

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 “shelter mobiles,” cargo vehicles to help an animal shelter, for each step of the Daisy Automotive Engineering badge.

Background for the Design Challenge 1

Automotive Engineering Nuts N’ Bolts 2

Photos of Vehicle Parts 2

Vehicle Materials List 13

How to Assemble the Shelter Mobile 13

Checklist for Automotive Engineering 1 14

Checklist for Automotive Engineering 2 15

BACKGROUND FOR THE DESIGN CHALLENGE

In the Automotive Engineering badge, Daisies work in pairs to engineer a cargo vehicle that can help an animal shelter. In Automotive Engineering 1, teams will create the engineering plans for their shelter mobiles in Step 1. In Automotive Engineering 2, each team will build and test one vehicle for Steps 2 and 3.

The goal is for each shelter mobile to be able to transport:

- 2 people
- 3 animals
- 2+ boxes of supplies (like food and water)

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

You’ll choose the materials for the vehicle bodies and wheels. Each team will also need 2 skewers/dowels and 2 plastic straws for their axles.

AUTOMOTIVE ENGINEERING NUTS N' BOLTS

Photos of Vehicle Parts

Axle



Axle



Door



Door



Door



Door



Hood



Trunk



Seat



Seat



Seatbelt



Seatbelt



Steering Wheel



Engine



Wheel



Wheel



Wheel



Wheel



Window



Window



Window



Windshield



VEHICLE MATERIALS LIST

EACH VEHICLE WILL NEED:

- **1 body:** 1 shoe box, tissue box, or some other similar box, aluminum foil loaf pan, empty plastic water or soda bottles, empty half gallon plastic or paper milk or juice cartons with one long side cut out.
- **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. If you think your Daisies might have a hard time using these supplies, you can assemble the axles (skewers through straws) and attach the wheels in advance. Then, the girls can just tape the completed axles to their vehicle bodies.

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 THE SHELTER MOBILE

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.

CHECKLIST FOR AUTOMOTIVE ENGINEERING 1

Prepare Ahead: Before the meeting...

- ☐ **Print and cut out the “Photos of Vehicle Parts”** in the “Automotive Engineering Nuts N’ Bolts” section of this Guide to use in a demonstration in Step One.
- ☐ **Use the “Vehicle Materials List”** in the “Automotive Engineering Nuts N’ Bolts” section of this Guide to choose what materials girls will use for the vehicle bodies and wheels.
- ☐ **Gather a sample set of vehicle materials for the meeting**, including: 1) 1 body in your choice of material, 2) 4 wheels in your choice of material, and 3) 2 wooden skewers (or thin dowels) and 2 plastic straws for the axles.

TIPS FOR THE MEETING

For Step 1: Create Your Automotive Engineering Plan

In the activity, teams will create their automotive engineering plans.

First, you’ll do a demonstration with the “Photos of Vehicle Parts”, an open box (the vehicle body), a doll (the driver/passenger), and stuffed animals (the cargo) to review the **Shelter Mobile Criteria Checklist**.

Interior Criteria:

- 2 seats and seat belts for passengers
- Space for 3 animal crates
- Storage space for two supplies, like food and water.

Exterior Criteria:

- 1 body
- 4 wheels
- 2 axles
- Windows
- Doors

Then, you’ll help teams to brainstorm special features to make their vehicles more useful and sketch their vehicles.

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

- **Imagine your shelter mobile.** Close your eyes and think about what the shelter mobile needs to do. What does it look like?
- **Start simple, then add details.** First, think about the shape and size of the shelter mobile. Then, think about the special features and other design criteria.
- **Use tracing paper to try out different ideas.** Try out a special feature before adding it to your drawing by drawing it on a piece of tracing paper and placing it over your drawing to see if you like it.
- **Sketch each side of your shelter mobile.** Draw more than one view: top, side, back, and front.
- **Be bold!** Pick your favorite crayon, marker, or colored pencil and add color to your sketches.

At the end of Automotive Engineering 1, make sure to...

- ☐ Collect and save the Daisies’ **Shelter Mobile 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 enough materials for each team (pair of girls) to create one vehicle, including 1 body, 4 wheels, and 2 axles (2 wooden skewers and 2 plastic straws). See the “Vehicle Materials List” in the “Automotive Engineering Nuts N’ Bolts” section for more information.
- ☐ **Build 1 sample shelter mobile.** Follow the “How to Assemble the Shelter Mobile” instructions under “Automotive Engineering Nuts N’ Bolts” to assemble a sample vehicle.
- ☐ **Create 1 testing ramp for every 2-4 engineering teams (4-8 girls).** Create each ramp by leaning a piece of cardboard or a baking sheet on something like a stack of books or blocks. Teams will test their prototypes by taking turns to roll them down the ramp.

TIPS FOR THE MEETING

For As Girls Arrive: Gather Materials for Your Vehicle

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

For Step 2: Build a Vehicle Prototype

In the activity, teams will build their shelter mobiles.

First, they’ll decide on the front/back of their vehicle and draw windows and doors on their vehicle bodies.

Then, follow the “How to Assemble the Shelter Mobile” instructions under “Automotive Engineering Nuts N’ Bolts” and in the meeting plan to demonstrate how to build a basic vehicle. Use your extra set of materials to show girls how to do each step. Then, give them time to do the same step before moving on to the next.

Here are a few tips to support teams as they build their shelter mobiles:

- **If the wheels aren’t staying attached,** have a variety of materials available for teams to stabilize and secure the wheels to the skewers, such as glue, modeling clay, pieces of sponge (to stick on the ends of the skewers), and rubber bands (to wrap around the ends of the skewers 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 spin easily,** ask the team to make sure the straws are short enough for the skewers 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.

For Step 3: Test Your Vehicle Prototype

In the activity, teams will use the testing ramps you prepared to test their shelter mobiles and use what they learned from testing to improve their vehicles.

First, they'll test their vehicles for forward motion.

As girls revise their prototypes, here are a few tips to 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. 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**, it's good when things go wrong when testing a prototype. That's how engineers find out what to fix!

Then, they'll test their vehicles for carrying cargo successfully.

Here are a few tips for helping girls to test their vehicle prototypes with cargo:

- **If the passengers or cargo come loose during testing**, reinforce the tape 'seat belts.'
- **If there isn't enough room for the passengers and cargo**, find other ways to store the supply boxes. Will they fit under the drivers or animals? Can the boxes be stacked?

Want More Challenge? Try this!

Test how far the vehicles can travel. If you have time and brought a tape measure, girls can test their vehicles a third time to see how far they go. Use a piece of masking tape to mark how far each shelter mobile goes after being pushed down the ramp with cargo in it.

Once all the teams have tested their prototypes and marked their result with a piece of tape, use a tape measure to measure how far each prototype went with cargo.

Then, have the girls brainstorm about the design differences in the prototypes and guess why some went farther than others.