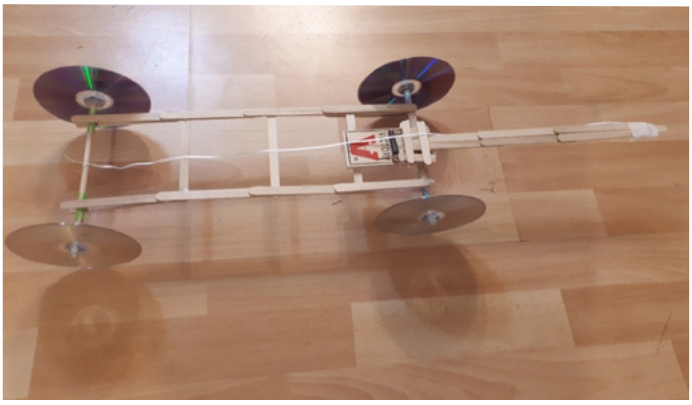
The Mousetrap Car: Grades 9 to 10

YOUR MISSION

Today you will build a mousetrap car out of common household items and craft materials. Your car will use a mousetrap as its means of propulsion. In the end, you will learn how to convert a mousetrap's spring energy into rotational work needed to spin the wheels of your car. These are important concepts frequently used by mechanical engineers.



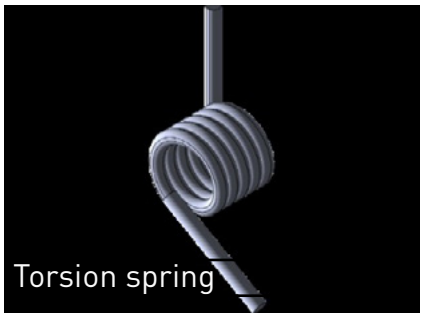
WHAT'S GOING ON

Mechanical engineers design components for machines and other systems with moving parts. Aerospace, automotive, industrial, and materials engineering are just some of the different mechanical engineering fields. More specifically, automotive engineers design engines, transmissions, braking systems, and frames for cars, trucks, motorcycles and other vehicles.

Common mechanical devices used by engineers are springs which are found in a wide variety of mechanical applications. For example, heavy-duty helical (coil) springs are used in the suspension system of your car and are designed to absorb bumps and vibrations while driving. When a helical spring is under **compression**, an inward force is applied squeezing the spring.

On the other hand, when it is under **tension**, an outward pulling force is applied thus stretching the spring. The difference in length of the spring is called **deflection**. In both cases the spring always wants to go back to its original length. Finally, these concepts equally apply to torsion springs which are twisted radially instead.


Helical spring


Torsion spring

In today's activity, you will use a mousetrap which contains a torsion spring that is attached with a string to the one of the wheel axles of your car. Winding the string up around the axle will load the spring and store mechanical energy. Releasing the loaded spring will turn the shaft connected to the wheels of your car, propelling your car forward. Finally, CDs will be the wheels of your car as they are almost perfectly circular and their edges are smooth, which is optimal for reducing friction.

KEY TERMS

- **Helical spring:** A coil-shaped device usually made of steel designed to resist compression and/or tension and store mechanical energy.
- **Torsion spring:** A spring device made to resist twisting motion.
- **Compression:** The stress of an object when being squeezed.
- **Tension:** The stress of an object when being pulled apart.
- **Torsion:** The twisting of an object from an applied torque.
- **Deflection:** The difference in length of a spring from its original position (when no external force is applied).
- **Force:** The measurement of a push or pull on an object.
- **Energy:** The capacity of an object to perform work.
- **Work:** The product of force and displacement.
- **Friction:** The force between two contacting surfaces preventing them from sliding.

