



Invention Project®



E-RACER BOTS



Innovation Exploration Kit™, Invention Project® Series

Read prior to using the product.

SAFETY & HYGIENE



Warning: Choking hazard—small parts.
Not for children under 3 years.

- Activities require adult supervision.
- Ages 10+.
- Read and follow all instructions.
- For safety and hygiene purposes, please wash your hands after each activity.
- Do not put materials in or near anyone's eyes, mouths, and ears.
- If anyone has an allergy, remove any materials that may trigger an allergic reaction for them. Note: The feathers can be allergenic.
- Do not play with or place plastic bags near the face or mouth.
- Ventilate the room when using markers.
- Remove the batteries during long periods of non-use. Always remove exhausted batteries. Battery leakage and corrosion can cause damage.
- Never short-circuit the battery terminals.
- Dispose of batteries safely. Do not dispose of batteries in fire. The batteries may explode or leak.
- Coin batteries can be harmful if swallowed. Please take precautions to make sure they are not placed near the mouth.
- Do not allow coin batteries to touch when not in use.



Use this password to access your
E-Racer Bots experience:

motor



For an enhanced experience,
VIDEOS can be found online at
[invent.org/Invention-Project/E-Racer-Bot](https://www.invent.org/Invention-Project/E-Racer-Bot)

E-RACER BOTS

Take trial and error to the next level! Investigate the infinite possibilities of creating a simple robot that moves through vibration.



MATERIALS

Binder clips | Chart paper
| Coin batteries | Corks | Erasers |
E-Racer Bots sheet | Feathers
| Large paper clips | Markers |
Masking tape | Pencil | Pushpins
| Rubber bands | Scissors |
Small paper clips | Vibrating motors
| Webbing Out Sample sheet

WEB OF IDEAS

Have you ever thought about all of the ways you can get from one place to another? You might choose a different means of transportation depending on how far you are going or where you are traveling. One thing all types of transportation have in common is they require power.

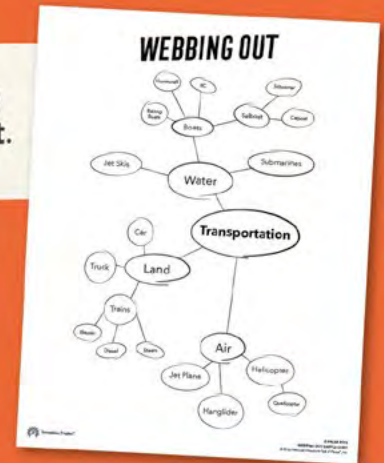


LET'S GET STARTED

Use a technique called Webbing to explore your knowledge, thoughts, and ideas on a topic.

1. Grab a sheet of chart paper and your markers.

2. Find the **Webbing Out Sample sheet**.



This sheet is an example web of the topic "Transportation."

Notice how big topics or ideas branch off into smaller ones.

The invention of the first vehicle came from the need to transport people and goods. Over time, people's needs have changed. What kind of transportation do you want in the future?

3. Now you will make your own web of the topic "Robots." To start, use a marker to draw an oval in the center of a sheet of chart paper.

4. Write the word "Robots" inside the oval.

Robots are machines that can do simple or complex actions automatically. Robots rely on programming, a computer language that gives the machine instructions on what to do. Robots have mechanical functions and often do tasks typically performed by humans.

5. Draw lines that resemble branches off of the main oval. Then, add circles onto the ends of the branches like on the **Webbing Out Sample sheet**.

6. In the circles, write words or draw symbols and pictures about robots. Think about these questions as you are writing.

- What might you know or have heard about robots?
- How might robots help transport goods or people?
- How might a robot move?
- If robots are the main topic, what might be some of the subtopics? Examples include retail, farming, and medical assistance.

7. Share your webbing chart with someone else, to see if they can think of anything else to add.

Scientists and engineers are always exploring new ways robots can help complete a task or transport goods and people. Think about processes, projects, or jobs that might be better or easier with the help of robots.



Try not to think too hard about your subtopics or worry if the ideas are good or right.

Keep moving and feel free to draw symbols or pictures to make your web more fun, colorful, and expressive of your ideas.

MORE TO EXPLORE

Webbing is a useful tool for exploring and understanding the overall structure, as well as the parts and pieces, of a subject or system. There are many different types of webbing techniques with various adaptations that can be used to visually explore topics. How might you use webbing to explore other topics?



When we allow our thoughts and ideas to take on a visual form, we are able to investigate their possibilities in a new way!



