

## Automotive Engineering

# How to Prepare for the Automotive Engineering Challenge

Use this guide to prepare, gather materials, and support girls as they build and test prototypes of emergency vehicles for Steps 2-5 of the Brownie Automotive Engineering badge.

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## BACKGROUND FOR THE DESIGN CHALLENGE

In the Automotive Engineering badge, Brownies work in pairs to engineer a specialized vehicle that can help in an emergency. In *Automotive Engineering 1*, teams will create their emergency vehicle engineering plans for Step 3. In *Automotive Engineering 2*, each team will build and test one vehicle for Steps 4 and 5.

Each team will choose to build a vehicle for 1 of 3 emergency situations: 1) a hurricane, 2) a blizzard, or 3) an earthquake

The most important goal is that the vehicles are as safe as possible while also being useful for the emergency.

### Engineering Challenge Options

- **A hurricane:** This vehicle must be able to drive through deep water and float. Hurricanes often have very strong winds, so it needs to be strong enough to hold up if it's hit by falling branches or debris.

**Specialized Criteria:** Vehicle body that can hold up in water

- **A blizzard:** This vehicle must be able to drive through deep snow. Blizzards often have very strong winds, so it needs to be strong enough to hold up if it's hit by falling branches or debris.

**Specialized Criteria:** Wheels that can go through snow

- **An earthquake:** This vehicle must be able to drive over damaged roads and rubble. After earthquakes, pieces of buildings sometimes fall, so it needs to be strong enough to hold up if something falls on it.

**Specialized Criteria:** Wheels that can go over damaged roads and rubble

## AUTOMOTIVE ENGINEERING NUTS N' BOLTS

### VEHICLE MATERIALS LIST

Each team will build one vehicle with 1 body, 4 wheels, and 2 axles (2 wooden skewers/dowels and 2 plastic straws).

You'll provide teams with an assortment of options to choose from for their bodies and wheels. Each team will also need 2 skewers/dowels and 2 plastic straws for their axles.

Each vehicle will need:

- **1 body:** 1 shoe box, tissue box, or some other kind of box, aluminum foil loaf pan, empty plastic water or soda bottles, empty half gallon plastic or paper milk or juice cartons
- **4 wheels:** 4 cardboard circles, cds, plastic bottle caps with holes punched in them, empty spools, plastic take-out container lids, or yogurt cup lids with holes cut in them
- **2 axles:** 2 wooden skewers (or thin dowels) and 2 plastic straws

**Important Note:** For the wheels to spin easily, make sure: 1) the width of each body is smaller than the length of the straw and 2) the skewers are longer than the length of the straw. If need be, you can cut the straws or skewers to make them the correct length.

### HOW TO ASSEMBLE A BASIC VEHICLE

1. **Gather materials.** Choose 1 body, 4 wheels, and 2 axles (2 skewers and 2 straws).
2. **Create your vehicle body.** Look at your vehicle body and decide what's the front, the back, the top, and bottom of the vehicle.
3. **Attach the axles to the vehicle body.** Tape the straws across the bottom of the vehicle body in a straight line. Make sure the straw is in a straight line across the body, so the vehicle will roll in a straight line.
4. **Connect a wheel and axle.** Take a wooden skewer or dowel and ONE wheel. If your wheel has a hole poked in it, put the axle through the hole. If it doesn't have a hole, use some of the clay or sponge to make a place in the wheel for the axle to stick.
5. **Connect the second wheel and axle.** Do Step 4 again with the second dowel or skewer, so you have 2 axles with 1 wheel each on them and 2 wheels left over.
6. **Connect the wheels and axles to the vehicle.** Feed the two axles with wheels through the straws. Then, attach the remaining wheels using clay or pieces of sponge.

### HOW TO CREATE THE OBSTACLE PANS

- For the hurricane vehicles, put water in a shallow sheet pan or paint roller pan.
- For the blizzard vehicles, put flour in a pan or box.
- For the earthquake vehicle, put pebbles, sticks, or other "debris" in another box or pan.