MATERIALS NEEDED

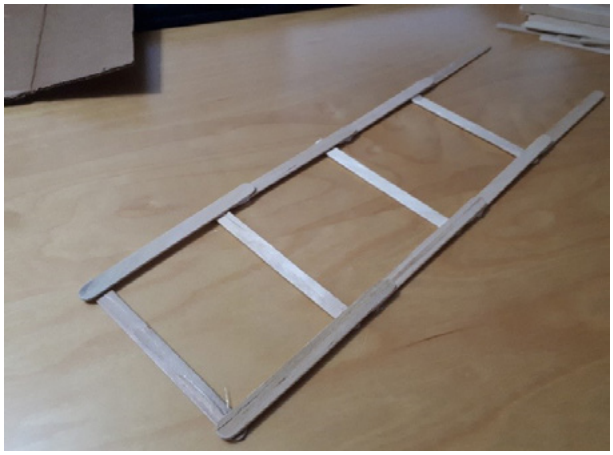
- Mousetrap
- Popsicle sticks
- 4 CDs or DVDs
- String OR dental floss
- Large straw
- Masking tape
- Two 1' long diameter dowels
- Any type of strong craft glue
- 1/4" and 3/8" washers (four of each)
- Four 1/4"-20 palnuts (self-threading hex washer nuts)
- Scissors

WHAT YOU NEED TO DO

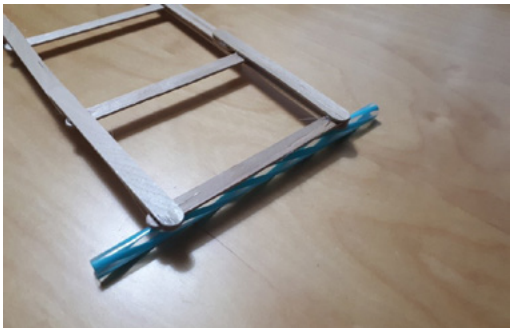
Though you may follow these instructions step-by-step, don't be afraid to customize your design! Feel free to sketch out your design on a piece of paper before you begin.

- Popsicle Stick Frame/Chassis.

- Glue a rectangular frame together with popsicle sticks that is 1 stick wide and 3 to 5 sticks long. To strengthen the structure, you should add sticks in the middle connecting both sides, but leave both ends free for now, allowing space for the front and rear axles. Your frame should resemble a ladder. You may decrease or increase the length of your frame as you like, but make sure it is rigid enough that it won't sag or bend easily.

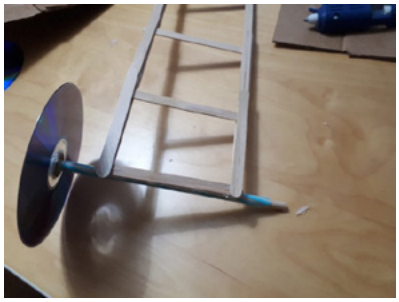


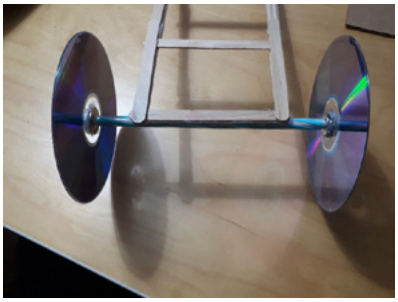
- Wheels: front axle
  i. Glue a popsicle stick on the front end of the frame, connecting the free ends.
  ii. Glue a plastic straw to the underside of this front-end stick.



iii. Make sure the dowel you use can fit inside the straw.
iv. Centre and glue a washer on the hole of a CD (left). Make sure the dowel can fit in the washer first before gluing the washer on the centre of your CD's. Though another attachment method can be used, force a 1/4" palnut on the dowel as shown below (centre), and then to the outside of the wheel also shown below (right).

