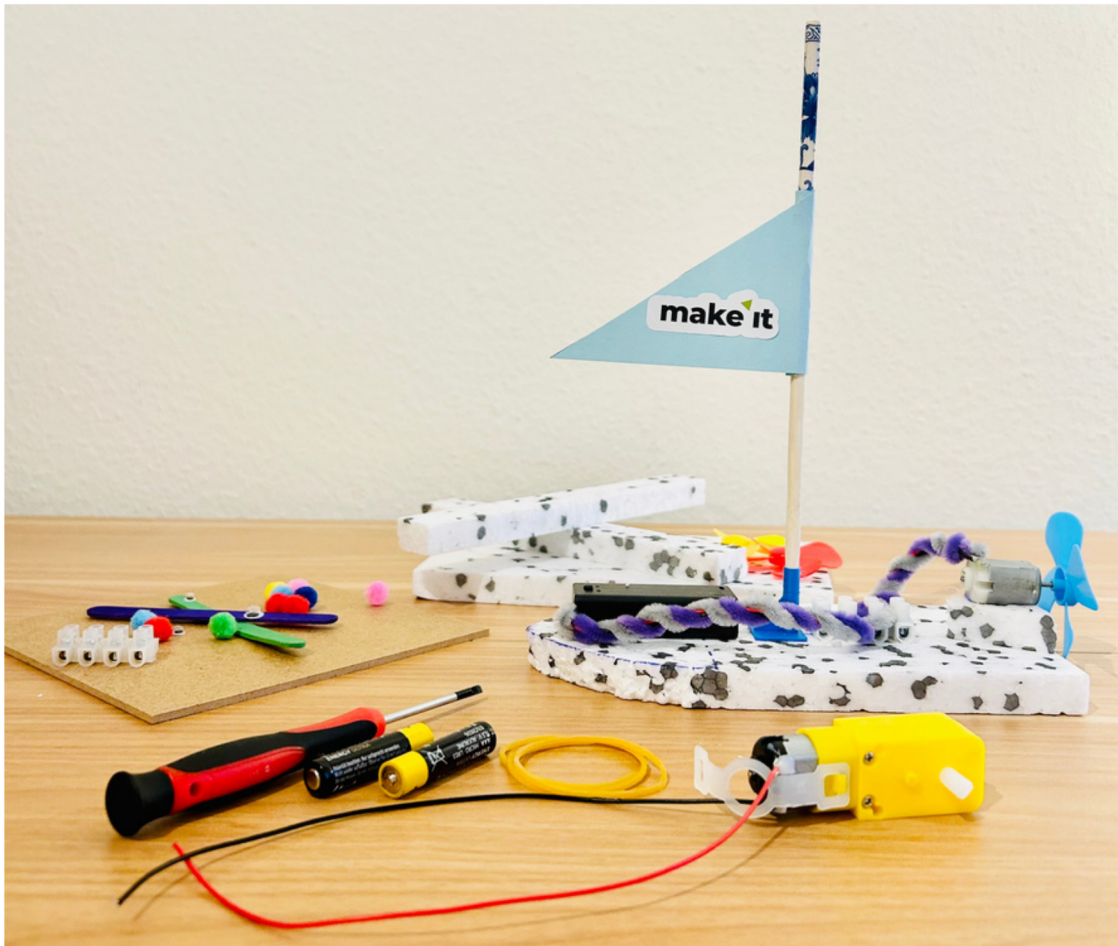


Welcome to the

self **eSTEAM** CHALLENGE'24

This step-by-step tutorial will guide you to design and craft an electric boat through fun research tasks and practical experiments! With the material you find in the box, you can easily build a functioning boat. Of course, you can always use additional materials or different designs to make your electric boat unique. Feel free to let your creativity run wild! The important thing is to build a boat that can float and move forward in the water!





Your first Maker project?

You don't know what an electric circuit is? You have not worked with a screwdriver or crafted something before?

No worries! The tutorial is here for you to guide you step by step through an exciting journey of research and experimentation, from a first sketch to an outstanding boat. You will not only learn how to build a boat but you will also get a touch of how electronic and hydrodynamic make the boat move forward.

Some problems while building is part of your journey... it's just normal if things don't work out right away! All you need to do is to analyse what did not work well and then try again. Take a break if necessary, and very important: do not hesitate to sometimes ask others to help you.