## HOW TO BUILD THE TESTING STATIONS

1. Before *Automotive Engineering 2*, set up 3 small ramps by leaning a piece of cardboard or a baking sheet on something like a stack of books or blocks.
2. Prepare the 3 Obstacle Pans as listed above.
3. At the meeting, keep the ramps and obstacles separate from each other, to be referenced in Step Three and eventually used together in Step Four.

## CHECKLIST FOR AUTOMOTIVE ENGINEERING 1

### PREPARE AHEAD: BEFORE THE MEETING...

- ☐ Use the “Vehicle Materials List” in the “Automotive Engineering Nuts N’ Bolts” section of this Guide to choose 3 material options for the vehicle bodies and wheels.
- ☐ Gather a sample set of vehicle materials for the meeting, including: 1) your choice of 3 materials for the vehicle bodies, 2) your choice of 3 materials for the vehicle wheels, and 3) 2 wooden skewers (or thin dowels) and 2 plastic straws for the axles.
- ☐ Follow “How to Prepare the Obstacle Pans” in the “Automotive Engineering Nuts N’ Bolts” section of this Guide to create 3 obstacle pans that model the different kinds of terrains for testing.

### TIPS FOR THE MEETING

#### For Step 2: Engineer a Vehicle for Safety Using Criteria

In the activity, teams will create their automotive engineering plans. Use the questions below to help teams brainstorm special features to make their vehicles more useful.

#### BRAINSTORMING QUESTIONS:

- What kind of wheels will your vehicle need?
- What special feature can you add to the interior to make it more helpful in the emergency?
- What special feature can you add to the exterior to help gather information about what’s going on? For example, what’s the wind speed or temperature?
- What materials will help your vehicle to be useful in the emergency? Will it need to be strong or waterproof?
- Most importantly, what do you need to make your emergency vehicle as safe as possible?

If girls need help sketching their vehicles, use these “Tips for Sketching Vehicles”:

- **Imagine your vehicle.** Close your eyes and think about what your emergency vehicle needs to do and how it will help people. What does it look like?
- **Consider safety and your customer’s needs.** Remember why your customer needs a special vehicle and how the vehicle will help them to stay safe during an emergency. Do your criteria and sketches reflect what your customer needs and wants?
- **Design a vehicle for its surroundings.** Think about the emergency weather situation your vehicle will be in: will it need to move through snow, rain, or over bumpy terrain? What special features or parts can you include?
- **Start simple, then add details.** First, draw the shape and size of your vehicle. Then, add in your criteria, including all the important parts and special features.

- **Use tracing paper to try out different ideas.** If you have tracing paper, you can see what a special feature looks like before adding it to your sketch. First, draw the feature on a piece of tracing paper. Then, place the tracing paper over your drawing to see if you like it as part of your final design.
- **Sketch like a professional!** Draw more than one view of your vehicle: top, side, back, or front. This helps others to understand what your vehicle looks like from every angle.
- **Be bold!** Use crayons, markers, or colored pencils to add color to your sketches.

**AT THE END OF *AUTOMOTIVE ENGINEERING 1*, MAKE SURE TO...**

- ☐ Collect and save the Brownies' **Emergency Vehicle Criteria Checklists**, notes, and sketches for *Automotive Engineering 2*.

## CHECKLIST FOR AUTOMOTIVE ENGINEERING 2

### PREPARE AHEAD: BEFORE THE MEETING...

- ☐ **Gather vehicle materials for girls.** Bring an assortment of materials for the bodies and wheels (enough for each pair of girls to have 1 body and 4 wheels), 2 wooden skewers/thin dowels for each pair, and 2 plastic straws for each pair.
- ☐ **Build 1 sample basic vehicle.** Follow the “How to Assemble a Basic Vehicle” instructions under “Automotive Engineering Nuts N’ Bolts” to assemble a sample basic vehicle.
- ☐ **Create 3 testing ramps.** Follow the “How to Build the Testing Stations” instructions under “Automotive Engineering Nuts N’ Bolts” to create 3 ramps.
- ☐ **Prepare 3 obstacle pans.** Follow the “How to Create the Obstacle Pans” instructions under “Automotive Engineering Nuts N’ Bolts” to create one obstacle pan for each of the three challenge options.