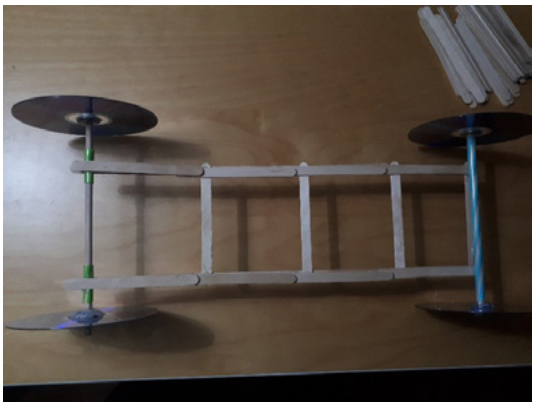
v. Glue a wheel on each side of the dowel. Be sure to avoid gluing the wheels to the straw.





- Wheels: rear axle
  i. On the rear end of the frame, glue two 1-inch-long straw pieces under each free end.
  ii. Sandwich both straws with their own popsicle sticks to reinforce the connection of the straws to the frame. Alternatively, you may use the dowel instead for the arm.

  iii. Make sure the dowel can freely spin in both straws.
  iv. Glue a wheel to each side of the dowel. Again, do not glue them to the straws.

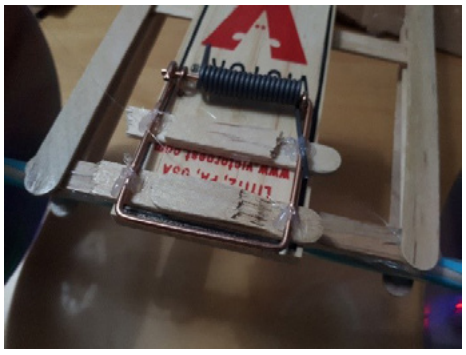


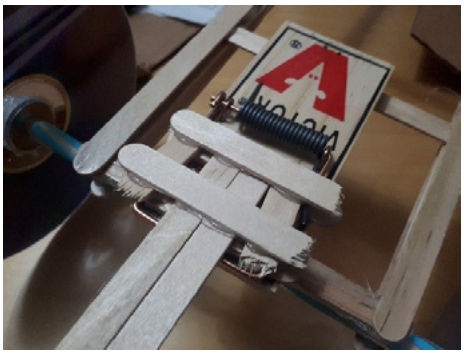
- Arm
  i. Remove the catch and staples from a mousetrap, as shown below.

- Seat the mousetrap on the two front-most popsicle sticks with the hammer (rectangular bar) facing the front. Glue it to the frame.

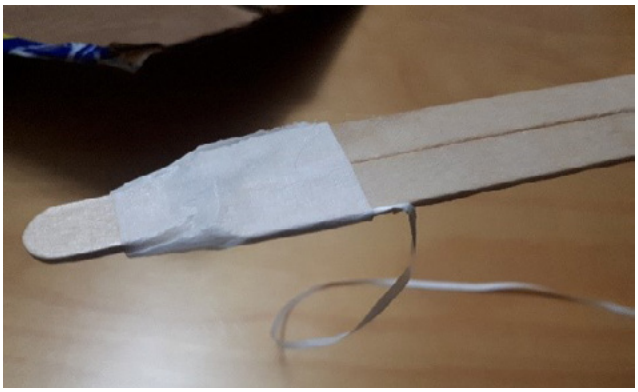
- Build an arm out of popsicle sticks that is approx. the total length of the frame.

- Sandwich one end of the arm to the hammer of the mousetrap with popsicle sticks. Ensure a rigid connection with the hammer. The arm should be hanging in the front of the car, NOT the back.