One Guide Many Solutions!

In this small workbook, you will discover step-by-step how to build the base for your boat. However, this is not a unique solution; there are many ways to craft an electric boat and one of them is absolutely your way. In this workbook, however, this tutorial will provide you with small tasks and research questions to help you, while you craft your own idea. These symbols show you what the tasks are about.



This is what you need



Research questions



Write something here



Good to know



Remember this



Note to tutors and parents



Work on the boat



Geek Corner

Teamwork **makes the dream work!**

If you find some steps tricky, feel free to work together with your friend(s). Depending on your age, you might be unfamiliar with some tools or techniques. Feel free to inform yourself, e.g. by asking an adult to support you. But let's make sure they don't take over the whole project- because it's your time to shine!

Do you have a **different idea?**

You already have done more advanced challenges and you find the tutorial too basic? Do you have a different or more complex idea to craft using the provided materials? That's great! You are welcome to put the tutorial aside and to work on your idea. We are excited to learn about your innovative solution!

No matter if you are **a beginner or advanced:**

- **Keep trying...** In case you ever get stuck, don't worry!
- **Try step by step:** Don't wait till the end to check your progress. Test also in intermediate steps. If the electric circuit doesn't work, check all connections again. Sometimes it helps to reconnect the cables.
- Or have a look at our **video tutorial**, there you will find some additional solutions.
- You can also ask us your questions personally: come to our Robotics-Makerspace at the CNFPC in Esch/Alzette.
- Drop by the **MakerBuzz**. Our mobile Makerspace travels around the country and is certainly also stopping by your region.

Here you can find more information about the Makerspace and MakerBuzz dates: www.makerbuzz.lu

Dear Parents, Dear Tutors,



We are happy to have you reading this. You certainly can be of great help to the person who asked for your assistance. Please assist with one basic rule in mind: don't let your experience overrun the creativity and ingenuity of the person who asked for just a little help... it shall remain her/his/their learning experience...

If you are stuck as a coach, don't be alarmed NOR ashamed.

Refer to other parents/coaches, or join one of our workshop sessions.

Find more details on www.makerbuzz.lu

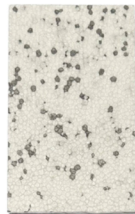
That's what you have in your Kit:



Propeller



Styropor plate



Motor with gear-box



Battery case



Luster terminal



wooden plate



Rubber bands



Chopsticks



3D-printed support



Crafting material



Cable ties



Batteries



Wooden sticks



Wheel



Pencil



Screw driver



Dough



Copper cable



Chocolate egg surprise



You may need some **additional tools**:

- Glue: you will need a type of glue that is compatible with your boat components
 - a. The glue should not attack the Styropor plate
 - b. It should not get dissolved in the water
- A pen or a marker
- A ruler
- A wire stripper
- Scissors and/or a cutter

Is something **missing**?



- Do you want to work on your boat and need more components? That's totally cool! You can use any additional components.
- Do you have a broken component? Just visit us, so that we can replace your faulty component(s)!

You find more information at: www.makerbuzz.lu

Safety first!




Always be careful when using sharp or hot tools.

- You can check out our basic safety tips at www.makerbuzz.lu (bottom of the page).
- In case of a little mishap, you'll find some handy plasters in your Self-eSTEAM kit.





1. Develop **your plan, your idea!**

- What can float?
-  • What can move a boat forward?

Let your creativity afloat and list/sketch your ideas here:



Brainstorm...



- All ideas are fine! write down or sketch as many options as possible.
- If you have a first idea, try to develop it further: What if I make it bigger, what if I turn one of the elements around, if I try something totally new?
- What's in the box to help with it?



2. Make your idea float!



- Why do some objects float and some objects sink in water?



- Density is a measure that shows how much mass is packed in a certain volume.



- Unwrap and open the surprise egg... You may put the chocolate aside for later... Now, take out the inner plastic cocoon:
 - If you put it in a cup of water, does it float?
 - Now open the cocoon and replace the paper and plastic that was inside with something much heavier, some stones, some metal). Close the cocoon again and put it back on the water. Does it still float?
- If an object's density is higher than the density of water, the object (sinks/floats) in water.
- If the object's density is less than the density of water, the object (sinks/floats) in water.