### TIPS FOR THE MEETING

#### For As Girls Arrive: Choose the Materials for Your Prototype

In the activity, teams will gather their vehicle materials. Each team will need these materials to build one vehicle: 1 body, 4 wheels, and 2 axles (2 skewers/dowels and 2 plastic straws).

#### For Step 3: Build a Vehicle Prototype

In the activity, teams will build their emergency vehicles. If they need help, follow the “How to Assemble a Basic Vehicle” instructions under “Automotive Engineering Nuts N’ Bolts” and in the meeting plan to demonstrate how to build a basic vehicle.

Here are a few tips to support teams as they build their basic vehicles:

- **If the wheels aren’t staying attached,** have a variety of materials available for teams to stabilize and secure the wheels to the skewers/dowels, such as glue, modeling clay, pieces of sponge (to stick on the ends of the skewers/dowels), and rubber bands (to wrap around the ends of the skewers/dowels after the wheels are attached).
- **If the straws holding the axles don’t stay attached,** encourage the team to add more tape to the bottom of the vehicle.
- **If the axles don’t rotate easily,** ask the team to make sure the straws are short enough for the skewers/dowels and wheels to stick out a bit on each side. If they aren’t, trim the ends of the straws to allow the wheels to spin easily.

Once girls have built their basic vehicles, encourage them to add special features, such as:

- Drawing doors and windows on their vehicles.
- Adding other features to the vehicle exterior that might help with the extreme weather conditions, like special lights or a plow.
- Using tape, glue, or other materials to make their vehicles stronger or better able to handle the extreme weather conditions.



### For Step 4: Test and Revise Your Vehicle Prototype

In the activity, teams will use the testing ramps and obstacle pans you prepared to test their emergency vehicles. They'll test their vehicles for 1) forward and backward motion and 2) the ability to maneuver extreme weather conditions.

As girls revise their prototypes, here are a few tips to test and improve the vehicles:

- **If the wheels don't spin**, check that the skewers/dowels inside the straws are able to spin freely. If not, trim the straws a little to make them shorter, creating more space between the wheels and the end of the straws.
- **If the vehicle doesn't roll straight**, check that the axles are attached straight across the vehicle body. Check to make sure the wheels are firmly attached to the axles.
- **If the wheels come off**, secure them with glue or modeling clay.
- **No matter what happens**, remind girls that it's good when things go wrong when testing a prototype. That's how engineers find out what to fix!

#### Want More Challenge? Try this!

Brownies can test for other extreme conditions by:

- **Simulating high winds.** Use a hair dryer or fan to simulate high winds for the hurricane or blizzard.
- **Simulating an earthquake.** Shake the box with debris in it as the prototype rolls in it to simulate an earthquake.
- **Simulating flying debris.** Drop a block or shoe on top of the vehicle to see if it can withstand being hit by flying debris. In a real-life situation, this might include falling branches or parts of buildings.

### For Step 5: Share Your Vehicle Prototype and Testing Results

In the activity, teams will create milestone review presentations as a way to tell others about their work, give and get feedback on their project, and discover new ideas or ways to make their vehicle even better.

Here are the questions they'll answer, found in the meeting plan and on the **Share Your Emergency Vehicle** handout for girls:

1. Which kind of emergency vehicle did you engineer?
2. What special features did you include to help in the emergency?
3. How did your vehicle do in the tests for: 1) forward and backward motion and 2) moving in the extreme weather condition?
4. How did you improve your prototype after testing?