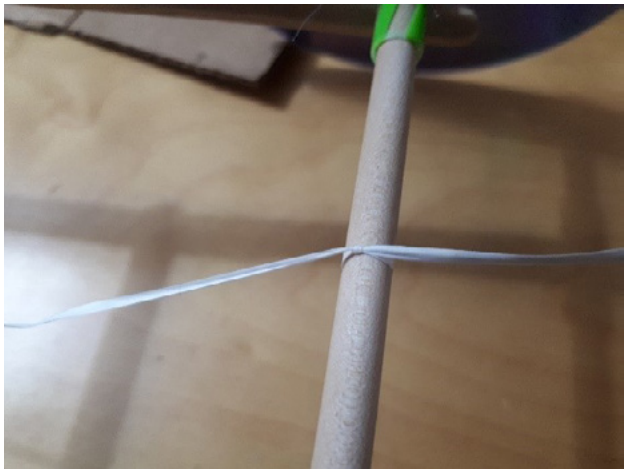




- Glue the end of a string or dental floss to the end of the arm.



- Tie the other end of the string to the rear axle dowel.



- Race! To activate your mousetrap car, you'll need to swing the arm back from the front to the back, while at the same time, spin the back wheels to wrap the string around the rear axle.

- Once you're ready to test your car, release the arm and watch your contraption go!

FURTHER REFLECTIONS

1. How far did your mousetrap car travel? Did it travel at all?
2. If it's having trouble rolling, you may have to remove the axles and sand down the dowels, shorten the straws, etc.
3. What would happen if you used a longer arm instead?
4. What would happen if you used smaller wheels instead?
5. In what ways can you modify your design to maximize the distance traveled?
6. In what ways can you modify your design to increase your car's speed?
7. What physics and engineering concepts did you learn today?

ENGINEERING DESIGN PROCESS

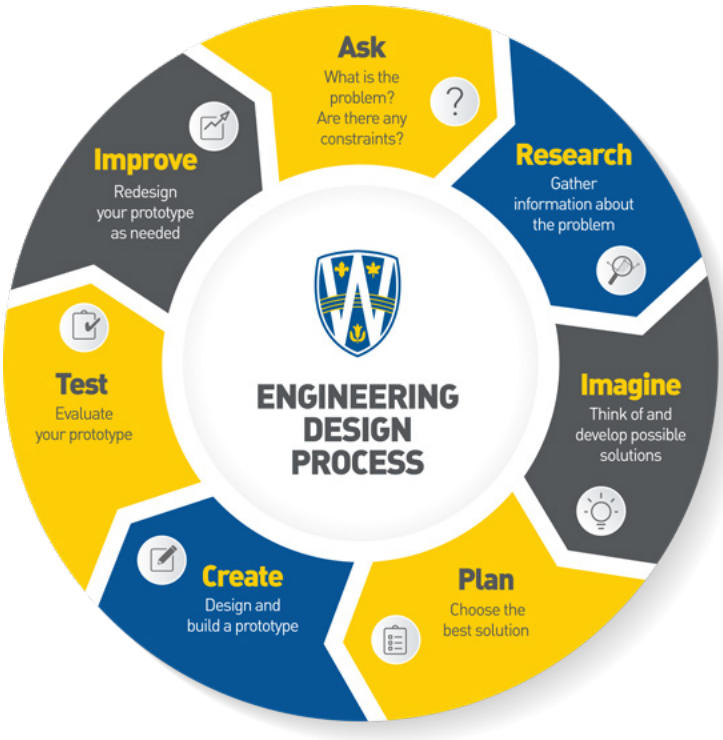
All engineers use the Engineering Design Process to plan, build, test and reflect on their designs and when coming up with solutions to a problem. The steps for the Engineering Design Process are listed below. Use the Engineering Design Process to test and improve your design.

First, think of the problem.

How can you fix it? Think of as many ideas as you can that you think will solve this problem.

It might be helpful to first sketch out your ideas on a piece of paper. Make as many different designs as you can!

Test and compare all of your solutions. Which one solves the problem and works the best?



CURRICULUM UNIT CONNECTIONS

Grades 9-10 – Physics; Grades 11-12 – Forces, Energy and Momentum, Kinematics, Dynamics

SHARE YOUR DESIGNS WITH US!

Tag us on our UWindsor Engineering Social Media Pages and show us your designs!

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