- What do you find in the kit that can float on water? What can be used as your boat plate?
- What is the most efficient design for the bow (front), hull (body), and stern (back) of the boat? Pointed? Narrow? Wide? Tapered? Why?!

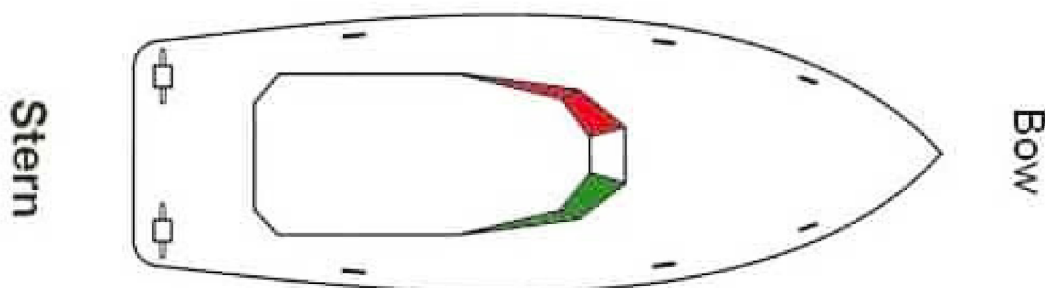


Image Source: www.boatinggeeks.com

Shape your boat ...



- Get the pen/pencil and ruler

- Get the Styropor plate

- Get a cutter



- Use your ruler to measure the width and length of the Styropor (or other material you plan to use as your boat plate).
- Which side would be the bow and which would be the stern of your boat?
- How wide or narrow will be the bow, hull, and stern of your boat? Remember to consider the capacity of carrying the batteries, motor, propeller, antenna, crafts, and decoration weights for your boat!

Here are some examples of shape that a boat might have:





- Use your pen and ruler to draw your boat design on the Styropor or the wooden plate. You can practice drawing it on paper first and then draw your final design on the plate.

- Use your cutter to cut along your design lines. If necessary, ask an adult to help you with cutting.

3. Make your idea **move forward!**

Review the materials provided in the kit and answer the following questions.

- Which one gives power to the boat?
- Which one converts the power into motion?
- How does a propeller run the boat forward?



Let the propeller rotate!



The propeller in your boat can be designed to rotate either in water or air. This tutorial provides instructions for the latter scenario, requiring the removal of the motor from the gearbox to directly attach the propeller.

Alternatively, depending on your boat's design, you can keep the motor inside the gearbox. In this alternative setup, you can fix the wheel onto the gearbox and attach the propeller to the wheel or transform the wheel with other components into a paddle wheel. This configuration allows the propeller to safely rotate inside the water without exposing the motor to water. Furthermore, you are allowed to use more advanced materials, more powerful motors, and different types of propellers. To ensure safety, powerful motors need to be mounted in a way that avoids any harm. You may for instance mount it with the help of a safety cage.



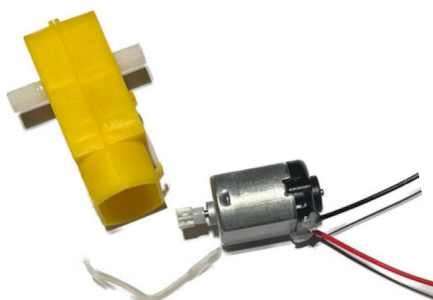
- Put two batteries inside the battery case
- Get the motor and the propeller.



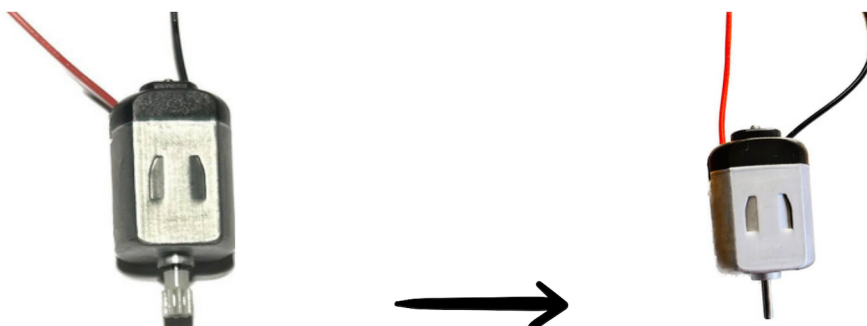
- Open the white/half-transparent belt.



