invent an emergency shelter that can fit a person and is sturdy and quick to build.

In this challenge, kids: (1) think about a familiar shape in new ways; (2) learn about an injured hiker who survived by building a makeshift shelter; (3) brainstorm shelter designs; (4) follow the design process to invent a solution to the challenge.

1 Prepare ahead of time

- Read the leader notes and the challenge sheet.
- Get paper and pencils for the warm-up activity.
- Gather the materials (per team):
 - 2 cardboard sheets (approx. 8.5x11 in.)
 - 3 33- or 42-gal. garbage bags, cut open into sheets
 - 16 3-ft. bamboo plant stakes
 - scissors
 - duct tape
 - string

NOTE #1: The bamboo plant stakes (available at garden centers and hardware stores) come in various lengths. The 3-foot length is the best for this challenge.

NOTE #2: Don't use fiberglass stakes. If a kid lets go of a bent fiberglass stake, it will immediately straighten. Kids could be hurt if an end that's whipping through the air hits them.

NOTE #3: As a safety measure, cut the garbage bags open into sheets before the session. This way, kids can't get stuck inside a bag and risk suffocation.

2 Warm up: Spark kids' imaginative thinking (10 minutes)

Draw a triangle on a board and show kids how it can be turned into an object (see examples at right). Next, have kids draw eight triangles on a sheet of paper, leaving some space around each one. Challenge them to turn their triangles (or pairs of triangles) into objects. After a minute or two, have kids share their ideas. Tell them inventors think about things in new ways and see interesting possibilities.



3 Introduce the challenge (5 minutes)

Put today's challenge in context by reading the following news story.

It started as a pleasant hike. But soon John Balgrano was in trouble. While hiking alone in the mountains of New Zealand, he slipped and fell down a mountainside, injuring his leg so badly he couldn't walk. Plus he'd lost his camping gear in the fall. That night, a storm blew in, bringing high winds, freezing temperatures, rain, and hail. Balgrano needed shelter—fast. He grabbed branches, strips of bark, and leaves and did his best to turn them into a weatherproof roof. Then he waited, growing colder and weaker throughout the stormy night. Twelve hours later, just as he was slipping into what he called the “jaws of death,” a search party rescued him.

In this challenge, kids explore how shapes, such as triangles, can be used to make a stable structure. As a warm-up, kids stretch their imaginations by turning triangles into something different.

SHOW KIDS A RELATED
INVENTEAM PROJECT



Norfolk Technical Vocational Center's InvenTeam invented an ergonomic backpack that reduces the strain on a person's back. Check out this project and others at web.mit.edu/inventeams.

4 **Brainstorm design ideas** (10 minutes)

To help the kids brainstorm design ideas, tell them today's challenge and ask:

- How could you use different parts of plants to make a shelter that would be strong enough to withstand the wind and rain? (*Use long, sturdy branches and large leaves to block the wind and rain. Weave them together or layer them.*)
- Besides hikers, who else might use such a shelter? (*People who are homeless, stranded at sea, shipwrecked, or affected by natural disasters, such as hurricanes and earthquakes*)
- Buildings have to resist forces like the pushes and pulls caused by gravity and wind. What are some ways engineers help create sturdy buildings? (*They make sure that the structure has a solid base, the materials are strong enough, and the parts are securely fastened together.*)
- In addition to triangles, what shapes are good when building structures and why? (*Cubes, squares, rectangles, pyramids, domes, cylinders, and arches. They distribute force, such as the weight of the roof, among different parts of the frame. Triangles, domes, and arches are particularly strong shapes because they spread the force to nearly every other part of a frame.*)
- How can you make a wobbly frame more stable? (*Make sure each part is connected to, and supported by, two or more other parts.*)
- Tents have three basic parts: a frame, a cover, and connectors to hold the parts together. Look at the materials and sketch at least three shelter designs. (*An effective design will be similar to "skin and skeleton" structures, such as a tent or skyscraper. The skeleton is the frame [e.g., the pole or steel frame] and the skin is the covering material [e.g., fabric or glass]. Some structures, such as large tents and radio towers, use wires for added stability.*)

Inventors think about things in new ways and see interesting possibilities.

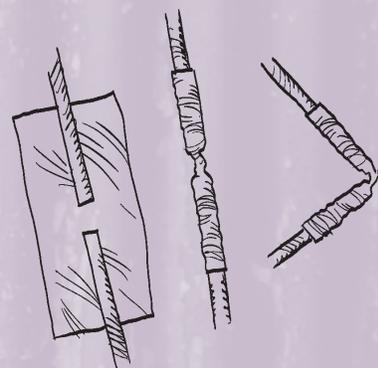


During testing, we ended up with a variety of designs. These pictures show several possible solutions. But don't show them to kids—they're likely to copy the ideas they see.

5 Build, test, and redesign (25 minutes)

During testing, we encountered some problems that your kids might also face:

- **Connecting parts together is hard**—Make strong, flexible joints with duct tape (see illustration).
- **The frame tilts or twists**—One way to strengthen a frame is to connect each part to one or more other parts. Also, kids can brace the corners of their frame with cardboard. Or, they can run a bamboo stake at an angle between two parts of the frame. This creates a triangular brace, which adds rigidity to a frame.
- **The frame wobbles**—To increase stability, anchor the frame to the floor with tape, or secure it by running lengths of string from the frame to the floor and taping them down.
- **The roof collapses the frame**—Remind kids that the plastic roof will push down on the top of the frame. Have them simulate this force by pushing down gently on the top of the frame. Reinforce the frame as necessary.
- **The plastic slides off**—Have kids tape two or three plastic sheets together before draping it over the frame. Once in place, they can secure the cover with tape or string.



To connect two plant stakes, lay a 3-inch length of duct tape on the floor, sticky side up. Lay the ends of the plant stakes on the tape, keeping a $\frac{1}{2}$ -inch gap between them. Close the tape over the ends of the two stakes. Now the tape can act like a hinge.

6 Discuss what happened (10 minutes)

Ask kids to present, compare, and discuss their designs.

- What force affected your shelter the most? (*Gravity—including the weight of the frame, plastic, and any objects placed on the tent*)
- What tent shapes seemed to be the strongest? (*Triangles and domes are particularly strong shapes because they spread the force to nearly every other part of a frame.*)
- What were some successful strategies for making your shelter more stable? (*The base was securely attached or weighted down to the ground, the frame is a stable shape, and the parts were reinforced where they join together.*)
- What design changes would make your shelter easier to use or more useful in an emergency? (*Making it more portable by reducing the size and weight; making it easier to put up and take down; and making it a bright color so rescuers can see it.*)

TINKER SOME MORE

- (1) Show kids the D-Squad ProFile of engineer Connie Yang who designs tents and talks about how engineering lets her combine a passion for sports with a love of solving interesting problems. Watch it online at pbs.org/designsquad/profiles/connie_yang.html.
- (2) Challenge kids to make a shelter that:
 - is small enough to fit in a backpack,
 - takes only one person to set up,
 - doesn't require tools to put together,
 - can be collapsed and used again.

CHALLENGE THE STEREOTYPE

Tell kids that inventors and engineers enjoy solving problems about things that really matter to people. For example, they develop handy, inexpensive, weatherproof shelters for hikers and for people who are homeless, stranded at sea, or affected by natural disasters, such as hurricanes and earthquakes. Also show kids videos in which young engineers describe how engineering lets them lead interesting, exciting lives and do cool things. See them online at:

- pbs.org/designsquad/profiles
- web.mit.edu/inventteams/videos.html