MAKING STUFF FASTER

NOVA PBS WGBH

How do engineers use design and materials science to make stuff faster?

THE STORY OF FASTER

Ever since humans have stood on two feet, we've had the basic urge to go faster. What does it take to make humans go faster?

TALKING "FASTER"

Start the conversation with the following questions:

- What does "fast" mean to you? Are there different kinds of fast?
- What are some examples of fast movement?
- What are some examples of fast processes?
- Why do we want or need to make things faster?

REAL-WORLD EXAMPLES

- "Powering Torque in the Trunk" clip from *MAKING STUFF Faster*
- Faster PPT Slides

PROJECT PREVIEW

In the following series of investigations, students will build a simple car out of a block of wood and get comfortable using hand tools. They'll make modifications and test their car for speed, learn what makes cars faster, and then apply that knowledge to the design of a model car, built from scratch.

ACTIVITY: BUILD A SIMPLE WOOD BLOCK CAR

Overview

Students will build a simple model car and then compare its performance in a series of races.

Materials

Recommended for each student:

- Pencil and paper
- Wood for the car body (1" x 2" x 6" or 1" x 3"x 6" recommended)
- Wheels
- Axles
- Sandpaper
- (Optional) Variety of decorative materials, such as markers and stickers
- (Optional) Inclined plane or propped-up, long table to use as a test track
- Hand saw
- Ruler
- Clamp
- Hammer/mallet
- Safety glasses

Brainstorm & Discuss

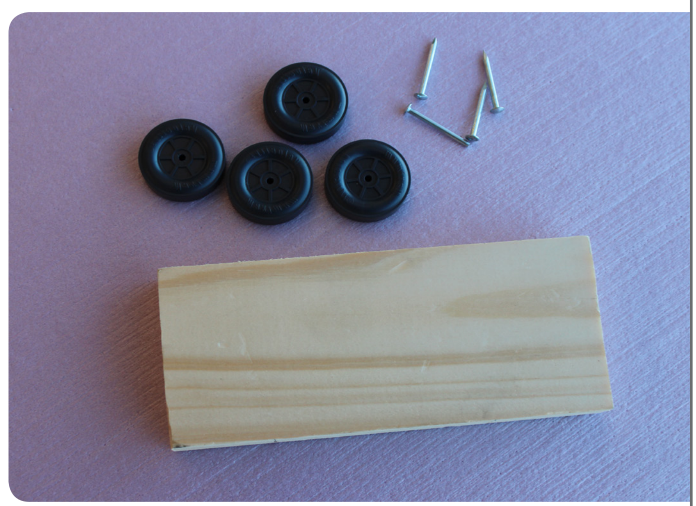
Begin the brainstorm. Let students know that they'll be building basic cars. Ask them:

- What are some factors that might influence your car's performance?
- If you had your choice, how would you design the perfect model car?

DESIGN & BUILD

Encourage students to use the ideas they developed during the brainstorm to begin designing their basic car.

1. Have students start by sketching a potential design for their vehicle. (Students should understand that the car body will be made from a single piece of wood. This will limit design variety.)
2. The materials list above provides only what is needed for the construction of a basic car. If possible, offer students a choice of decorative materials to empower them to make decisions that best suit their creative capacities.
3. Once students have selected and gathered their materials, it's time to start building!



Tips and Tricks for Inclusion

It may be difficult and/or unsafe for students with impairments to design and build a vehicle using the tools listed above. Consider the following approaches to making this activity more inclusive:

- Provide Lego bricks as the building blocks for the vehicle (see Tool L1 in the Tools Table in the Appendix).
- Allow students to use Lego's Digital Design Software to design a vehicle in place of pencil/paper (see Tool S11 in the Tools Table in the Appendix).
- Provide modeling clay as the building block for the vehicle (see Tool C7 in the Tools Table in the Appendix.)
- Provide precut blocks of wood.

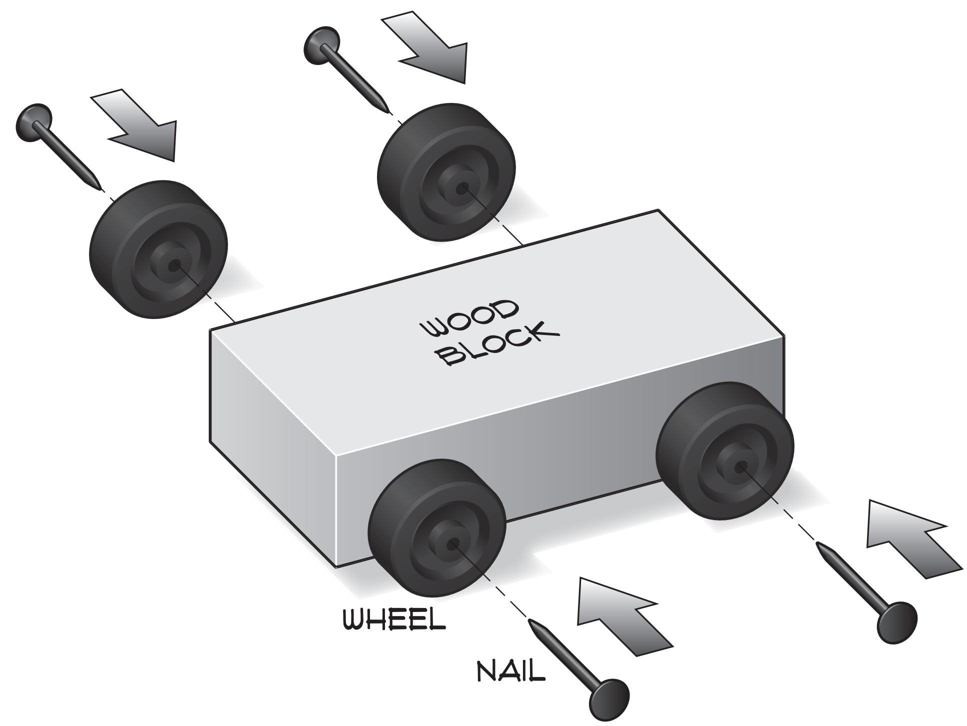
4. If the wood isn't precut, students will need to make their car bodies themselves. A car body can be made by cutting a long piece of wood (1" x 3") into smaller sections. Students should measure and cut the car body using a ruler and a pencil to make sure that the block is cut to design specifications.