- Take out the motor from inside the yellow gearbox.

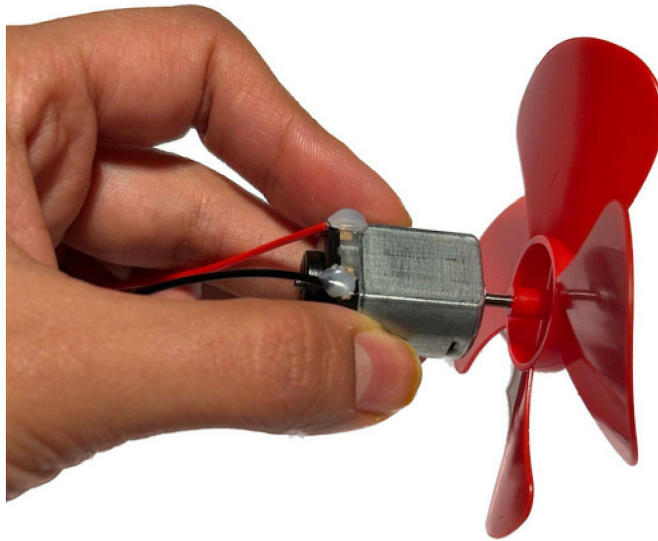


- Remove the white small ring on the motor's shaft. You will need a hard tool (clamp, plier, cutter,...)

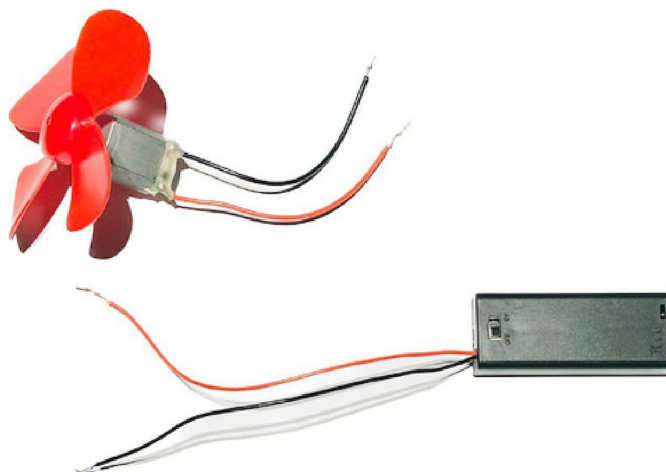




- Place the propeller on the motor's shaft. Make sure it doesn't fall off the shaft and that it can turn without any friction.



- You now have the first two components with two cables each in front of you. The battery case and the motor.

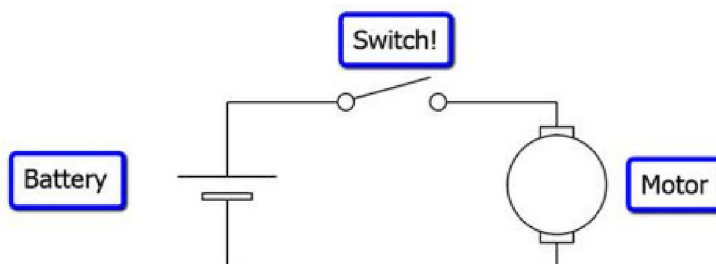


- How do you get the propeller rotating?



- The motor needs electricity to run. If you connect the motor to the battery, an electric circuit is created and electricity can flow. The electricity can flow only when all the cables are connected.
- A switch can disconnect and connect the circuit. The electricity flows in the circuit when the switch is on and it doesn't flow when the switch is off.

The battery box combines two functions: It holds them in place on your boat and has already a switch included.