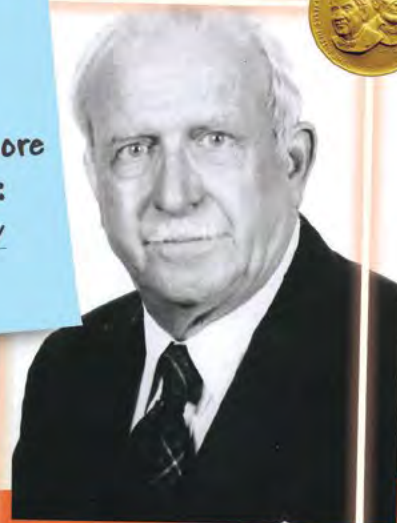
MEET A HALL OF FAMER

National Inventors Hall of Fame® (NIHF) Inductee George Devol began realizing the value of factory automation while working on magnetic recording technology. He filed a patent for a robotic arm that could move and store step-by-step digital commands on a drum or other medium. This would become the Unimate industrial robot. Devol's patent for the first digitally operated programmable robotic arm represents the foundation of the modern robotics industry. Today, industrial robots have transformed factories into safer places and improved products with precision and consistency.



If possible, learn more about Devol here:

invent.org/inductees/george-devol



DESIGN E-RACER BOTS

Many inventions can be found on or inside a robot, like a microprocessor, sensor, and motor. Some inventions can be a combination of several inventions, like a smartphone that includes a phone, a camera, and a computer! Check out these examples.



E-RACER BOTS

1. Using the eraser as a base and the pushpins as legs, sketch several unique E-Racer Bots on the **E-Racer Bots sheet**.

2. Think about how you will design your E-Racer Bots to move. Sketch ideas on how you could add more materials, like a coin battery and a vibrating motor, to power up your Bots.

3. Circle your top two E-Racer Bot sketches.

4. Choose a name for each of your Bots.

POWER UP E-RACER BOTS

No matter what method of transportation you use, it requires power! From the very first steam engines that powered trains and ships to internal combustion engines that power cars and even rockets, they all require a form of power to get moving.

Your E-Racer Bot uses a coin battery to power a motor to get it to vibrate.



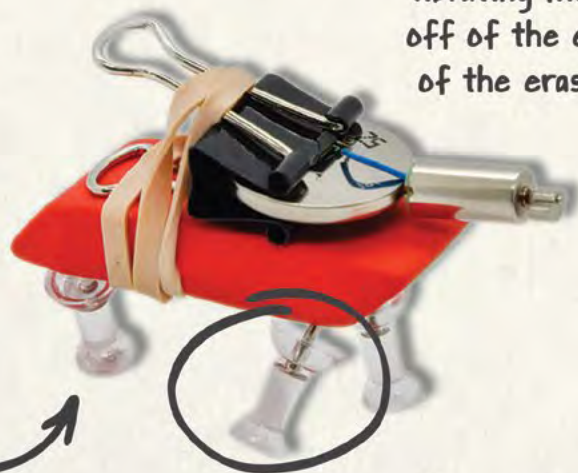
1. It's time to get your E-Racer Bots to move! Refer to your sketches and grab the materials to build and test your top two E-Racer Bots.

2. Use this image as building inspiration.

3. To raise your eraser off the ground, place pushpins into the bottom of the eraser to serve as feet.

4. Use a binder clip to hold the wire ends on the battery. Then, secure the binder clip and battery to the eraser using a rubber band.

Hang the vibrating motor off of the edge of the eraser.



Try inserting your pushpins like this.

MEET A HALL OF FAMER

Energy storage expert and NIHF Inductee Esther Takeuchi led efforts to invent and refine the lifesaving lithium/silver vanadium oxide (Li/SVO) battery technology, used in the majority of today's implantable cardioverter defibrillators (ICDs).

ICD batteries have high energy density with the ability to support intermittent high-power pulses. In addition, they have a long life and are safe and durable. In Takeuchi's innovation, the cathodes employ two metals, silver and vanadium, rather than just one, allowing for more energy. In addition, the Li/SVO chemistry lets the ICD monitor the level of discharge, allowing it to predict end of service in a reliable manner.