DESIGN & BUILD (CONTINUED)

Safety Tip: *If you plan to have students use a saw to cut their own car bodies, make sure to demonstrate the proper way to use the tools before students get started. Have students practice sawing on scrap wood before working with their actual materials.*

5. After cutting, students can use sandpaper to smooth out any rough edges on the wood block and make small design modifications.

6. Next, have students mark where they want to place their axles.



Safety Tip: *These axles will not run clear through the car body; instead, they'll be put in place with a hammer/mallet and nails. The placement of the wheels and axles—called the alignment—is a very important factor in making the car go straight and fast! Students should try to align the axles as symmetrically as possible. Students will be able to measure and mark with precision if they use a clamp to hold the car still.*

7. After marking the location of each of the four axles, have students slide an axle through the hole in each wheel and use a hammer or mallet to attach the wheel to the car body. Remind students to place each axle into the car at as close to a right angle as possible.

Quick Tip: *Add both of the wheels to one side of the car before working on the other side.*

TEST & REBUILD

Once students have put together their block car, they can begin to test performance.

1. Have each student roll his or her car across the table to ensure that the car rolls smoothly. Students should adjust their design until their car rolls freely when placed on a slight-to-moderate incline.
2. Have students race their cars in small groups, or "heats," with the winners advancing to the next round.
3. Have students examine the fastest group of cars. Ask them to share their ideas about why these cars might outperform others.

Tips & Tricks for Inclusion: *Timing may be difficult for students with certain impairments. To make this activity more inclusive, consider having students facilitate timing on a computer or AAC device.*

WRAP UP

Once students have finished with the activity, give them time to share their findings.

Ask them:

- Were there any patterns in design and performance?
- Were there any surprises, or things you didn't expect?
- How might you change your design given more time or a wider variety of materials?

DESIGN CHALLENGE: MAKING A CAR FROM SCRATCH

Overview

Students apply what they learned in the previous activity and use their newfound knowledge to design a car using the materials of their choice.

Materials

This Design Challenge encourages students to use what they know to design a model vehicle from scratch. Because the challenge is designed to allow for maximum creativity and choice, materials should vary widely depending on availability. Students should be encouraged to find and select whatever materials they believe will contribute to a sound design. Such materials could include cardboard, plastic water bottles, metallic objects, other recyclables, craft supplies, etc.

Brainstorm & Discuss

Begin the Brainstorm. Ask students for ideas on how they might make their car faster by using alternative materials. Have them draw on what they noticed about the faster cars that emerged during the first activity. Students should consider:

- How does the shape of the vehicle affect its speed?*
- How does the weight of the vehicle affect its speed?
- How does the size of the wheels affect the speed of the vehicle?
- Where does friction impact your car? (i.e., where do two solid surfaces rub together?)
- Based on the answers to the above questions, what materials can be used to make the vehicle faster?

**At these speeds, the drag created by airflow over the car isn't a factor, and aerodynamics don't need to be taken into account. However, aerodynamics and other considerations can be addressed for purposes of discussion.*

DESIGN & BUILD

After considering the various elements that go into designing a car, students can begin the design process.

1. Have students sketch or list ideas for a new car design using whatever materials are available.
2. Once students have completed their designs, selected their materials, and gathered the necessary supplies, it's time to start building!

TEST & REBUILD

Once students have completed a prototype of their uniquely designed car, they should test its performance.

1. Students should perform a preliminary test run of their vehicle, ensuring that their design is reasonable and sound.
2. Next, students can race their vehicle as they did in the first activity. As before, have students examine the fastest group of cars. Encourage students to redesign and retest based on their findings.

WRAP UP

After providing adequate time for testing and revision, students should reconvene as a group to discuss what they learned.

Encourage discussion with the following questions:

- What materials did you select for the Design Challenge? Why?
- Consider the real-world applications of what you've learned. How do you think your findings would relate to the design of automobiles on the road today?

In conclusion, watch the clip "Powering Torque in the Trunk" from *MAKING STUFF Faster.*