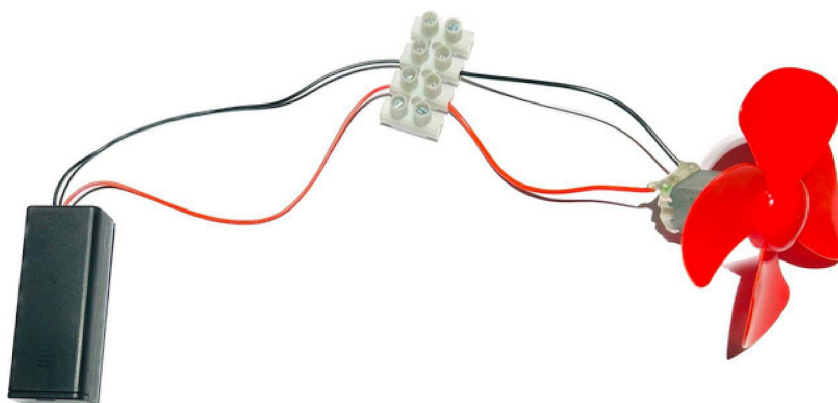
Hands-on Practice!



- Get the screwdriver
- Get the luster terminal
- Get the battery case (with batteries included) and the motor (with the propellor)



- You can connect cables with the help of the luster terminals. Switch off the power on the battery case. Insert one of the battery cables into one side of the luster terminal and tighten the screw with the screwdriver on top of the terminal. Now plug one of the motor cables into the opposite side of the luster terminal and tighten the screw again. Do the same for the other pair of cables. This way the electricity flows through the connected cables. Activate the power switch on the battery case and test the motor.



- Learn more about [How Electricity Works!](#)





- How does the propeller rotate when the cables of the same or the opposite color are connected? Try different combinations with the four cables.



- The propeller rotates clockwise if black+..... & red+..... are connected.
- It rotates counterclockwise if black+..... & red+..... are connected.



- How does the propeller rotation direction impact the movement of the boat?! We will get back to this later!

Now that you have your motor connected to the battery with the propeller installed, your boat is ready to be assembled!

Assemble the Boat

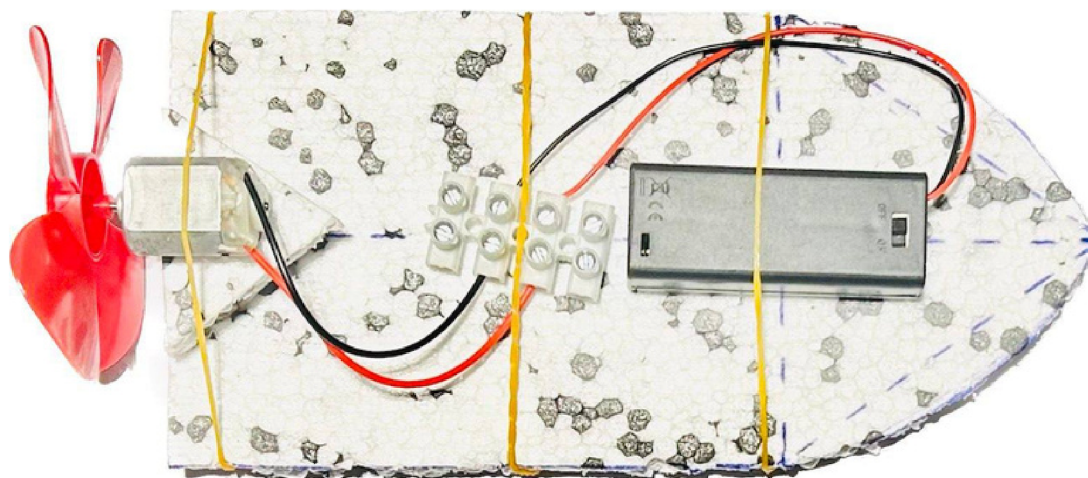


- Get your boat plate
- Get rubber bands or tape
- Get your electric circuit
- Get your chocolate egg



- Where would you like to place the motor on your boat? front, middle, back? Position the motor, battery case, and luster terminal on the boat. Use a rubber or tape to temporarily secure the electric circuit on the boat preventing the component from sliding into the water.