If possible, learn more about Takeuchi here:

[invent.org/inductees/
esther-sans-takeuchi](https://invent.org/inductees/esther-sans-takeuchi)

MORE TO EXPLORE

Collegiate Inventors Competition® (CIC) Graduate Bronze Prize Winners Rahul Mukherjee and Eklavya Singh, from Rensselaer Polytechnic Institute, invented Advanced All-Carbon Lithium Ion Batteries. Mukherjee and Singh's Advanced All-Carbon Lithium Ion Battery technology uses a mix of materials to deliver faster and longer-lasting charges. Their invention is a biodegradable "green" chemistry combination, with no toxic metals, for abundant electricity on the go.



Watch the Team Advanced Batteries video to see CIC Graduate Bronze Prize Winners Rahul Mukherjee and Eklavya Singh.

TEST AND RETEST

It's time to experiment with your E-Racer Bots by observing how they move.

1. Add feathers to the Bot body. You could also try attaching a cork as a counterbalance to the motor head. Observe how this affects the movement of your Bots. Explore using paper clips for feet. Finally, try cutting your eraser in half.
2. If your E-Racer Bots don't move much, switch up materials, or change how they are attached, and try again!

Check out
this fun Bot!



TROUBLESHOOTING TIPS



I Wonder...

What materials did you use to design your E-Racer Bots? Why did you choose those?

What discoveries did you make during your trial-and-error process?

What other materials might you use to make a simple robot that moves through vibration?

If at any point your E-Racer Bot does not move, use the following troubleshooting tips:

- Think about weight and where you placed the battery and motor. Adjust to change how the Bot moves.
- Consider counterbalance. Position the "legs" of the E-Racer Bot in a way that puts the Bot slightly off balance, so that it moves along with the motor's vibration.
- If using a cork, check that it is positioned in a way that it makes the Bot's movements off-balance.

START YOUR MOTORS



Now let's get your
E-Racer Bots moving!

1. First, on a piece of scrap paper, list at least five of your favorite characters from TV shows, movies, games, or the internet.

2. Assign each character a point value such as 10, 20, and so on.

My Favorite Characters

- 1.
- 2.
- 3.
- 4.
- 5.

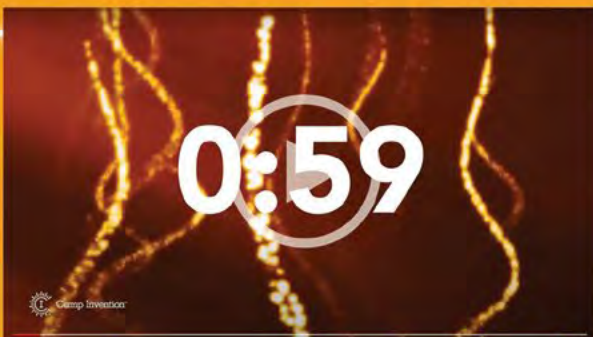
3. Then, using a piece of chart paper and a marker, draw at least 10 dime-sized circle targets close together.

Don't make the track too big, as these little Bots must vibrate their way to their destinations!

4. Draw an image or write the name of one of your favorite characters from your list in each target. It's okay if you use a character more than once.

5. Write in the point values next to the corresponding characters as you ranked them on a piece of paper.

6. Place your E-Racer Bots on any of the circles and see how many targets they can cross over or touch!
If possible, play the One-Minute Timer video or set a one-minute timer as your Bots are on the go!



7. Keep score on a piece of paper.



CONGRATULATIONS ON BUILDING
and investigating unique, vibrating robots!


MORE TO EXPLORE

The possibilities of building small robots are endless. If you enjoyed making a simple circuit and experimenting with a variety of materials to try to make an object move, consider testing different types of motors, bases, batteries, and add-ons. Many inventors designed their products or processes through simple tinkering and discovery.



MEET THE HALL OF FAMERS

NIHF Inductees Raffaello D'Andrea, Mick Mountz, and Peter Wurman created the Kiva system, which has dramatically advanced warehouse order fulfillment for e-commerce. Using thousands of autonomous mobile robots to lift and move racks of inventory shelves to workers who select items for individual shipments, the Kiva system substantially reduced the time from order placement to shipping.

 If possible, watch the Mountz, Wurman, and D'Andrea story to explore more about how mobile robots are used in order fulfillment.



Learn more about
D'Andrea here:

[invent.org/inductees/
raffaello-dandrea](http://invent.org/inductees/raffaello-dandrea)



Learn more about
Mountz here:

[invent.org/inductees/
mick-mountz](http://invent.org/inductees/mick-mountz)



Learn more about
Wurman here:

[invent.org/inductees/
peter-wurman](http://invent.org/inductees/peter-wurman)



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