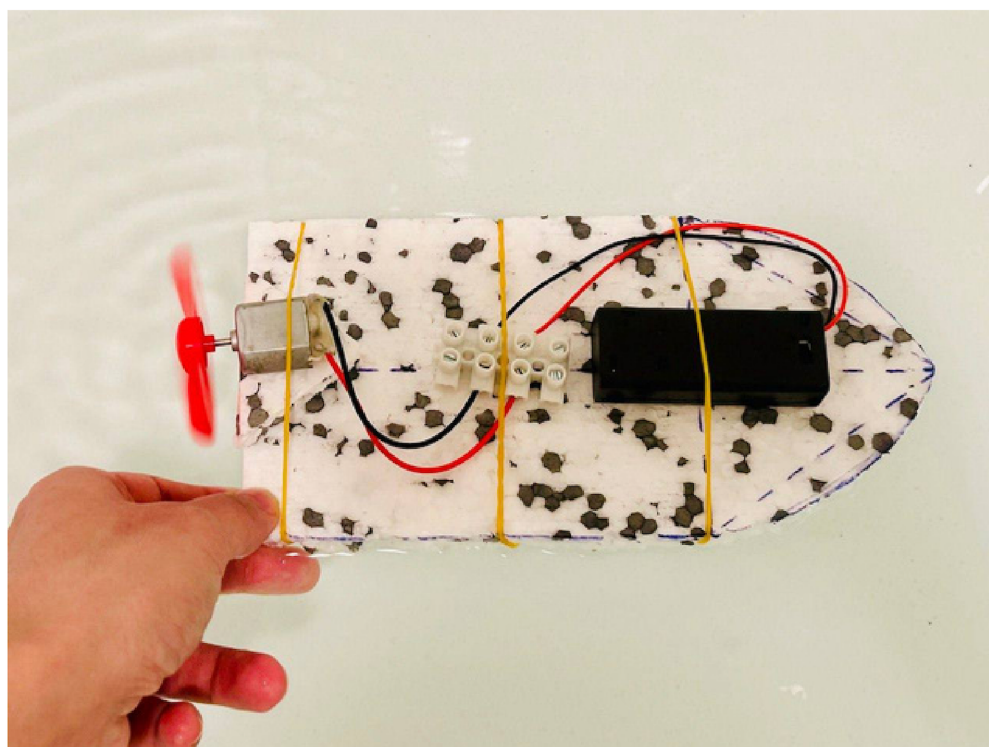
Your boat is ready for the first test!



Test the Boat



- Where would you like to test your boat? In a small pond or at home? Fill a big pot, bucket, or bathtub with some water. Switch on the power and place the boat on the water.



Does your boat float? Does it move forward or backward?



- If the cables of the same color are connected the boat moves
(forward/backward)
- If the cables of opposite colors are connected the boat moves
(forward/backward)



- Depending on your boat design, you may need to revise cable connections, the weight distribution of the components on your boat, or the boat shape. Was the boat test successful? Bravo! You are almost there! Have the first half of the chocolate and get ready for the next steps!

Final Assembly



- Get Glue, zip ties, tape, and screws,...

- Use glue, tape, or other materials to permanently fix the motor, battery case, and luster terminal onto the boat.

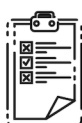
During the boat test, you may have observed that the boat doesn't necessarily move straight forward, it turns slightly to one side. What explains this behavior?



The propeller's rotation creates an air or water current which pushes the boat to move. The propeller's rotation in one specific direction (clockwise or counterclockwise) impacts the air or water current to push the boat in one direction.



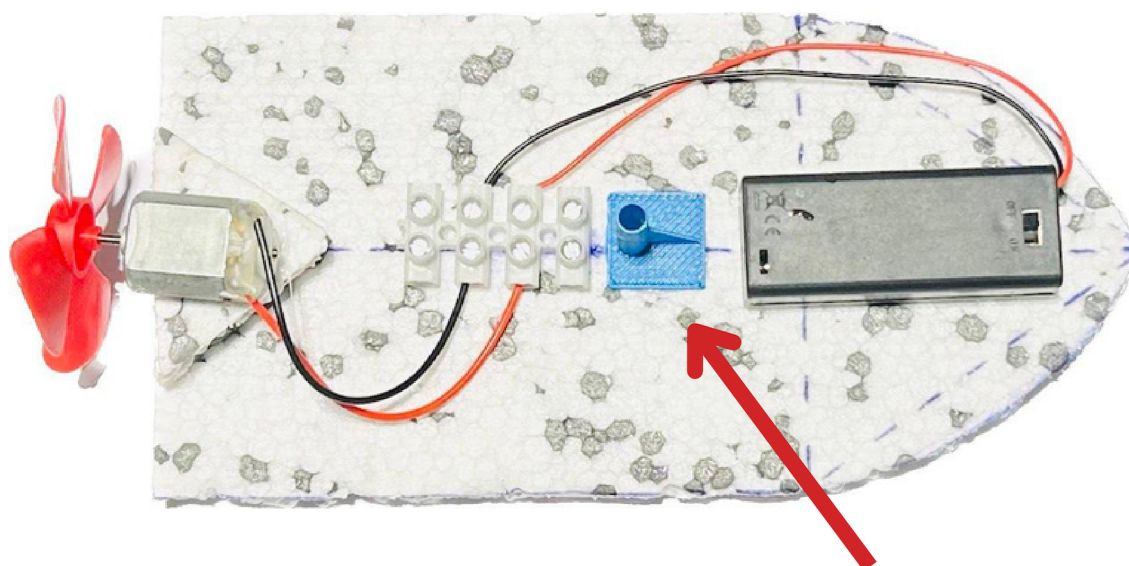
If you join the Grand Finale, we will use a guidance system to have all boats move from one side of our pond to the other: A thin rope will be pulled from one side to the other. Your boat therefore needs to have a mast/antenna that can reach over the level of this rope.



- Get a chopstick
- Get the antenna support



- Glue the antenna support on your boat. We recommend placing the antenna support at the front point of your boat.



- Try placing the antenna on your boat through the support.



Congratulations! You did a great job!
Celebrate your sweet achievement with the second half of your chocolate!



4. Make your boat stand out!



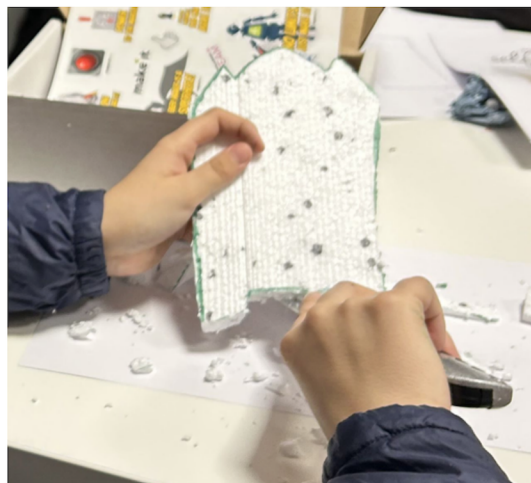
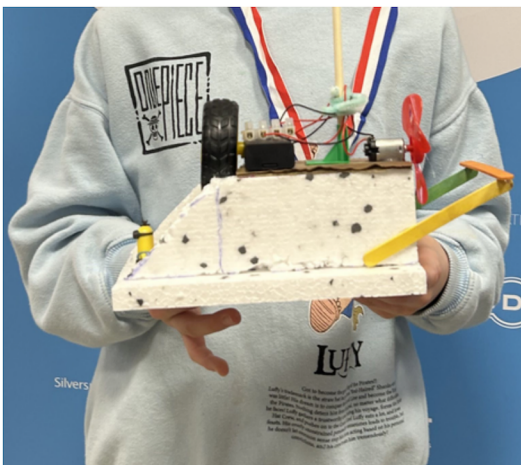
Now it's time to finalize your boat! What makes your boat unique? What needs to be built on top to complete the implementation of your idea? You are welcome to use further materials and components to advance your boat and to pimp it. We are looking forward to your ideas!



If you wish to win in one of our categories:

Visit www.makerbuzz.lu to discover the various categories of the challenge. This will enable you to customize your boat to match the category that inspires you the most! once your boat is ready:

1. Send a photo of your boat along with a brief description to office@makeit.lu.
2. Join the Grand Finale during the MakerFaire. There you can present your boat and exchange ideas with other fellow boatbuilders. You can also continue working on your boat on the spot.



Enjoy your boat-building adventure!

We can't wait to see you and your
boats at the Grand Finale
at the Luxembourg Maker Faire
on 18-19 May 2024
in Rosport.

Until then,
Your MakerBuzz Crew



Visit www.makerfaire.lu to learn more about the Maker Faire Luxembourg

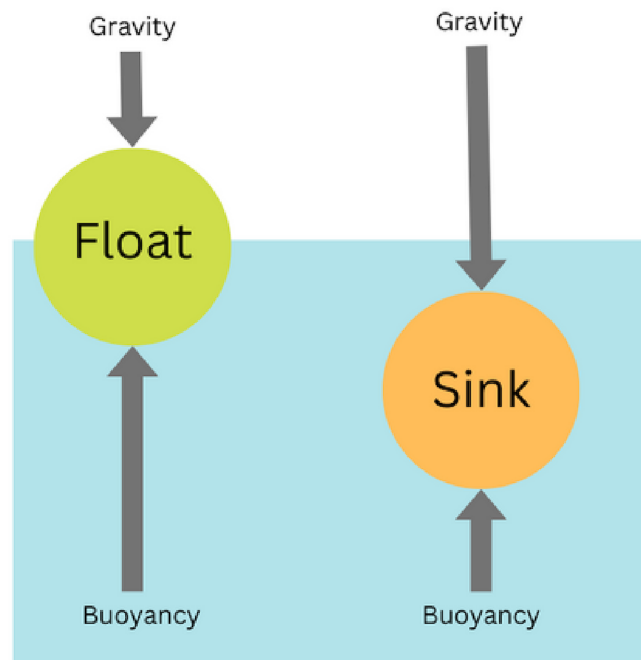


Dive deeper into the Science of Buoyancy!



When an object enters water, it moves water to the sides. The displaced water creates a force called buoyancy which pushes the object upward, same time object's weight pulls the object downward due to gravity.

If the buoyancy force is more than the gravity force the object floats, if the gravity force is more than the buoyancy force the object sinks. This is known as Archimedes principle.



How does the shape and weight of the boat determine if it floats or sinks in water?



- The boat shape features a large hull, the bottom part, which displaces a significant amount of water. This displacement creates a powerful upward buoyancy force, counteracting the pull of gravity trying to bring the boat down.
- Inside the hull, there's air, a substance with very low density. Despite the boat's size, the overall weight is relatively light because of this airy interior. This lower density compared to the water it displaces is a key factor. It ensures that the buoyancy force remains greater than the force of gravity, preventing the boat from sinking.
- In simpler terms, the boat's clever shape and lightweight design make it so buoyant that it effortlessly stays on the water's surface

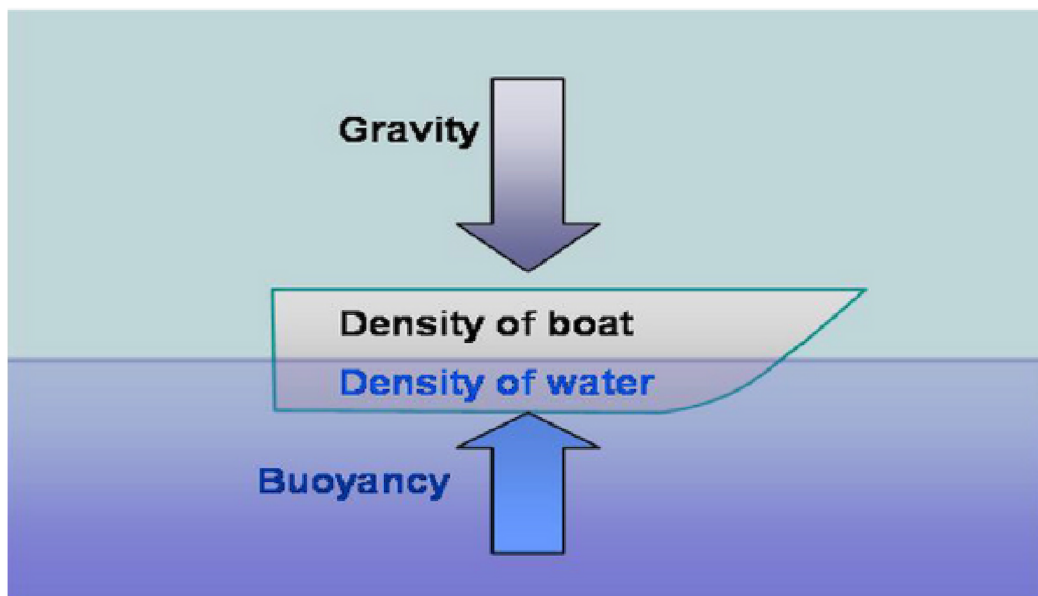


Image Source: Asiri, Saeed. (2022). Smart solutions for monitoring, control, and safety of swimming pools using a savvy boat. Measurement and Control.

Learn more about How Do Boats Float on Water:

